TMS30 Vet

Veterinary Telemetry System

Operator's Manual

Release date: 2023-06

IMPORTANT!

The product is for veterinary use only.

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Customer Service Department

Global Service Department

Company name:	Shenzhen Mindray Animal Medical Technology Co., Ltd.
Address:	Room 702, Tower 4, YESUN Intelligent Community III, No.1301-88 Guanguang Road, Xinlan Community, Guanlan Street, Longhua District, Shenzhen 518110, P. R. China
Website:	www.mindrayanimal.com
E-mail Address:	service@mindrayanimal.com
Tel:	+86 755-33997000

North American Service Department

Company name:	Mindray Animal Medical Technology North America Co., Ltd.
Address:	1200 MacArthur Blvd, Unit 302B, Mahwah, NJ 07430, USA
E-mail Address:	naservice@mindrayanimal.com
Tel:	1.800.864.5364

Preface

Manual Purpose

This manual contains the instructions necessary to operate the product safely and in accordance with its function and intended use. Observance of this manual is a prerequisite for proper product performance and correct operation and ensures animal and operator safety.

This manual is based on the maximum configuration and therefore some contents may not apply to your product. If you have any question, please contact us.

This manual is an integral part of the product. It should always be kept close to the equipment so that it can be obtained conveniently when needed.

Intended Audience

This manual is geared for clinical professionals who are expected to have a working knowledge of medical procedures, practices and terminology as required for monitoring of critically ill animals.

Illustrations

All illustrations in this manual serve as examples only. They may not necessarily reflect the setup or data displayed on your equipment.

Conventions

- ***Italic text*** is used in this manual to quote the referenced chapters or sections.
- **Bold text** is used to indicate the screen texts.
- → is used to indicate operational procedures.

Contents

1 Safety

1.1 Safety Information

WARNING

- **Indicates a potential hazard or unsafe practice that, if not avoided, could result in death or serious injury or property damage.**

CAUTION

- **Indicates a potential hazard or unsafe practice that, if not avoided, could result in minor personal injury or product/property damage.**

NOTE

- **Highlights important precautions and provides descriptions or explanations for better use of this product.**

1.1.1 Warnings

WARNING

- **To ensure the safe and continuous use of the equipment, follow the instructions in the manual.**
- **Do not use the equipment in the presence of oxygen-rich atmospheres, flammable or explosive materials to prevent fire or explosion.**
- **Do not use the equipment in conjunction with Electro Surgical Unit (ESU). If you use the equipment near ESU, the signal transmission from the equipment may be interrupted or interfered.**
- **To avoid the risk of heat burns, Do not use the equipment during the ESU.**
- **Do not expose the equipment to a Magnetic Resonance (MR) environment.**
  - **Thermal injury and burns may occur due to the metal components of the equipment which can heat during MR scanning.**

- **The equipment may present a risk of projectile injury due to the presence of ferromagnetic materials which can be attracted by the MR magnet core.**
- **The leadwires and electrodes will generate artifacts in the MR image.**
- **The equipment will not function properly due to the strong magnetic and radio frequency fields generated by the MR scanner.**

- **The equipment is intended to be used for a single animal at a time.**
- **Before using the equipment, the operator must check and verify that the equipment, connecting cables, and accessories can work properly and safely.**
- **Only the personnel trained and authorized by Mindray Animal Medical are qualified to repair and upgrade the equipment.**
- **Do not use cables, accessory cables or sensors if prior visual inspection reveals cable damage or the presence of liquid, lint or dust inside.**
- **Physiological waves and data, and prompts provided by the equipment should not be used as the sole basis for diagnosis or therapy decisions. They must be used in conjunction with clinical signs and symptoms. Misinterpretation of the measured values or other parameters can endanger the animal.**
- **Use only accessories specified in this manual.**
- **Route, wrap and secure the cables to avoid inadvertent disconnection, stumbling, entanglement or electrical interference.**
- **When the equipment is in use, do not take out the battery compartment or operate the equipment casually.**
- **Do not touch the animal and conductive parts on the equipment at the same time.**

1.1.2 Cautions

CAUTION

- **When the Central Monitoring System prompts "No CMS", check the network connections.**
- **When disposing of the packaging material, be sure to observe the applicable local waste control regulations and keep it out of children's reach.**
- **The animal's location is of vital importance for the equipment. The animal should be required to move in a specified area. If the animal is at the edge of or outside the network coverage range, unstable network connection may compromise the monitoring performance.**
- **Mindray Animal Medical takes no responsibility for controlling the radio frequency environment in a hospital. If interference for the operating frequency of telemetry equipment exists, the equipment performance will be affected. Exercise caution when selecting the operating frequency of all the**

wireless equipment in a hospital as this is very important to avoid mutual interference among them.

- **The electromagnetic field will affect performance of the equipment. Therefore, other devices used around this equipment must conform to the corresponding EMC requirements. Mobile phones, X-rays, microwave oven, or MRI machines are possible sources of interference as they emit higher levels of electromagnetic radiation.**
- **Install or carry the equipment properly to prevent machine falling, collision, violent vibration, or other damage caused by external mechanical force.**
- **Dry the equipment immediately in case of rain or water spray.**
- **When the animal carrying the equipment moves in a hospital, signal quality can be impacted by the construction materials used within the hospital.**
- **When the equipment and its accessories approach the end of their service life, be sure to dispose of them in accordance with applicable local laws and regulations or the hospital's regulations. If you have any questions concerning disposal of the equipment, please contact Mindray Animal Medical.**
- **The equipment may generate Radiated RF EM fields and RF communication conflicts if it is not installed or operated in the way described in this manual.**

1.1.3 Notes

NOTE

- **Install the equipment in a place that facilitates observation, operation, and maintenance.**
- **The software was developed in compliance with IEC 62304.**
- **In normal use, the operator shall stand in front of the equipment.**
- **This manual describes the equipment based on the most complete configuration. The equipment you purchase may not support some configuration or functions.**
- **Keep this manual somewhere near the equipment for convenient and prompt access.**

1.2 Equipment Symbols

Symbol	Description	Symbol	Description
SN	Serial number		Date of manufacture

Symbol	Description	Symbol	Description
LOT	Batch code		Standby
	Humidity limitation		Atmospheric pressure limitation
	Temperature limit		Refer to instruction manual/ booklet
	Stacking limit by number		Keep dry
	Direct current		Alternating current
	Non-ionizing electromagnetic radiation		Defibrillation-proof type CF applied part
IPX1	Protected against vertically falling water drops	IPX7	Protection against temporary immersion in water
CE	CE marking	UK CA	UKCA marking
SGS C US 801341	NRTL certification mark		Manufacturer
	The following definition of the WEEE label applies to EU member states only: the use of this symbol indicates that waste electrical and electronic equipment must not be disposed of as unsorted municipal waste and must be collected separately. By ensuring that this product is disposed of correctly, you will help prevent bringing potential negative consequences to the environment and human health. For more detailed information with regard to returning and recycling this product, please consult the distributor from whom you purchased the product		

The general meaning assigned to geometric shapes, safety colors and contrast colors for safety signs are as follows:

Geometric shape	Meaning	Safety color	Contrast color	Graphical symbol color
	Prohibition	Red	White	Black
	Mandatory action	Blue	White	White
	Warning	Yellow	Black	Black

NOTE

- **Some symbols may not appear on your equipment.**

2 Equipment Introduction

2.1 Intended Use

The TMS30 Vet Veterinary Telemetry System is intended for use on ambulatory patients to monitor the physiological data of ECG, pulse oxygen saturation (SpO_2), and pulse rate (PR). It can be worn on patients and used in vet cages.

The system is to be used in animal hospitals, such as general wards, PACU, ICU/CCU, etc.

WARNING

- **The equipment must be operated only by clinical professionals or under their guidance.**
- **The equipment must be used together with the Central Monitoring System of Mindray Animal Medical.**
- **If the values displayed on the Central Monitoring System differs from those displayed on the equipment, determine the animal's vital signs by alternative means and verify that all equipment is working correctly.**
- **As the equipment transmits data wirelessly, there might be a risk of data loss.**

2.2 Contraindications

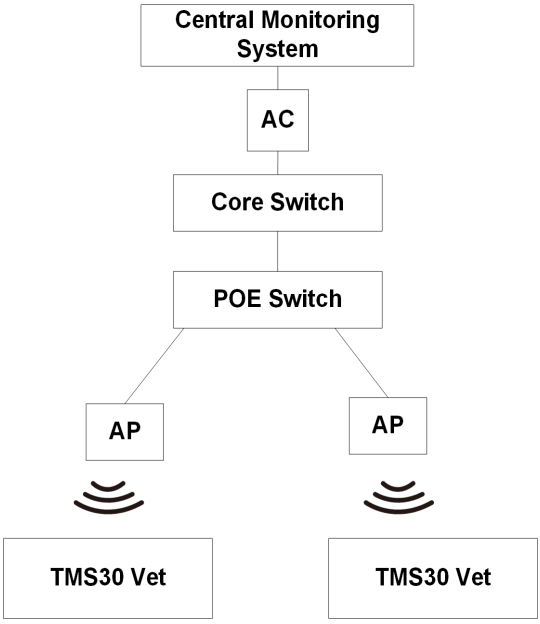
Not identified yet.

2.3 System Components

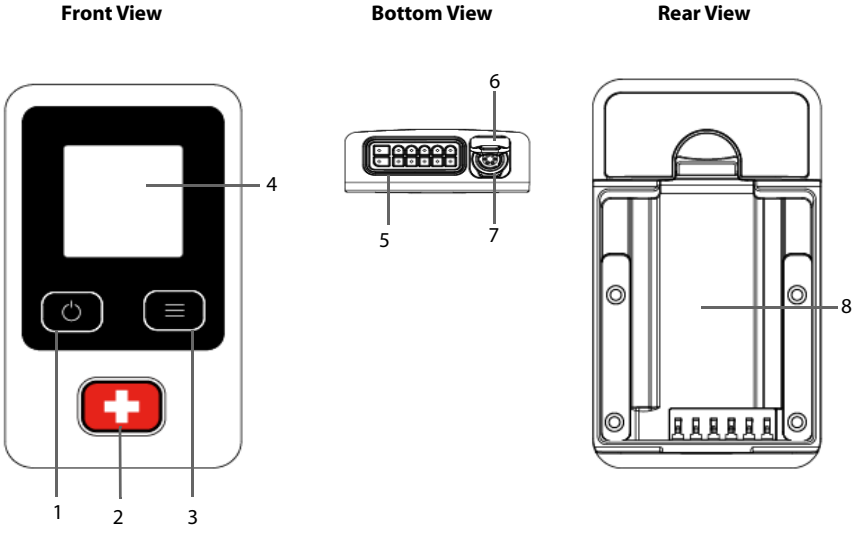
The system consists of telemetry transmitter, AP, AC, central charger and accessories.

The equipment is connected to the Central Monitoring System (Hereinafter called CMS) through the AP and AC. It transmits real-time data monitored by telemetry transmitter to the CMS and displays the data on the screen of the CMS.

The following figure shows the system components.


Central Monitoring System
AC
Core Switch
POE Switch
AP
AP
TMS30 Vet
TMS30 Vet

2.3.1 Telemetry Transmitter



No.	Description	Description
(1)	Power on/off and screen off key	◆ When the equipment is powered off, pressing this key will turn it on. ◆ If the screen display is on, press and hold this key for two seconds to display the power-off confirmation dialog box. ◆ If the screen display is on, pressing this key will turn it off. Note: Press the combination keys to turn the screen on. For details, see ***3.7 Turning the Display Screen On***.
	Upward key	On the System Info screen, press this key to browse the system information upward.
(2)	Function key	◆ Press this key to admit a new animal according to a prompt message. ◆ Used with other keys. For details, ***11.5 Viewing System Information***.

No.	Description	Description
(3)	Main menu key	◆ When the equipment is in standby mode, press this key to exit standby mode and return to main screen. ◆ When the equipment is in monitor mode, press this key to view other parameters and waveforms information, etc.
	Downward key	On the System Info screen, press this key to browse the system information downward.
(4)	Display screen	/
(5)	ECG the lead port	/
(6)	SpO_2 cap	Put on the SpO_2 cap when the SpO_2 sensor is not in use.
(7)	SpO_2 port	/
(8)	Battery compartment	Contain the lithium-ion battery or AA battery tray.

2.3.2 AP

The AP is used to bridge the equipment to the wired network. For details about the AP, see ***AC Config Tool Installation and Use Guide*** and ***Wireless Survey Tool Installation and Use Guide***.

2.3.3 AC

The AC is used to manage the AP, and connecting the CMS, etc, For details about the AC, see ***AC Config Tool Installation and Use Guide*** and ***Wireless Survey Tool Installation and Use Guide***.

2.3.4 Central Charger

The central charger is used to charge for lithium-ion battery. For details about the central charger, see Central Charger Operator's Manual.

2.3.5 Accessories

For details, see ***12 Accessories***.

3 Getting Started

WARNING

- **The equipment shall be installed by Mindray Animal Medical authorized personnel.**
- **The software copyright of the equipment is solely owned by Mindray Animal Medical. No organization or individual shall resort to altering, copying, or exchanging it or to any other infringement on it in any form or by any means without due permission.**
- **Only approved devices can be connected to this equipment. Among them, the switch connecting to the AP must meet the requirements of the applicable IEC or ISO standards Devices connected to this equipment must meet the requirements of the applicable IEC standards (e.g. IEC 62368-1 safety standards for information technology equipment and IEC 60601-1 safety standards for medical electrical equipment). The configurations of the devices must meet the requirements of the IEC 60601-1 medical electrical systems standard. Any personnel who connect devices to this equipment's signal input/output port is responsible for providing evidence that the safety certification of the devices has been performed in accordance to the IEC 60601-1. If you have any questions, please contact Mindray Animal Medical.**
- **If it is not evident from the equipment specifications whether a particular combination with other devices is hazardous, for example, due to summation of leakage currents, please consult the Mindray Animal Medical or else an expert in the field, to ensure the necessary safety of animals and all devices concerned will not be impaired by the proposed combination.**
- **Contact Mindray Animal Medical to relocate this equipment.**
- **Only Mindray Animal Medical authorized personnel can update the equipment.**

3.1 Unpacking and Checking

Before unpacking, examine the packing case carefully for signs of damage. If any damage is detected, contact the carrier or Mindray Animal Medical.

Open the package and remove the device and accessories carefully. Check all materials against the packing list. Check for any mechanical damage and item intactness. If you have any questions, contact Mindray Animal Medical.

WARNING

- **The equipment may be subject to microbacteria contamination during storage, transport, or use. Prior to use, please verify that the packages are intact, especially the packages of single use accessories. In case of any damage, do not apply it to animals.**

NOTE

- **Install the equipment in a place that facilitates observation, operation, and maintenance.**
- **Keep this manual somewhere near the equipment for convenient and prompt access.**
- **Save the packing case and packaging material as they can be used if the equipment must be reshipped.**

3.2 Environmental Requirements

The operating environment of the equipment must meet the requirements specified in this manual.

The operating environment of the equipment should be reasonably free from noises, vibration, dust, corrosive, flammable and explosive substances.

When the equipment is moved from one place to another, condensation may occur as a result of temperature or humidity difference. In this case, never start the equipment before the condensation disappears.

WARNING

- **Make sure that the operating environment of the equipment meets the specifications in this manual. Otherwise, unexpected consequences, e.g. damage to the equipment, could result.**

NOTE

- **The equipment transmits data through wireless communication technology. External radio frequency and network interference may result in occasional data dropout of waveform data. This is a normal phenomenon. Contact Mindray Animal Medical for any questions regarding the electromagnetic environment in the field where the equipment is to be installed.**

3.3 Installing the Batteries

The operator can use three AA batteries or an accompanying rechargeable lithium-ion battery to power the equipment.

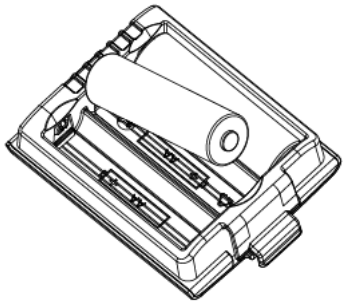
WARNING

- **Always keep the battery compartment dry.**
- **The lithium-ion battery or AA battery tray should be placed in the correct direction and should not be installed reversely. Otherwise, the waterproof ring surrounding the battery tray edge may be broken to affect the waterproof performance.**
- **Do not place the AA battery to battery compartment in the reverse positive and negative direction. Otherwise, startup error or other unacceptable risks may occur.**
- **Use only AA battery or specified lithium-ion battery. Otherwise, the battery symbol may be display inaccurately.**

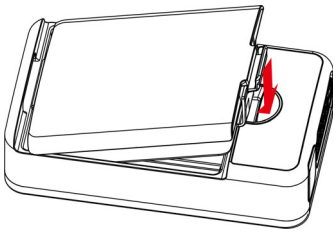
3.3.1 Installing the AA Batteries

To install the AA batteries, follow this procedure:

1. Insert three AA batteries into the AA battery tray. While placing the batteries, make sure that positive and negative polarities are matched with those on the battery tray as shown in below figure.



2. Align the metal terminal on the battery tray with that on the battery compartment, and place it into the battery compartment.
3. Press down the battery tray until you hear a “click”.



3.3.2 Installing the Lithium Battery

Make sure the lithium battery is charged prior to use. The lithium battery should be fully charged prior to first use. For details about the charging methods for the lithium battery, see ***9.8 Maintenance***.

To install the lithium batteries, follow this procedure:

1. Align the metal terminal of the lithium battery with that on the battery compartment, and place it into the battery compartment.
2. Press down the battery tray until you hear a "click".

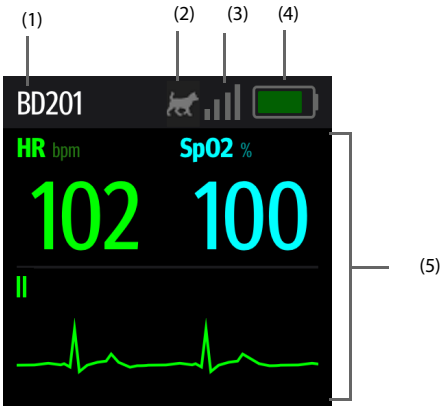
3.4 Turning On the Equipment

When the lithium battery or AA battery tray is properly installed into the compartment, the equipment will be powered on automatically. After startup, the equipment beeps, the Mindray Animal Medical icon appears, and then the **Patient Info** menu appears.

3.5 Screen Display

3.5.1 Normal Screen

The following figure shows the normal screen:



(1) Animal information area

This area shows animal ID and bed number.

(2) Ambulatory symbol: indicates that the animal is in ambulatory status.

(3) WMTS symbol: indicates the connection status of wireless network. For the details about WMTS symbol, see ***3.5.2 On-screen Symbols***.

(4) Battery symbol: indicates battery capacity. For details, see ***9.4 Checking the Battery Charge Status***.

(5) Prompt information or waveform area:

- Displays parameter value and waveform when the equipment is in normal status.
- Displays prompt information when the equipment is in abnormal status.

3.5.2 On-screen Symbols

The following table lists the on-screen symbols displayed on the screen:

Symbol	Description	Symbol	Description
	The battery power is to be depleted.		The battery works properly and the green part represents the remaining battery capacity.

Symbol	Description	Symbol	Description
	The equipment has been connected to WMTS wireless network and the signal coverage is very good. Stable data transmission can be guaranteed.		The equipment has been connected to WMTS wireless network and the signal coverage is very good. Stable data transmission can be guaranteed.
	The equipment has been connected to WMTS wireless network and the signal coverage can basically meet the requirements. Stable data transmission can be guaranteed.		The equipment has been connected to WMTS wireless network and the signal coverage is weak. Wireless offline may occur.
	The equipment has been connected to WMTS wireless network and the signal coverage is very weak. Wireless offline would occur.		The equipment is not connected to WMTS wireless network
	The animal is in moving status.	/	/

3.6 Turning the Display Screen Off

The operator can press  key to turn the display screen off. When the display screen is off, the equipment does not provide any information but all the measurement data will be sent to the CMS.

NOTE

- **When [Auto Enter Monitor Mode] to [No Central Monitoring] at the CMS, the operator can not turn the display screen off manually by pressing key if the equipmen disconnets to the CMS.**

3.7 Turning the Display Screen On

When the display screen is off, press  and  key at the same time for 2 seconds to turn on it.

WARNING

- **When the display screen is on, its temperature will be elevate. It may cause scalding to an animal if the display screen in contact with the animal' s skin for a long time. When the animal needs to be monitored with the display screen on for a long time, do not let the display screen touch animal's skin.**

3.8 Starting Monitoring an Animal

After turning on the equipment, follow this procedure to monitor an animal:

1. Admit an animal.
2. At the CMS, check the animal settings, ensure that the alarm limit and animal type settings are correct, and change the settings as desired.
3. Starting monitoring. For more information, see the corresponding measurement chapters.

3.9 Stopping Monitoring an Animal

To stop monitoring a parameter, follow this procedure:

1. Remove the accessories from an animal.
2. Disconnect the accessories from the equipment.

3.10 Entering the Standby Mode

If the operator wants to stop monitoring an animal temporarily but does not want to turn off the equipment, standby mode can be used.

Perform this operation at the CMS.

3.11 Using the Pouch

CAUTION

- **If an animal needs to take a shower, check the equipment as described in *11.3 Regular Check* before showering.**

During normal use, use the veterinary telemetry pouch specified by Mindray Animal Medical to fix the equipment.

For details about how to use the veterinary telemetry pouch, see ***Veterinary Telemetry Pouch Instructions For Use***.

3.12 Turning Off the Equipment

To turning off the equipment, follow this procedure:

1. Ensure that the animal monitoring is completed.
2. Disconnect the ECG cables and SpO_2 sensors from the animal.
3. Press and hold the  key for 2 seconds to pop up shutdown confirmation dialog box.
4. Press and hold the  key to turn off the equipment.

NOTE

- **The equipment will be turned on automatically after an accidental power failure. If the operator choose to admit a new animal after power-on, the equipment will load default setting. If the operator choose the current animal, the equipment will reserve the animal configure data before power-off.**

4 Managing Animals

4.1 Admitting the Animal

The equipment admits a new animal in the following situation:

- After restarting and the display screen prompts a message, press key to admit a new animal.
- After the CMS discharge an animal and the display screen prompts a message, press key to admit a new animal. For the details about discharging an animal, see ***BeneVision CMS Vet Veterinary Central Monitoring System Operator's Manual***.

The operator can admit an animal at the CMS directly.

After the animal is admitted, the operator need to edit the animal information at the CMS. For details about admitting and editing the animal information at the CMS, see ***BeneVision CMS Vet Veterinary Central Monitoring System Operator's Manual***.

4.2 Discharging the Animal

Before monitoring a new animal, the operator should discharge the old animal first. After the animal is discharged, the equipment restores to default department settings.

The operator need to discharge the animal at the CMS. For details about discharge the animal, see ***BeneVision CMS Vet Veterinary Central Monitoring System Operator's Manual***.

WARNING

- **Always discharge the old animal before admitting a new animal. Otherwise, the data of the next animal will be stored in the data of the current animal.**

5 Monitoring ECG

5.1 Overview

The electrocardiogram (ECG) measures the electrical activity of the heart and displays it on the monitor as waveforms and numerics. ECG monitoring provides 3-lead ECG monitoring.

NOTE

- **The equipment does not support automatic diagnosis and detection of ST-segment analysis, arrhythmia analysis, and QT measurements.**

5.2 Safety Information

WARNING

- **Make sure the conductive parts of electrodes and associated connectors, including the neutral electrode, do not contact any other conductive parts including earth. In particular, make sure that all of the electrodes are attached to the animal.**

CAUTION

- **Only use parts and accessories specified in this manual. Follow the Instructions for Use and adhere to all warnings and cautions.**
- **Periodically inspect the electrode application site to ensure skin integrity. If the skin quality changes, replace the electrodes or change the application site.**
- **Interference from ungrounded instrument near the animal and electrosurgery interference can induce noise and artifact into the waveforms.**

NOTE

- **After defibrillation, the waveform recovers within 10 seconds applied in accordance with the manufacturer's instructions for use.**

5.3 Preparation for Monitoring ECG

5.3.1 Preparing the Animal's Skin

Proper skin preparation is essential in obtaining an accurate ECG reading. Electrode sites should be clean and dry and should provide a smooth flat surface. To properly prepare the skin, choose flat areas and then follow this procedure:

1. Shave hair from skin at chosen electrode sites.
2. Gently rub skin surface at sites to remove dead skin cells.
3. Thoroughly cleanse the site with a mild soap and water solution.
4. Dry the skin completely before applying electrodes.

5.3.2 Applying Electrodes

Perform the following procedure:

1. Check that electrode packages are intact and the electrodes are not past the expiry date. Make sure the electrode gel is moist. If you are using snap electrodes, attach the snaps to the electrodes before placing electrodes on the animal.
2. Place the electrodes on the prepared sites. Make sure that all electrodes have good skin contact.
3. Follow the procedure below to connect the ECG leadwire plug to the ECG lead port of the equipment.
   a Align the ECG leadwire plug with the ECG connector.
   b Insert the ECG leadwire plug into the ECG lead port.

WARNING

- **Insert the ECG lead set into the ECG connector firmly. The following performances may be affected by a weak connection:**
  - **ECG signal quality**
  - **Water resistance**
- **Do not add other conductive gels and pastes to the conductive adhesive surface of the electrodes.**
- **Do not use the ECG leadwire to move or lift the equipment. This may cause the equipment to fall, thus damaging the equipment or injure the animal.**

NOTE

- **Store the electrodes at room temperature and open them just before use.**
- **Apply the electrodes to an animal immediately after unpacking it.**

- **Give special attention to the type of electrode used. Because some electrodes may generate greater electric offset due to polarization.**
- **Give special attention to the type of electrode used. Because some electrodes may generate greater electric offset due to polarization.**
- **Do not use electrodes of different metallic materials.**
- **When the polarization voltage is too high, the CMS will generate a"Check Leads" technical alarm to indicate the invalid ECG status.**
- **Avoid placing electrodes directly over bone prominences or over any high activity movement areas such as shoulders or arms because muscle motion produces electrical activity.**
- **Using a Transcutaneous Electrical Nerve Stimulator (TENS): since A tens UNIT transmits electrical impulses, avoid placing ECG electrode near the TENS electrodes. ECG electrodes may need to be repositioned and the ECG lead viewed may need to be adjusted until the optimum ECG tracing is obtained.**
- **It is recommended that the electrodes be changed at least every 24 to 36 hours to maintain proper contact with the skin. Some animals may require more frequent changing. Do not reapply disposable electrodes. Try to avoid reusing the exact same electrode site during reapplication. If an electrode becomes wet with fluid, change the electrode.**

5.3.3 Lead Wire Color Code

The following table lists the color coding of leadwires for both AHA and IEC standards.

Lead	AHA		IEC	
	Label	Color	Label	Color
Left hind leg	LL	Red	F	Green
Left foreleg	LA	Black	L	Yellow
Right foreleg	RA	White	R	Red

5.3.4 Electrode Placement

NOTE

- **When using the Mindray Animal Medical veterinary telemetry pouch, confirm the electrode placement according the electrode snap hole of the pouch.**

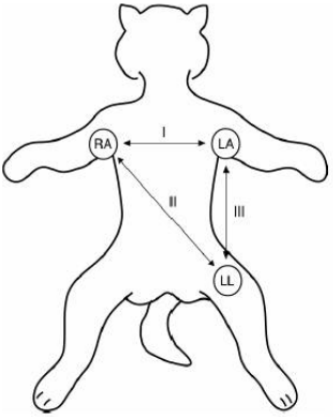
For lead placement, the ECG algorithm works best when the animal's R wave is significantly larger than the P wave or the T wave. If the R wave is not significantly larger than other lower voltage waves on the ECG tracing, the telemetry monitor may have some difficulty in

identifying the appropriate waves. For some animals, the operator need to adjust electrode placement and/or the viewed ECG lead to obtain a significant R wave.

In this manual, electrode placement is illustrated using AHA and IEC standards.

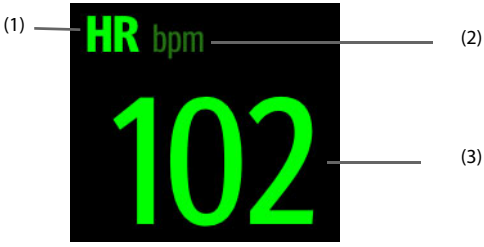
Taking AHA naming convention as an example, the following is an electrode configuration when a 3-leadwire cable is used:

- RA placement: on the right foreleg
- LA placement: on the left foreleg
- LL placement: on the left hind leg



5.4 ECG Screen Display

5.4.1 Parameter Area



(1) Parameter label

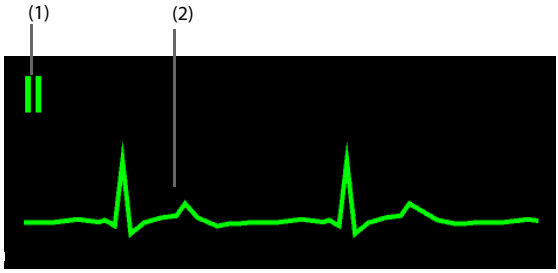
(2) HR unit

(3) HR value

NOTE

- **If the HR measurement is invalid, "- - -" displays in place of the HR value.**
- **The HR value displays "0" when the HR value is less than 15 bpm.**

5.4.2 Waveform Area



(1) ECG lead label

(2) ECG waveform

WARNING

- **The waveform is only used for indicating whether the ECG accessories are connected. It can not used as the sole basis for diagnosis or therapy decisions. For the actual waveform, see the CMS' display screen.**

6 Monitoring Pulse Oxygen Saturation (SpO_2)

6.1 Overview

SpO_2 monitoring is a non-invasive technique used to measure the amount of oxygenated hemoglobin and pulse rate by measuring the absorption of selected wavelengths of light. The light generated in the probe passes through the tissue and is converted into electrical signals by the photo detector in the probe. The SpO_2 module processes the electrical signal and displays a waveform and digital values for SpO_2 and pulse rate. This equipment is calibrated to display functional oxygen saturation.

6.2 Safety Information

WARNING

- **Check the SpO_2 sensor and the cable before using. Do not use them for SpO_2 monitoring in case of damage, block, deterioration or visible contamination. If any, clean the SpO_2 sensor or remove the dirt before use. If necessary, replace the SpO_2 sensor.**
- **When a trend toward animal deoxygenation is indicated, analyze the blood samples with a laboratory co-oximeter to completely understand the animal's condition.**
- **Do not use SpO_2 sensors during magnetic resonance imaging (MRI). Its induced current could potentially cause burns. The MRI unit may affect the accuracy of the SpO_2 measurements. The SpO_2 sensor may affect the MRI image.**
- **For the animal with prolonged continuous monitoring, inspect the SpO_2 sensor site every 2 hours and move the sensor if the skin quality changes. Change the application site every 4 hours. For animals with poor peripheral blood circulation or sensitive skin, inspect the SpO_2 sensor site more frequently. As the prolonged continuous monitoring may increase the risk of undesirable changes in skin characteristics, such as irritation, reddening, blistering or burns.**
- **Performance of the SpO_2 sensor may be compromised by motion. Try to keep the animal still and avoid the measured site suffering excessive motion.**
- **Always choose a site that is well perfused and will completely cover the detector window of the SpO_2 sensor.**

- **Clean the animal application site before use, and apply the SpO_2 sensor after the application site is completely dry.**
- **Try to place the SpO_2 sensor on a limb without an arterial catheter, NIBP cuff, or IV line.**
- **Tight the clips may cause venous pulsation, obstructed blood circulation, pressure marks, pressure necrosis, artifacts and inaccurate measurement, while loose sensor may lead to erroneous optical alignment or falling off.**
- **If the sensor site has very low perfusion, the SpO_2 reading may be inaccurate.**
- **Do not bend the cable for a long time. When the SpO_2 sensor is not applied to an animal, the equipment may display unexpected intermittent readings if the SpO_2 sensor moves, ambient light changes, or is subject to electromagnetic interference.**
- **Many animals have poor peripheral perfusion due to factors such as hypothermia, hypovolemia, severe vasoconstriction, and decreased cardiac output. These signs may cause SpO_2 to have no vital signs readings.**
- **Only use parts and accessories specified in this manual. Follow the Instructions for Use and adhere to all warnings and cautions.**

NOTE

- **A functional tester or SpO_2 simulator can not be used to assess the SpO_2 accuracy for both SpO_2 sensor and this equipment.**
- **A functional tester or SpO_2 simulator can not be used to determine the accuracy for both pulse oximeter and pulse SpO_2 probe. The accuracy of pulse oximeter and pulse SpO_2 probe needs to be verified by clinical data.**
- **The SpO_2 sensor and extension cable used with this equipment are validated and tested together with this equipment for ISO 80601-2-61 compliance.**

6.3 Measurement Limitation

If you doubt the measurement accuracy, adopt other methods to check the animal's vital signs, and then check the equipment and SpO_2 sensor.

The following factors may influence the accuracy of SpO_2 measurement:

- Animal physiological characteristics
  - Cardiac arrest
  - Hypotension
  - Darkly pigmented skin
  - Shock
  - Severe vasoconstriction
  - Hypothermia

- Severe anemia
- Ventricular septal defects (VSD)
- Venous pulsations
- Poor perfusion

■ Interfering substances

- Intravascular dyes (such as indocyanine green, methylene blue, indigo carmine, etc.)
- Dysfunctional hemoglobin, such as carboxyhemoglobin (COHb) and methemoglobin (MetHb)

■ Environmental conditions

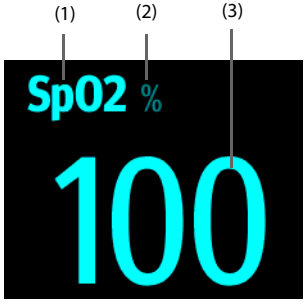
- Excessive ambient light
- Electrosurgery equipment
- Defibrillation (may cause inaccurate reading for a short amount of time)
- Excessive animal/sensor motion
- Electromagnetic field

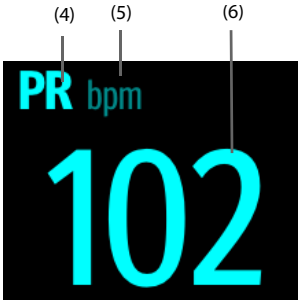
■ Others

- Inappropriate positioning of the SpO_2 sensor, or use of incorrect SpO_2 sensor
- Cuff or arterial blood pressure measurement device on the same limb as the SpO2 sensor

6.4 SpO_2 Screen Display

6.4.1 Parameter Area





(1) Parameter label

(2) SpO_2 unit

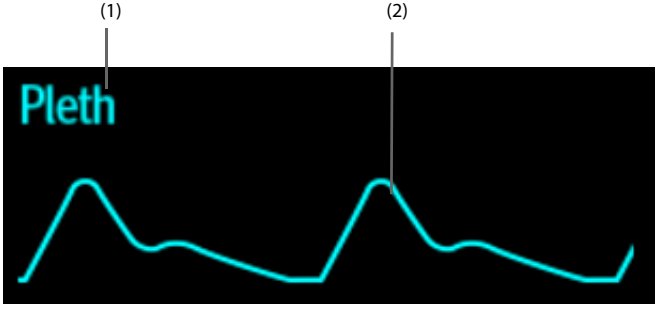
(3) SpO_2 value: percentage of oxygenated hemoglobin in relation to the sum of oxyhemoglobin and deoxyhemoglobin.

(4) Pulse rate (PR) label

(5) PR unit

(6) PR value: detected pulsations per minute.

6.4.2 Waveform Area



(1) Parameter label

(2) Pleth waveform (Pleth): visual indication of animal's pulse. The waveform is not normalized.

In the waveform area, the equipment automatically scales the SpO_2 waveform data area to maximize the vertical height of the Pleth waveform for the data range.

6.5 Preparing for SpO_2 Monitoring

Perform the following procedure:

1. Select an appropriate SpO_2 sensor according to the animal category and weight.

2. Clean the contact surface of the reusable sensor and animal application site.
3. Apply the sensor to the animal according to the Instruction for Use of the sensor.
4. Select an appropriate extension cable according to the connector type and connect the sensor to the extension cable.
5. Plug the cable into the SpO_2 connector of the equipment.

WARNING

- **Only use SpO_2 sensors specified in this manual. Use other SpO_2 sensors may result in degraded performance.**
- **Before measurement, unplug the extension cable.**
- **During defibrillation, do not disconnect the SpO_2 sensor connector from equipment.**
- **If the SpO_2 sensor is too tight because the application site is too large or becomes too large due to edema, excessive pressure may result in venous congestion distal from the application site, leading to interstitial edema and tissue ischemia.**

NOTE

- **Improper SpO_2 sensor placement may affect the measurement accuracy.**

7 Networked Monitoring

7.1 Overview

Using WMTS, the equipment connects to the CMS through AP and AC. After connected to the CMS, the equipment transmits real-time data monitored to the CMS and displays the data on the screen of the CMS. At the CMS, the operator can review the monitoring data, print report, manage animal, view and set the physiological alarm, etc.

This chapter mainly describes the operations such as how to connect this equipment to the CMS, and the common operations how to set alarms and parameters at the CMS.

For details about other operations at the CMS, see ***BeneVision CMS Vet Veterinary Central Monitoring System Operator's Manual***.

7.2 Safety Information

CAUTION

- **The wireless network designing, deploying, debugging and maintenance must be performed by Mindray Animal Medical service personnel or authorized technicians.**
- **The presence of obstacles (such as bearing wall) may affect the data transmission and even lead to network disconnection.**
- **The wireless network deploying shall comply with local laws and regulations.**
- **Ensure the safety of network encryption (such as password), and do not allow unauthorized personnel to obtain encryption information.**
- **If wireless network signal is poor, there may be a risk of CMS data loss.**
- **RF interference may result in wireless network disconnection.**
- **Disconnecting from the network may result in CMS data loss and function failure. Check the equipment in case of network disconnection and solve the network problem as soon as possible.**

7.3 Connecting to the CMS

For the details about how to connect this equipment to the CMS, see ***Wireless Survey Tool Installation and Use Guide*** and ***AC Config Tool Installation and Use Guide***.

7.4 Common Operations

When the equipment is successfully connected to the CMS, at the CMS, the operator can set whether to generate an alarm when an animal's monitored data exceeds the limits and search the equipment location.

7.4.1 Triggering an Alarm Reminding Animals' Location

Select **System Setup** → **Network** → **AP Management** at the CMS to enable the functionality of triggering an alarm when animals enter or move out of the restricted area.

7.4.2 Locating the Equipment

The operator can view the equipment location by selecting  symbol at the top of the **ViewBed** screen of the CMS. For details, see ***BeneVision CMS Vet Veterinary Central Monitoring System Operator's Manual***.

7.4.3 Switching On or Off Parameters

The operator can manually switch on or off a parameter at the CMS.

Select **Screen Setup** → **Parameters On/Off** at the bottom of the **ViewBed** screen, and switch on or off desired parameters. All parameters switch on by default.

When a parameter is switched off, the corresponding parameter module stops working, and the CMS and telemetry transmitter will not display this parameter value and waveform.

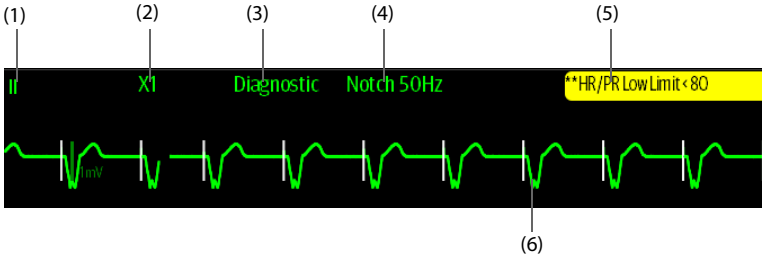
NOTE

- **ECG parameter is switched on by default and can not be switched off.**
- **When a parameter is switched off, even if the corresponding accessories are plugged in, this parameter can not be monitored.**

7.5 Monitoring ECG, Arrhythmia, ST and QT/QTc

Once the equipment is connected to the CMS successfully, the operator can view and set ECG monitoring information on Viewbed screen of the CMS.

7.5.1 ECG Display



(1) ECG lead label

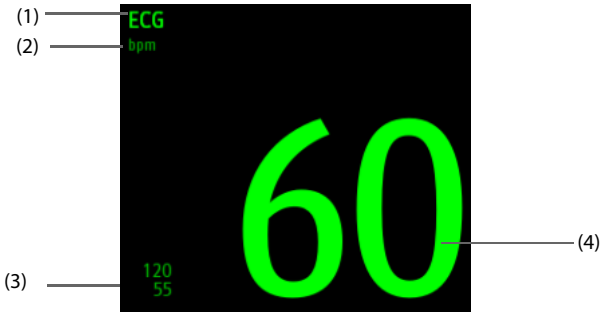
(2) ECG waveform gain

(3) ECG filter mode

(4) Notch filter status

(5) Alarm message area

(6) ECG waveform



(1) Parameter label

(2) HR unit

(3) HR alarm Limit

(4) HR value

NOTE

- **The ECG numeric area and waveform area are configured to be different for different lead type and ECG settings.**

7.5.2 Changing ECG Settings

The operator need to change the ECG settings at the CMS.

7.5.2.1 Setting ECG Alarm Properties

Perform the following procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select the Alarm tab to set alarm properties as desired.

7.5.2.2 Selecting the Leads of Displayed ECG Waveforms

Perform the following procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select the **Setup** tab to set the lead of each ECG waveform.
3. If more than three ECG waveforms are displayed, select the **More Leads** tab, and then select ECG to set leads of other ECG waveforms.

The waveform of selected lead should have the following characteristics:

- The QRS complex should be either completely above or below the baseline and it should not be biphasic.
- The QRS complex should be tall and narrow.
- The P waves and T waves should be less than 0.2 mV.

CAUTION

- **Ensure that the optimal leads with the best waveform amplitude and the highest signal-to-noise ratio have been selected. Selecting the optimal leads is important for detecting beats, classifying beats, and detecting ventricular fibrillation.**

7.5.2.3 Changing ECG Waveform Size

If the ECG waveform is too small or clipped, the operator can change its size by selecting an appropriate gain setting. To do so, follow this procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **Setup** tab.
3. Select the **ECG Gain** to set the size of each ECG waveform.
4. If more than three ECG waveforms are displayed, select the **More Leads** tab, and then select **ECG Gain** to change the size of other ECG waveforms. If you select **Auto**, the CMS automatically adjusts the size of the ECG waveforms.

7.5.2.4 Changing ECG Waveform Speed

Perform the following procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **Setup** tab.

3. Set **Speed**.

7.5.2.5 Setting the ECG Filter

Perform the following procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **Setup** tab.
3. Set **Filter**.
   - **Monitor**: used under normal measurement conditions.
   - **ST**: recommended for ST monitoring.
   - **Exercise**: recommended for active animal and use when the signal is subject to large interference.

7.5.2.6 Switching On or Off the Notch Filter

The notch filter removes the line frequency interference. To switch on or off the notch filter, follow this procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **Setup** tab.
3. Switch on or off **Notch Filter**.

7.5.2.7 Adjusting the Minimum QRS Detection Threshold

To avoid false asystole alarm due to low R wave amplitude, and to avoid tall T waves and P waves being mistaken for QRS complexes, the CMS provides a means to manually adjust the minimum QRS detection threshold.

To adjust the minimum QRS detection threshold, follow this procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **QRS Threshold** tab.
3. Select up or down arrow buttons to adjust the minimum threshold for QRS detection.

Selecting **Default** resets the QRS threshold to the default value (0.16 mV).

CAUTION

- **The QRS detection threshold settings affect arrhythmia detection, ST, QT/QTc detection and heart rate calculation sensitivity.**
- **If QRS amplitude is low, the equipment might not be able to calculate heart rate and false asystole calls may occur.**

7.5.3 Monitoring Arrhythmia

Arrhythmia events can only be displayed and set at CMS.

7.5.3.1 Arrhythmia Safety Information

WARNING

- **Heart rate reading may be affected by cardiac arrhythmias. Do not rely entirely on heart rate alarms when monitoring animals with arrhythmia. Always keep these animals under close surveillance.**
- **The arrhythmia analysis program may incorrectly identify the presence or absence of an arrhythmia. Therefore, a physician must analyze the arrhythmia information with other clinical findings.**

CAUTION

- **Since the arrhythmia detection algorithm sensitivity and specificity are less than 100%, sometimes there may be some false arrhythmias detected and also some true arrhythmia events may not be detected. This is especially true when the signal is noisy.**
- **The ECG size and minimum QRS detection threshold settings affect arrhythmia detection and heart rate calculation sensitivity.**
- **If QRS amplitude is low, the equipment might not be able to calculate heart rate and false asystole calls may occur.**
- **During the learning phase of the algorithm, arrhythmia detection may not be available. Thus, the operator should closely monitor animal's condition during and for several minutes after the learning phase to allow the algorithm to reach optimal detection performance.**

7.5.3.2 Arrhythmia Events

This section lists all arrhythmia events and their criteria after the equipment connects to the CMS.

Lethal Arrhythmia Events

Arrhythmia Message	Description
Asystole	No QRS complex detected within the set time interval in the absence of ventricular fibrillation or chaotic signal.
V-Fib/V-Tach	A fibrillatory wave for 6 consecutive seconds. A dominant rhythm of adjacent PVCs and the ventricular rate is greater than the V-tach rate limit.

V-Tach	The number of consecutive PVCs is greater than or equal to the V-Tach PVCs limit, and the ventricular rate is greater than or equal to the V-Tach rate limit.
Vent Brady	The number of consecutive PVCs is greater than or equal to V brady PVC limit and the ventricular rate is less than the V brady rate limit.
Extreme Tachy	The heart rate is greater than the extreme tachycardia limit.
Extreme Brady	The heart rate is less than the extreme bradycardia limit.

Nonlethal Arrhythmia Events

Arrhythmia Message	Description
R on T	R on T PVC is detected.
Run PVCs	More than two consecutive PVCs, but lower than the V brady PVCs limit, and the ventricular rate is lower than the V-Tach rate limit.
Couplet	A Pair of PVCs detected in between normal beats.
Multiform PVC	Multiform PVCs detected in Multif. PVC's Window (which is adjustable).
PVC	One PVC detected in between normal beats.
Bigeminy	A dominant rhythm of N, V, N, V, N, V.
Trigeminy	A dominant rhythm of N, N, V, N, N, V, N, N, V.
Tachy	The heart rate is greater than the tachycardia limit.
Brady	The heart rate is lower than the bradycardia limit.
Nonsus V-Tach	The number of consecutive PVCs is lower than the V-Tach PVCs limit but greater than 2, and the ventricular rate is greater than or equal to the V-Tach Rate limit.
Vent Rhythm	The number of consecutive PVCs is greater than or equal to the V Brady PVCs limit, and ventricular rate is greater than or equal to the V Brady Rate limit but lower than V-Tach Rate limit.
Pause	No QRS complex is detected within the set time threshold of pause.
Irr Rhythm	Consistently irregular rhythm (N, irregular RR interval change is greater than 12.5%)
PVCs/min	PVCs/min exceeds high limit.

Arrhythmia Message	Description
Pauses/min	Pauses/min exceeds high limit.
SVCs/min	SVCs/min exceeds high limit.

*N: normal beat; V: ventricular beat

7.5.3.3 Changing Arrhythmia Alarm Settings

Perform the following procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select the **Arrhythmia** tab→ **Alarm** tab.
3. Set the alarms according to the each arrhythmia alarm properties.

WARNING

- **If you switch off all arrhythmia alarms, the system will not alarm for any arrhythmia event. This may result in a hazard to the animal. Always keep the animal under close surveillance.**

NOTE

- **The priority of lethal arrhythmia alarms is always high. It cannot be altered.**

7.5.3.4 Changing Arrhythmia Alarm Threshold Settings

Some arrhythmia alarm threshold can be changed. When an arrhythmia violates its threshold, an alarm will be triggered. To do so, follow this procedure.

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **Arrhythmia** tab→**Threshold** tab.
3. Set the threshold of desired arrhythmia alarms.

NOTE

- **The asystole delay time relates to ECG relearning. When heart rate is less than 30 bpm, it is recommended to set Asystole Delay to 10 sec.**

7.5.3.5 Arrhythmia Threshold Range

Arrhythmia	Threshold Range
Asystole Delay	3 s ~ 10 s
Extreme Tachy	60 bpm ~ 300 bpm
Tachy (HR High)	60 bpm ~ 300 bpm
Brady (HR Low)	15 bpm ~ 115 bpm
Extreme Brady	15 bpm ~ 115 bpm
Multif PVCs Window	3 beats ~ 31 beats
PVCs/min	1~100
Pauses/min	1~15
Pause Threshold	1.5 s, 2.0 s, 2.5 s, 3.0 s
Irr Rhy End Time	0, 1 min, 2 min, 3 min, 4 min, 5 min, 10 min, 15 min, 30 min

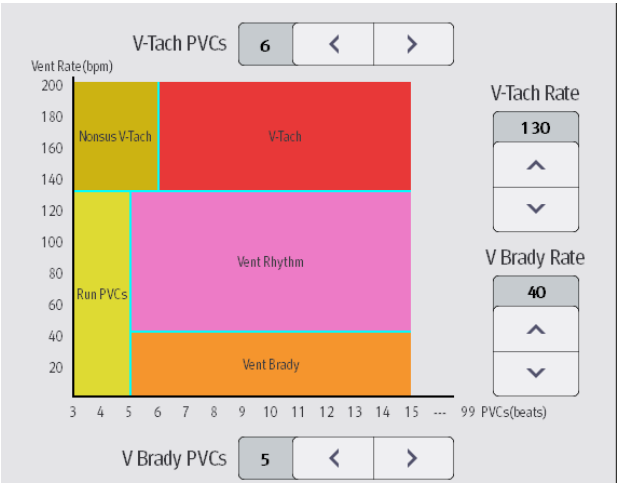
7.5.3.6 Setting Thresholds for PVC-Related Alarms

PVC-related alarms are detected on the basis of the current PVC rate and the number of consecutive PVCs.

To set the required thresholds for PVC-related alarms, follow this procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **Arrhythmia** tab→ **More Threshold** tab.
3. Adjust **V-Tach PVCs**, **V-Tach Rate**, **V-Brady PVCs**, and **V-Brady Rate** to set the threshold of desired PVCrelated alarms.

The following figure illustrates the conditions under which PVC alarms will be generated if **V-Tach PVCs** is set to 6, **V-Tach Rate** is set to 130, **V-Brady PVCs** is set to 5, and **V-Brady Rate** is set to 40.



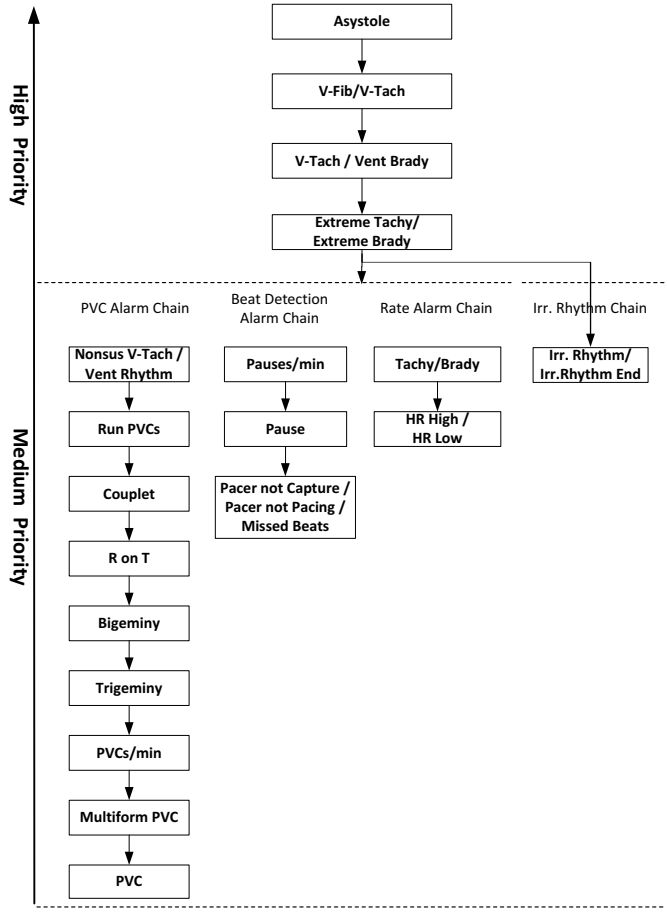
- If the number of consecutive PVCs is greater than or equal to the V-Tach PVCs limit (6), and the ventricular rate (Vent Rate) is greater than or equal to the V-Tach Rate limit (130), a V-Tach alarm is generated.
- If the number of consecutive PVCs is lower than the V-Tach PVCs limit (6) but greater than 2, and the ventricular rate is greater than or equal to the V-Tach Rate limit (130), a Nonsus V-Tach alarm is generated.
- If the number of consecutive PVCs is greater than or equal to the V-Brady PVCs limit (5), and the ventricular rate is lower than the V-Tach Rate limit (130) but greater than or equal to the V Brady Rate limit (40), a Vent Rhythm alarm is generated.
- If the number of consecutive PVCs is lower than the V-Brady PVCs limit (5) but greater than 2, and the ventricular rate is lower than the V-Tach Rate limit (130), a Run PVCs alarm is generated.
- If the number of consecutive PVCs is greater than or equal to the V-Brady PVCs limit (5), and the ventricular rate is lower than the V Brady Rate limit (40), a Vent Brady alarm is generated.

7.5.3.7 Intelligent Arrhythmia Alarm

Normally, an arrhythmia alarm is presented when an alarm condition is detected. However, there are certain situations that can inhibit audible and visible alarm indications even though an alarm condition was detected. For details, see ***7.5.3.7 Intelligent Arrhythmia Alarm*** and ***7.5.3.11 Arrhythmia Alarm Refractory Period***.

7.5.3.8 Arrhythmia Alarm Chains

If multiple alarms overlap, announcing all of the detected alarm conditions would be confusing, and a more serious condition might be overlooked. So arrhythmia alarms are prioritized by alarm "chains".



7.5.3.9 Setting Arrhythmia Alarm Shielding Period

The CMS provides the function of shielding arrhythmia alarm, and it can disable alarm light and alarm tone for designated period of time when certain arrhythmia alarms are detected. For details, see ***BeneVision CMS Vet Veterinary Central Monitoring System Operator's Manual***.

NOTE

- **The arrhythmia shielding period is only applicable to the alarms in the medium priority chains and Irr. Rhythm chain. For the alarms in the high priority chain,**

alarm tone and alarm light are presented as soon as the alarm condition is detected.

7.5.3.10 Arrhythmia Alarm Shielding Rules

The following table explains how audible and visual alarm indicate during arrhythmia alarm shielding period.

Previous Alarm	Current Alarm	Alarm Indication
Alarm in high priority chain	Alarm in high priority chain	Alarm light and alarm tone
	Alarm in medium priority chain	During the shielding period, alarm light and alarm tone are disabled. When the shielding period is reached, alarm light and alarm tone are reactivated.
Alarm in medium priority chain	Alarm in high priority chain	Alarm light and alarm tone
	Alarm in the same medium priority chain, but with higher priority	Alarm light and alarm tone
	The same alarm reoccurs	During the shielding period, alarm light and alarm tone are disabled. When the shielding period is reached, alarm light and alarm tone are reactivated.
	Alarm in the same medium priority chain, but with lower priority	During the shielding period, alarm light and alarm tone are disabled. When the shielding period is reached, alarm light and alarm tone are reactivated.
	Alarm in other medium priority chain	Alarm light and alarm tone

7.5.3.11 Arrhythmia Alarm Refractory Period

The refractory period can be set for some arrhythmia alarms in the medium priority alarm chain. After the arrhythmia alarms affected by refractory period disappear, the arrhythmia alarms and the low-priority alarm in the alarm chain will be shielded in the refractory period. Even if the corresponding alarm condition reappears, the CMS does not generate the corresponding alarm.

To set the refractory period of arrhythmia alarms, follow this procedure:

1. Select the ECG numeric area or waveform area on the Viewbed screen to enter the ECG menu.
2. Select **Arrhythmia→Threshold** tab.

3. Set **Primary Refractory Period** and **Secondary Refractory Period**.

The primary refractory period is 3 minutes by default, and the secondary refractory period is 10 minutes by default. To enable the refractory period, set the refractory period to **Off**.

The types of arrhythmias applicable to the primary and secondary refractory periods are illustrated in the alarm chain diagram in ***7.5.3.8 Arrhythmia Alarm Chains***.

NOTE

- **The refractory period of arrhythmia alarms is only applicable to arrhythmia alarms in the medium chain.**
- **Tachy, Brady, HR Too High, HR Too Low, and Irr Rhythm/Irr Rhythm End are not affected by the refractory period.**

7.5.4 ST Segment Monitoring

The ST segment of the ECG waveform refers to the period from the end of ventricular depolarization to the beginning of ventricular repolarization, or from the end of the QRS complex (point J) to the beginning of the T wave. ST segment analysis is often used to monitor the animal's oxygen supply and myocardial viability.

ST segment can only be displayed and set at CMS.

7.5.4.1 ST Safety Information

WARNING

- **ST values may be affected by such factors as some drugs or metabolic and conduction disturbances.**
- **ST deviation is often calculated at a fixed offset from the J point. Changes in heart rate may affect ST.**
- **The ST deviation measurement algorithm has been tested for accuracy. The significance of ST segment changes needs to be determined by a physician.**
- **This CMS provides ST deviation level change information. The clinical significance of the ST level change information should be determined by a physician.**

7.5.4.2 Enabling ST Monitoring

The ST monitoring function is disabled by default.

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **ST** tab→ **Setup** tab.
3. Switch on **ST Analysis**.

Reliable ST monitoring cannot be ensured under the following situations:

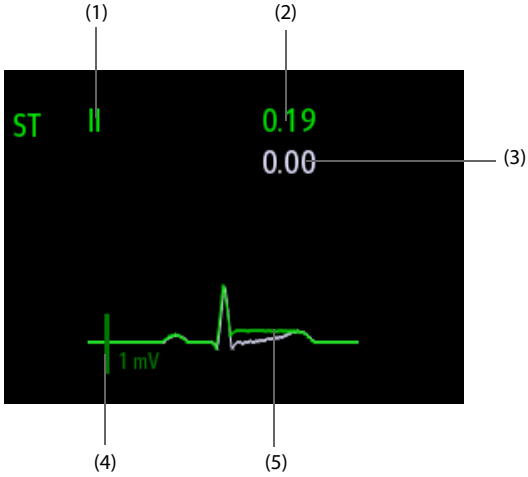
- Unable to get a lead that is not noisy.
- Arrhythmias cause irregular baseline.
- The animal has left bundle branch block.

In these cases, the operator may consider switching off ST monitoring.

7.5.4.3 ST Screen Display

The waveform area displays the current and baseline ST segments. It also displays the current and baseline ST values. The current ST segment and value are in green, while the baseline ST segment and value are in white. The following figure shows the ST waveform area:

7.5.4.4 Entering the ST View



(1) ST lead label

(2) Current ST value

(3) Baseline ST value

(4) 1 mV scale

(5) Current ST segment (green) and baseline ST segment (white)

The ST View shows a complete QRS segment for each ST lead. The operator can enter **ST View** screen to view these segment. The color of current ST segments and ST values is consistent with the color of ECG waveforms, normally green. The color of baseline ST segments and ST values is white.

The operator can enter the ST View screen either by selecting the ST segment in the waveform area or by the following ways:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **ST** tab.
3. From the bottom of the screen, select **ST View**.

7.5.4.5 Saving the Current ST as Baseline

ST deviation is typically monitored as a relative change from a baseline value. Set an ST baseline when ST values become stable. If the operator did not set the ST baseline, the CMS automatically saves the baseline when valid ST values appear for 1 minute. The operator can also manually update the baseline by selecting **Set Baselines** at the bottom left corner of **ST View** window.

The operator can perform the following operations:

- Display or hide ST baseline by selecting **Display Baseline** or **Hide Baseline**.
- Display or hide the position of ISO point, J point and ST point by selecting **Display Marker** or **Hide Marker**.

CAUTION

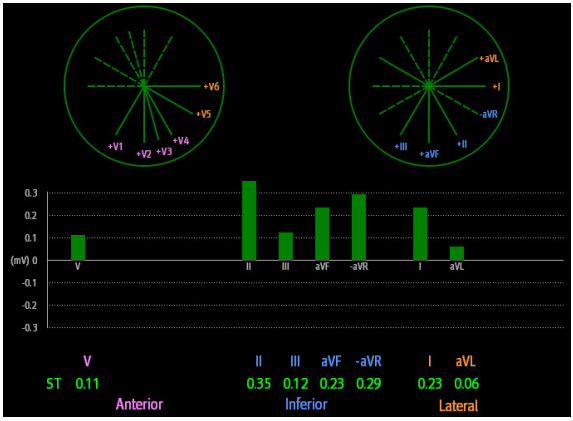
- **Updating ST baseline affects ST alarms.**

7.5.4.6 Entering the ST Graphic Window

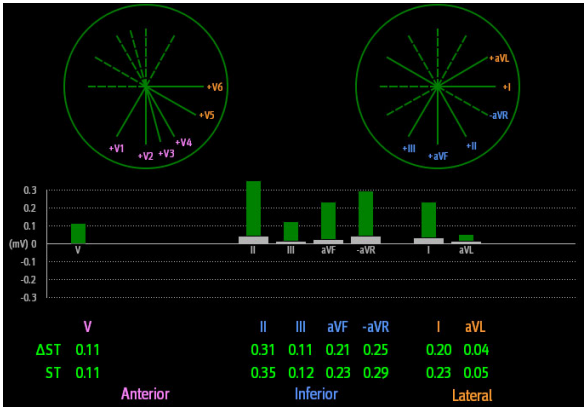
Perform the following procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **ST** tab.
3. From the bottom of the screen, select **ST Graphic**.

The following figure shows the ST Graphic when **ST Alarm Mode** is set to **Absolute**. The height of the bar indicates the ST value of corresponding ST lead. The color of the bar indicates ST alarm status: green indicates that corresponding ST value is within alarm limits; cyan, yellow and red indicate that the ST value exceeds the alarm limits. The color matches ST alarm priority.



The following figure shows the ST Graphic when **ST Alarm Mode** is set to **Relative**. The height of grey bar indicates the baseline ST value and the green bar (cyan, yellow or red if an alarm occurs) indicates ΔST.



7.5.4.7 Setting ST Alarm Properties

Perform the following procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **ST** tab.
3. Set **ST Alarm Mode** to **Absolute** or **Relative**.
   - Absolute: separately set the alarm properties for each ST alarm.
   - Relative: set the alarm properties for **ST Single** and **ST Dual** alarms.
4. Set ST alarm properties as desired.

7.5.4.8 Changing Leads for ST Display

The CMS automatically selects the three most deviated leads for ST display. The operator can also manually select the leads. To do so, follow this procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **ST** tab → **Setup** tab.
3. Select **ST Segment** to set the desired leads. The operator can select up to 3 leads.

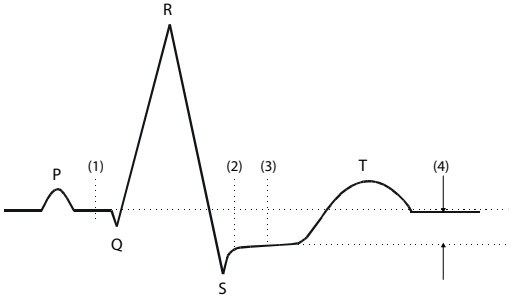
7.5.4.9 Showing ISO Point, J Point, and ST Point Marks

In the waveform area, the ISO point, J point, and ST point mark do not display on the ST segments by default. To show these marks, follow this procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **ST** tab → **Setup** tab.
3. Switch on **Show Markers**.

7.5.4.10 About ST Point, ISO Point, and J Point

The ST deviation value for each beat is the potential difference between the isoelectric (ISO) point and the ST point. The ISO point is located between the end of P-wave and the start point of QRS. It provides the baseline. The ST point is at the midpoint of the ST segment. The J point is the end of the QRS complex. As the J point is a fixed distance away from the ST point, it can be useful to help you correctly position the ST point.



(1) ISO point (2) J point (3) ST point (4) ST value

7.5.4.11 Setting ST Point, ISO Point, and J Point

CAUTION

- **The operator need to adjust the ST points before starting monitoring, or if the animal's heart rate or ECG morphology changes significantly, as this may affect the size of the QT interval and thus the placement of the ST point. Artificial ST segment depression or elevation may occur if the isoelectric point or the ST**

point is incorrectly set. Always make sure that the positions of ST points are appropriate for your animal.

To set ST point, ISO point, and J point, follow this procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **ST** tab → **Adjust** tab.
3. Set **ST** Point.

The setting of **Auto Adjust** defines the method of adjusting the ISO point and J point. Auto Adjust is enabled by default. In this case, positions of ISO point and J point are automatically adjusted accordingly. If **Auto Adjust** is disable, the operator need to manually adjust the position of ISO point and J point by selecting the arrows at the right sides of ISO and J.

- The ISO point (isoelectric) position is given relative to the R-wave peak. Position the ISO point in the middle of the flattest part of the baseline (between the P and Q waves).
- The J point position is given relative to the R-wave peak and helps locating the ST point. Position the J point at the end of the QRS complex and the beginning of the ST segment.

The ST point is positioned a fixed distance from the J point. Move the J point to position the ST point at the midpoint of the ST segment. Position the ST point relative to the J point at J+60/80ms, J+40ms, J+60ms or J+80ms. When J+60/80ms is selected, the ST point will be positioned 80 ms (heart rate 120 bpm or less) or 60 ms (heart rate more than 120 bpm) from the J point.

7.5.5 QT/QTc Interval Monitoring

The QT interval is defined as the time between the beginning of the Q-wave and the end of the T-wave. It measures the total duration of ventricular depolarization (QRS duration) and repolarization (ST-T). QT interval monitoring can assist in the detection of long QT syndrome.

The QT interval has an inverse relationship to heart rate. Faster heart rates shorten the QT interval and slower heart rates prolong the QT interval. Therefore, several formulas can be used to correct the QT interval for heart rate. The heart rate corrected QT interval is abbreviated as QTc.

QT/QTc interval monitoring information can only be displayed and set at CMS.

7.5.5.1 QT/QTc Monitoring Limitations

The following factors may influence the accuracy of QT measurement:

- R-wave amplitudes are too low.
- The presence of frequent ventricular ectopic beats.
- Unstable RR intervals.

- P-waves tending to encroach on the end of the previous T-wave at high heart rates.
- The T-wave is very flat or T-wave are not well defined.
- The end of the T-wave is difficult to delineate because of the presence of U-waves.
- QTc measurements are not stable.
- In the presence of noise, asystole, ventricular fibrillation, atrial fibrillation, and ECG lead off.

For these cases the operator should select a lead with good T-wave amplitude and no visible flutter activity, and without a predominant U-wave or P-wave.

Some conditions such as left or right bundle branch block or hypertrophy can lead to a widened QRS complex. If a long QTc is observed, the operator should verify it to ensure that it is not caused by QRS widening.

Because normal beats followed by ventricular beats are not included in the analysis, no QT measurement will be generated in the presence of a bigeminy rhythm.

If the heart rate is extremely high (over 180bpm), QT will not be measured. When the heart rate changes, it can take several minutes for the QT interval to stabilize. For reliable QTc calculation it is important to avoid measurements when the heart rate is changing.

7.5.5.2 Enabling QT/QTc Monitoring

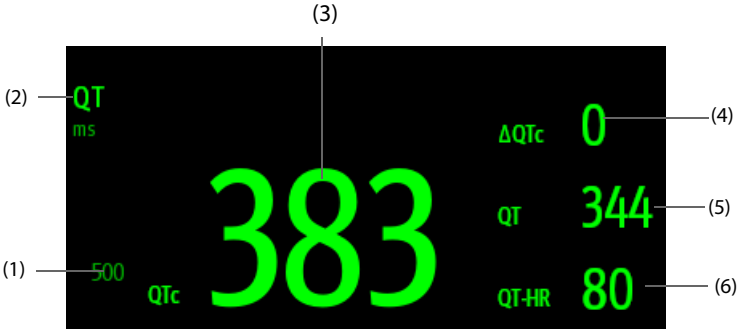
The QT/QTc monitoring function is disabled by default. Before starting QT/QTc monitoring, enable the QT/QTc function.

To do so, follow this procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **QT** tab → **Setup** tab.
3. Switch on **QT Analysis**.

7.5.5.3 QT Numeric Screen Display

The following picture shows the QT numeric area:



(1) QTc alarm limit (If QTc alarm is off, the alarm off symbol is displayed)

(2) Parameter label

(3) QTc value

(4) ΔQTc value (the difference between the current and baseline QTc values)

(5) QT value

(6) QT-HR value

7.5.5.4 Entering the QT View

QT View shows the current and baseline QT parameter values and waveforms.

To enter the **QT View**, follow this procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **QT View**.

The following picture shows the QT view.

- The current waveform is shown on upper position and its color is consistent with the color of ECG waveforms, normally green.
- The baseline waveform is shown below in white.
- The start of QRS complex and the end of the T wave are marked with a vertical line.
- In some conditions, no QT measurement can be calculated. Then the cause of failed QT measurement is shown at the bottom of the QT numerics area and the message "Cannot Analyze QT" is shown in the technical alarm area.

Select the left or right arrow to switch leads. Corresponding waveform will be highlighted.

7.5.5.5 Saving the QT as Baseline

For the better to quantify changes in the QTc value, set a QTc baseline. If no baseline has been set for this animal within the first 5 minutes after getting valid QT values, the CMS will automatically set a baseline.

To set the current values as baseline, follow this procedure:

1. From the QT View window, select **Set Baseline**.
2. From the pop-up dialog box, select **OK**. This baseline will then be used to calculate ΔQTc.

If a new baseline is set, the previous baseline is discarded. Discharging the animal will remove the baseline.

Display or hide QT baseline by selecting **Display Baseline** or **Hide Baseline**.

CAUTION

- **Updating QT baseline affects ΔQTc value and ΔQT alarm.**

7.5.5.6 Setting QT Alarm Properties

To set the QT alarm limits, follow this procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Set QTc and ΔQTc alarm properties.

7.5.6 ECG Relearning

Changes in ECG template could result in incorrect arrhythmia alarms and/or inaccurate heart rate.

The CMS provides ECG relearning function. ECG relearning allows the CMS to learn new ECG template so as to correct arrhythmia alarms and HR value. Once learning is complete, the dominant QRS complex is stored as a reference template. The reference template is used as a normal morphology of that animal and it is compared with incoming beats to identify possible arrhythmias.

7.5.6.1 Auto ECG Relearning

Auto arrhythmia relearning happens in the following situation:

- The ECG lead type or lead label is changed.
- ECG leads are off and are not reconnected within 60 seconds.

7.5.6.2 Initiating an ECG Relearning Manually

To manually initiate an ECG relearning, follow this procedure:

1. Select the ECG numeric area or waveform area to enter the ECG menu.
2. Select **Relearn** at the bottom left corner of the menu.

CAUTION

- **Take care to initiate ECG relearning only during periods of predominantly normal rhythm and when ECG signal is relatively noise-free. If ECG learning takes place during arrhythmia, the wrong QRS complex may be incorrectly learned as normal ECG template. This may result in missed detection of subsequent events of arrhythmia.**

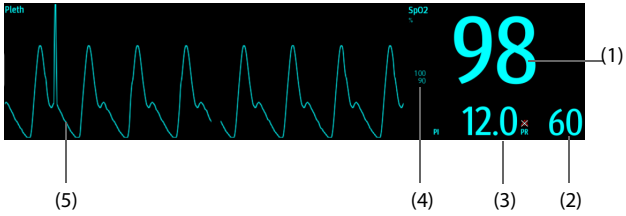
7.6 Monitoring Pulse Oxygen Saturation (SpO_2)

Once the equipment is connected to the CMS successfully, the operator can view and set SPO_2 monitoring information on Viewbed screen of the CMS.

WARNING

- **Alarm system will be invalid when the alarm limit is set to the limited value.**

7.6.1 SpO_2 Display



(1) SpO_2 value: percentage of oxygenated hemoglobin in relation to the sum of oxyhemoglobin and deoxyhemoglobin.

(2) PR value: detected pulsations per minute (derived from the pleth wave).

(3) Perfusion index (PI): gives the numerical value for the pulsatile portion of the measured signal caused by arterial pulsation. PI is an indicator of the pulsatile strength. PI value can also be used to assess the SpO2 signal strength.

- Above 1 is optimal.
- Between 0.3 and 1 is acceptable.
- Below 0.3 indicates low perfusion. 0.3 ≤ PI<1: the PI value is displayed on a yellow background; PI<0.3: the PI value is displayed on a red background, and the SpO_2 value is displayed in hollow font. Reposition the SpO_2 sensor or find a better site. If low perfusion persists, choose another method to measure oxygen saturation if possible.

(4) SpO_2 alarm limit

(5) (2) Pleth waveform (Pleth): visual indication of animal's pulse. The waveform is not normalized.

7.6.2 Changing the SpO_2 Settings

Perform SpO_2 settings at the CMS.

7.6.2.1 Setting SpO_2 Alarms

To set the SpO_2 alarm limits, follow this procedure:

1. Select the SpO_2 numeric area or waveform area to enter the SpO_2 menu.
2. Select **Alarm** tab .
3. Set alarm properties as desired.

7.6.2.2 Setting Sensitivity

The sensitivity mode depends on signal quality and animal movement.

To set sensitivity, follow this procedure:

1. Select the SpO_2 numeric area or waveform area to enter the SpO_2 menu.
2. Select **Setup** → **Sensitivity**.
3. Select a desired item.
   - **High**: reflects the actual physiological status of the animal but may be subject to external interference.
   - **Middle**: the best combination of sensitivity and immunity for most animals.
   - **Low**: the least sensitive to reflect the animal's physiological status, but has the best anti-interference performance.

7.6.2.3 Showing/Hiding PI

To display PI in the SpO_2 parameter area, follow this procedure:

1. Select the SpO_2 numeric area or waveform area to enter the SpO_2 menu.
2. Select **Setup** tab.
3. Switch on or off **Display PI**.

7.6.2.4 Changing the Sweep Speed of the Pleth Wave

To set the sweep speed of Pleth waveform, follow this procedure:

1. Select the SpO_2 numeric area or waveform area to enter the SpO_2 menu.
2. Select **Setup** tab.
3. Set **Speed**.

7.6.2.5 Changing the PR Settings

- Setting PR Alarm Properties

  To set PR alarm properties, follow this procedure:

  a. Select the SpO_2 numeric area or waveform area to enter the SpO_2 menu.
  b. Select **PR Alarm** tab.
  c. Set the alarm properties as desired.

- Showing/Hiding PR

  To display the PR, follow this procedures:

  a Select the SpO_2 numeric area or waveform area to enter the SpO_2 menu.
  b. Select **Setup** tab.
  c. Switch on or off **Display PR**.

7.7 Changing Alarm Settings

After the equipment is connected to the CMS, the CMS will display the alarm limits of physiological parameters.

7.7.1 Initiating Auto Alarm Limits

The CMS provides the auto alarm limits function to automatically adjust alarm limits according to the animal's vital signs. When auto limits are selected, the CMS calculates safe auto limits based on the latest measured values. To get accurate auto alarm limits, collect a set of measured vital signs as a baseline.

To initiate auto alarm limits for all physiological parameters, follow this procedure:

1. Select the **Alarm Setup** quick key.
2. Select **Auto Limits**.

To initiate auto alarm limits for a physiological parameter, follow this procedure:

1. Select the numeric area or waveform area of a physiological parameter.
2. In the **Setup** section, select **Alarms**.
3. Select **Auto Limits**.

The CMS will automatically calculate alarm limits based on the latest measured values. These alarm limits will remain unchanged until you select auto limits again or adjust them manually. Before applying these automatically created alarm limits, confirm if they are appropriate for your animal from the Limits menu. If not, you can adjust them manually.

7.7.2 Auto Alarm Limit Rules

The CMS calculates auto limits basing on the following rules:

Module	Parameter	Low Limit	High Limit	Auto Limit Range
ECG	HR / PR (bpm)	(HR/PR×0.8) or 40, whichever is greater	(HR/PR×1.25) or 240, whichever is small	35~240
SpO_2	SpO_2(%)	Same as the default alarm limit	Same as the default alarm limit	Same as the measurement range

7.7.3 ECG Alarm Limits

Alarm limit	Scope	Step
ST High	(low limit + 0.2 mV) to 2.0 mV (ST alarm mode: Absolute) 0 mV to 2.0 mV (ST alarm mode: Relative)	0.05 mV
ST Low	-2.0 mV to (high limit - 0.2 mV) (ST alarm mode: Absolute) -2.0 mV to 0 mV (ST alarm mode: Relative)	
HR High	HR ⩽ 40bpm: (low limit + 2 bpm) to 40 bpm HR > 40 bpm: (low limit + 5 bpm) to 295 bpm	HR ⩽ 40bpm: 1 bpm HR > 40 bpm: 5 bpm
HR Low	HR ⩽ 40bpm: 16 bpm to (high limit - 2 bpm) HR > 40 bpm: 40 bpm to (high limit - 5 bpm)	
QTc High	200 ms ~ 800 ms	10 ms
ΔQTc High	30 ms ~ 200 ms	

7.7.4 SpO_2 Alarm Limits

Alarm Limit	Scope	Step
SpO_2 High	(low limit + 2%) to 100%	1%
SpO_2 Low	(Desat + 1%) to (high limit - 2%)	
SpO_2 Desat Low	0 to (low limit - 1%)	

7.7.5 PR Alarm Limits

Alarm Limit	Scope (bpm)	Step (bpm)
PR High	PR ≤ 40: (low limit + 2) to 40 PR > 40: (low limit + 5) to 295	PR ≤ 40: 1 PR > 40: 5
PR Low	PR≤ 40: 16 to (high limit - 2) PR > 40: 40 to (high limit - 5)	

7.8 Parameters Default Settings

After the equipment is connected to the CMS, the CMS will display monitoring parameters on Viewbed screen. This chapter describes the default settings of these monitoring parameters.

7.8.1 ECG, Arrhythmia, ST and QT Default Settings

7.8.1.1 ECG Default Settings

Setting Item		Default Setting
HR/PR	Alarm switch	On
	High limit	Canine: 160 bpm Feline: 180 bpm Other: 160 bpm
	Low limit	Canine: 60 bpm Feline: 100 bpm Other: 60 bpm
	Alarm Level	Medium
	Alarm outputs	Off
Alarm Source		Auto

Setting Item		Default Setting
ECG 1		II
ECG 2		V
ECG 3		I
ECG 4		III
Waveform Speed		25 mm/s
Filter		Monitor
Notch filter		On
Lead Set		Auto
ECG Gain (ECG1~ECG7)		×1
Analysis Mode		Multiple Leads
Threshold		0.16 mV

7.8.1.2 Arrhythmia Default Settings

Arrhythmia Alarm Default Setting

Setting Item	Alarm switch	Alarm Level	Alarm Outputs
Asystole	On	High, unadjustable	Off
V-Fib/V-Tach	On	High, unadjustable	Off
V-Tach	On	High, unadjustable	Off
Vent Brady	On	High, unadjustable	Off
Extreme Tachy	On	High, unadjustable	Off
Extreme Brady	On	High, unadjustable	Off
R on T	Off	Medium	Off
Run PVCs	Off	Low	Off
Couplet	Off	Prompt	Off
Multiform PVC	Off	Medium	Off
PVC	Off	Prompt	Off
Bigeminy	Off	Medium	Off
Trigeminy	Off	Medium	Off
Tachy	Off	Medium	Off

Setting Item	Alarm switch	Alarm Level	Alarm Outputs
Brady	Off	Medium	Off
Missed Beat	Off	Prompt	Off
Nonsus V-Tach	Off	Medium	Off
Vent Rhythm	On	Medium	Off
Pause	Off	Low	Off
Irr Rhythm	Off	Prompt	Off
PVCs/min	Off	Medium	Off
Pauses/min	Off	Medium	Off
Supraventricular tachycardia	Off	Medium	Off
SVCs/min	Off	Medium	Off

Arrhythmia Threshold Default Settings

Setting Item	Default Setting
Asystole Delay	5 s
Tachy (HR High)	Canine: 160 bpm Feline: 180 bpm Other: 160 bpm
Brady (HR Low)	Canine: 60 bpm Feline: 100 bpm Other: 60 bpm
Extreme Tachy	Canine: 180 bpm Feline: 200 bpm Other: 180 bpm
Extreme Brady	Canine: 50 bpm Feline: 90 bpm Other: 50 bpm
Multif PVCs Window	15 beats
PVCs/min	10
Pauses/min	8
Pause Threshold	2.0 s

Setting Item	Default Setting
AF End/Irr Rhy End Time	2 min
V-Tach Rate	130 bpm
V-Brady Rate	40 bpm
V-Tach PVCs	6 beats
V-Brady PVCs	5 beats
SVCs/min	10

7.8.1.3 ST Default Settings

Setting Item		Default Setting
ST Alarm Mode		Absolute
ST-I, ST-II, ST-III, ST-aVR, ST-aVL, ST-aVF, ST-V1, ST-V2, ST-V3, ST-V4, ST-V5,ST-V6, ST-Va, ST-Vb (ST Alarm Mode set to Absolute)	Alarm switch	Off
	High limit	0.2 mV
	Low limit	-0.2 mV
	Alarm Level	Medium
	Alarm outputs	Off
ST Single, ST Dual (ST Alarm Mode set to Relative)	Alarm switch	Off
	High limit	0.1 mV
	Low limit	-0.1 mV
	Alarm Level	Medium
	Alarm outputs	Off
ST Analysis		Off
ST Segment		Auto
Show Markers		Off
ST point		J + 60 ms
Auto		On
ISO point		-80 ms
J point		48 ms

7.8.1.4 QT/QTc Default Settings

Setting Item		Default Setting
QTc	Alarm switch	Off
	High limit	460
	Alarm Level	Medium
	Alarm outputs	Off
ΔQTc	Alarm switch	Off
	High limit	60
	Alarm Level	Medium
	Alarm outputs	Off
QT Analysis		Off

7.8.2 SpO_2 Default Settings

Setting Item		Default Setting
SpO_2	Alarm switch	On
	High Limit	100
	Low Limit	90
	Alarm Level	Medium
	Alarm outputs	Off
SpO_2 Desat	Alarm switch	On
	Low Limit	80
	Alarm Level	High (unadjustable)
	Alarm outputs	Off
Sensitivity		Medium
Display PI		On
Waveform Speed		25 mm/s
PR	Alarm switch	On
	High Limit	Canine: 160 bpm Feline: 180 bpm Other: 160 bpm

Setting Item		Default Setting
	Low Limit	Canine: 60 bpm Feline: 100 bpm Other: 60 bpm
	Alarm Level	Medium
	Alarm outputs	Off
	Alarm Source	Auto
	Display PR	On
SpO_2 Statistics	Section	Section 5: 95(start); 100(End); Target: selected

7.9 Alarm Information

This chapter describes the physiological alarms and technical alarms of the equipment displayed at the CMS. For details, see ***8.2 Prompts***.

7.9.1 Physiological Alarm Messages

7.9.1.1 General Physiological Alarm Messages

Alarm Messages	Default Priority	Cause and Solution
XX* high	Medium	XX value has risen above the high alarm limit. Check the animal's condition and check if the animal category and alarm limit settings are correct.
XX* low	Medium	XX value has fallen below the low alarm limit. Check the animal's condition and check if the animal category and alarm limit settings are correct.
Note: XX represents a measurement or parameter label, such as HR, NIBP, PVCs, RR, SpO_2, PR, and so on.		

7.9.1.2 ECG Physiological Alarms

Alarm Messages	Default Priority	Cause and Solution
ECG Weak Signal	High	ECG signal is weak and the system can not analysis it. Check the animal's condition and ECG ECG connections.

7.9.1.3 Arrhythmia Alarm Messages

Alarm Messages	Default Priority	Cause and Solution
Asystole	High	When arrhythmia alarms occur, check the animal's condition and the ECG connections.
V-Fib/V-Tach	High	
V-Tach	High	
Vent Brady	High	
Extreme Tachy	High	
Extreme Brady	High	
PVCs/min	Medium	
Pauses/min	Medium	
R on T	Medium	
Bigeminy	Medium	
Trigeminy	Medium	
Supraventricular tachycardia	Medium	
Tachy	Medium	
Brady	Medium	
Multiform PVC	Medium	
Vent Rhythm	Medium	
Nonsus V-Tach	Medium	
Run PVCs	Low	
Pause	Low	
Couplet	Prompt	When arrhythmia alarms occur, check the animal's condition and the ECG connections.
PVC	Prompt	
Irr Rhythm	Prompt	
Missed Beat	Prompt	
SVCs/min	Medium	

7.9.1.4 ST Physiological Alarm Messages

ST Alarm Mode	Alarm Messages	Default Priority	Cause and Solution
Absolute	ST-XX* High	Medium	The ST value of respective ECG lead has risen above the high alarm limit. Check the animal's condition and check if the animal category and alarm limit settings are correct.
	ST-XX* Low	Medium	The ST value of respective ECG lead has fallen below the low alarm limit. Check the animal's condition and check if the animal category and alarm limit settings are correct.
Absolute	ST Single	High	ST value of any ECG leads has risen above the high alarm limit or fallen below the low alarm limit. Check the animal's condition and check if the animal category and alarm limit settings are correct.
	ST Dual	Medium	ST values of two or more ECG leads have risen above the high alarm limit or fallen below the low alarm limit. Check the animal's condition and check if the animal category and alarm limit settings are correct.
*: XX represents the ECG lead label.			

7.9.1.5 SpO_2 Physiological Alarm Messages

Alarm Messages	Default Priority	Cause and Solution
SpO_2 Desat	High	The SpO_2 value falls below the desaturation alarm limit. Check the animal's condition and check if the alarm limit settings are correct.

7.9.1.6 PR Physiological Alarm Messages

Alarm Messages	Default Priority	Cause and Solution
No Pulse	High	The pulse signal was so weak that the system cannot perform pulse analysis. Check the animal's condition, SpO_2 sensor and measurement site.

7.9.2 Technical Alarm Messages

7.9.2.1 ECG Technical Alarm Messages

Alarm Messages	Default Priority	Alarm Indication	Possible Cause	Solution
ECG Lead Off	Low	Technical alarms are changed to the prompt messages.	The electrode has become detached from the animal or the lead wire has become disconnected from the adapter cable.	Check the connections of the electrodes and leadwires.
ECG ECG Lead Off	Low	Technical alarms are changed to the prompt messages.		
ECG Module Error	High	The alarm is silenced and a √ appears before the alarm message.	ECG Module Error. ECG module does not work properly.	Restart the equipment. If the alarm persists, contact Customer Service Department or sales representative.
ECG Noisy	Low/ Prompt	The alarm is silenced and a √ appears before the alarm message.	The ECG signal is noisy.	Check for any possible sources of signal noise around the cable and electrode, and check the animal for excessive motion.
Check Leads	Low	The alarm is silenced and a √ appears before the alarm message.	The ECG amplification channel signal is saturated or overloaded.	Check the animal for excessive motion. The electrode has become detached from the animal or the lead wire has become disconnected from the adapter cable. Check whether the ECG electrodes has been expired.
HR Overrange	Low	The alarm is silenced and a √ appears before the alarm message.	HR value exceeds the measurement value.	Contact Customer Service Department or sales representative.

Alarm Messages	Default Priority	Alarm Indication	Possible Cause	Solution
*: XX represents ECG lead name.				

7.9.2.2 SpO_2 Technical Alarm Messages

Alarm Messages	Default Priority	Alarm Indication	Possible Cause	Solution
SpO_2 Sensor Off	Low	Technical alarms are changed to the prompt messages.	The SpO_2 sensor has become detached from the animal or the module. The SpO_2 sensor is faulty. Using the SpO_2 sensor is not specified in this manual.	Check the installation position of the SpO_2 sensor, SpO_2 sensor type and whether the sensor is damaged. Reconnect the SpO_2 sensor or replace with a new one.
SpO_2 Sensor Error	Low	the alarm is silenced and a √ appears before the alarm message.		
SpO_2 No Sensor	Low	Technical alarms are changed to the prompt messages.		
SpO_2 Module Error	High	The alarm is silenced and a √ appears before the alarm message.		
SpO_2 Excess Light	Low	The alarm is silenced and a √ appears before the alarm message.	Ambient light is too strong.	Move the sensor to a place with lower level of ambient light or cover the sensor to minimize the ambient light.
SpO_2 No Pulse	Low	The alarm is silenced and a √ appears before the alarm message.	The SpO_2 sensor failed to obtain pulse signal.	Replace the sensor application site.

Alarm Messages	Default Priority	Alarm Indication	Possible Cause	Solution
PR Overrange	Low	The alarm is silenced and a √ appears before the alarm message.	The measured PR value exceeds the measurement range.	Contact Customer Service Department or sales representative.
SpO_2 Searching Pulse	Prompt	/	SpO_2 is searching for pulse.	Normally, no action required.
SpO_2 Low Perfusion	Prompt	/	The SpO_2 sensor is not properly placed or the animal's perfusion index is too low.	1. Check the sensor and sensor position. 2. Reposition the sensor if necessary.

7.9.2.3 Power Supply Technical Alarm Messages

Alarm Messages	Default Priority	Alarm Indication	Possible Cause	Solution
Low Battery	Med Alarms	The alarm is silenced and a √ appears before the alarm message.	Critically Low Battery	Use fully charged batteries.
The battery power is insufficient	High	The alarm is silenced and a √ appears before the alarm message.	The battery power is to be depleted.	

Alarm Messages	Default Priority	Alarm Indication	Possible Cause	Solution
Battery Maintenance Required	Med Alarms	The alarm is silenced and a √ appears before the alarm message.	Lithium battery is aging.	Replace battery.
Battery Error	Med Alarms	The alarm is silenced and a √ appears before the alarm message.	Lithium battery is faulty.	
Battery Type Error	Med Alarms	The alarm is silenced and a √ appears before the alarm message.	The battery is in poor contact.	

7.9.2.4 Other Technical Alarm Messages

Alarm Messages	Default Priority	Alarm Indication	Possible Cause	Solution
Device Error	High	The alarm is silenced and a √ appears before the alarm message.	The main control board self-test fails. Parameter module or MPAN module self-test error. Parameter module communication or initialization error.	Restart the equipment. If the alarm persists, contact Customer Service Department or sales representative.
Recovering latest configuration fails	Low	The alarm is silenced and a √ appears before the alarm message.	Recovering latest configuration error.	
Loading default configuration fails	Low	The alarm is silenced and a √ appears before the alarm message.	Loading default configuration error.	

8 Troubleshooting

8.1 General Problems

The following table lists the problems that are likely to occur. If the problem persists after corrective actions have been taken, contact Customer Service Department or sales representative.

For methods to troubleshoot the central charger, see ***Central Charger Operator's Manual***.

Fault Symptom	Solution
ECG parameter area and waveform area are not displayed on screen.	Check that the ECG electrodes and leadwires are connected securely. If necessary, replace the ECG electrodes and leadwires.
ECG noise	• Check that the electrodes are in good contact with the skin. • Check that the leadwires are connected securely. • Check that the animal does not contact any ungrounded electric equipment.
Noisy ECG traces	• Check whether the alligator clips get loose or conductive gel of electrodes gets dry. If necessary, replace new electrodes with moist conductive gel. • Check that the leadwires are damaged. If necessary, replace the leadwires. • Check that cables or leadwires are routed too close to other electrical devices.
Muscle noise	• Inadequate skin preparation, tremors, tense subject, or poor electrode placement. • See ***5.3.1 Preparing the Animal's Skin*** for skin preparation again and replace the electrodes. • Replace new electrodes with moist conductive gel. Avoid muscular areas.
Intermittent signal	• Check that the cable is reliably connected. • Check if alligator clips get loose or conductive gel of electrodes get dry. See ***5.3.1 Preparing the Animal's Skin*** for skin preparation again and replace the electrodes with moist conductive gel. • Check that cables or leadwires. If necessary, replace the cables and leadwires.

Fault Symptom	Solution
Excessive alarms: heart rate, lead fault	• Check whether conductive gel of electrodes gets dry. See for skin preparation again and replace the electrodes with moist conductive gel. • Check for excessive animal movement or muscle tremor. Replace the electrodes. If necessary, replace new electrodes with moist conductive gel.
Low amplitude ECG signal	• Check that the ECG gain is not set too low. • See ***5.3.1 Preparing the Animal's Skin*** for skin preparation again. • Check electrode application sites. Avoid bone or muscular area. • Check whether conductive gel of electrodes gets dry. Replace new electrodes with moist conductive gel.
No ECG waveform	• Check that the ECG gain is not set too low. • Check that the cables and leadwires are properly connected. • If necessary, change the cables and lead wires.
Base line wander	• Check for excessive animal movement or muscle tremor. Secure leadwires and cable. • Check that electrodes are not detached or dry. See ***5.3.1 Preparing the Animal's Skin*** for skin preparation again and replace the electrodes with moist conductive gel. • Check for ECG filter setting. Set ECG Filter mode to **Exercise**.
SpO_2 parameter area and waveform area are not displayed on screen.	• Check that the cable connections of SpO_2 sensor and the extension cable are tight. If necessary, replace the SpO_2 sensor or the extension cable.
Dashes "- -" display in place of numerics.	• Check that the cable connections of SpO_2 sensor and the extension cable are tight. If necessary, replace the SpO_2 sensor or the extension cable. Perform the following checks at the CMS. • Check whether the alarm **SpO_2 Sensor Off** appears. If the alarm appears, reconnect the SpO_2 sensor. • Check the PI value. If the PI value is too low, adjust the SpO_2 sensor, or apply the sensor to the site with better perfusion. • Check whether the alarm **SpO_2 Excess Light** appears. If the alarm appears, move the SpO_2 sensor to the place with weaker light, or cover the SpO_2 sensor with shade cloth.
Low amplitude pleth waveform	• Reposition the SpO_2 sensor or find a better site. • Check for the application site of SpO_2 sensor.

Fault Symptom	Solution
SpO_2 value is inaccurate	• Check the animal's vital signs. • Check for conditions that may cause inaccurate SpO_2 readings. For more information, see ***6.3 Measurement Limitation***. • Check the equipment or the SpO_2 sensor for proper functioning.
No pulse	The SpO_2 sensor may fail to obtain the pulse signal. Check the animal's physiological status or change the application site. If the error persists, replace the SpO_2 sensor.
The equipment can not connect to the CMS, and the screen displays 	• Check whether the battery capacity of telemetry transmitter is depleted. • Check whether the animal is outside coverage area of the AP wireless array. • Check whether the SSID number is correct. • Check whether the equipment is properly connect to the ECG leadwires. • Restart the equipment.
SpO_2 data is not displayed at the CMS	The equipment may be faulty. Contact Customer Service Department or sales representative.
Reusability startup	The batteries may be depleted. Replace them with new batteries.

8.2 Prompts

The following table lists the most important prompt message displayed on the equipment. Some prompt messages may not list here.

8.2.1 ECG Technical Alarm Messages

Prompts	Possible Cause	Solution
Lead-off detection current XX* lead off	The electrode has become detached from the animal or the lead wire has become disconnected from the adapter cable.	Check the connections of the electrodes and leadwires.
Module error	• ECG module error. • The connection problem between ECG module and this equipment may exist.	Restart the equipment. If the alarm persists, contact Customer Service Department or sales representative.

Prompts	Possible Cause	Solution
Check leads	The ECG amplification channel signal is saturated or overloaded.	• Check animal for excessive motion. • Check that the ECG electrodes and skin are connected securely. • Check if the ECG electrodes has been expired.
*: XX represents ECG lead name.		

8.2.2 SpO_2 Technical Alarm Messages

Prompts	Possible Cause	Solution
SpO_2 sensor off	• SpO_2 sensor has become detached from the animal. • SpO_2 sensor is faulty. • Using the SpO_2 sensor is not specified in this manual.	• Check the installation position of the SpO_2 sensor, SpO_2 sensor type and whether the sensor is damaged. • Reconnect the SpO_2 sensor or replace with a new one.
SpO_2 sensor error		
SpO_2 no sensor		
Module error		

8.2.3 Others

Prompts	Possible Cause	Solution
Device error	• The main control board self-test fails. • Parameter module self-test error • Parameter module communication or initialization error.	Restart the equipment. If the alarm persists, contact Customer Service Department or sales representative.

9 Battery

9.1 Overview

The equipment can be powered by a lithium battery or AA batteries. This chapter provides instructions on how to use, maintain, and dispose of the batteries.

9.2 Safety Information

WARNING

- **Keep the batteries out of children's reach.**
- **Only use recommended AA batteries or specified lithium-ion battery to power the equipment. Other power supplies may cause damage to the equipment or lead to body injury.**
- **Keep the batteries in their original package until you are ready to use them.**
- **Do not allow the battery to come into contact with liquid. If the surface of the battery is stained with liquid, dry it with a dry soft cloth.**
- **Make sure to install the lithium-ion battery or the AA battery tray and close the battery compartment during defibrillation.**
- **Do not mix old and new AA batteries.**
- **Take caution when handling the rechargeable lithium-ion battery. Misuse or abuse may cause bodily injury or equipment damage. Do not crush, drop or puncture the battery. Mechanical abuse can lead to internal damage and internal short circuits. If a battery has been dropped or banged against a hard surface, whether damage is externally visible or not, remove the battery from use and dispose of it properly.**
- **Do not incinerate batteries or expose them to temperatures above 60°C This may cause the battery to burn, explode, leak, or become hot, causing personal injury.**
- **If a battery shows signs of damage or signs of leakage, replace it immediately. Use caution in removing the battery. Avoid contact with skin. Consult qualified service personnel.**
- **Some failure conditions, such as short circuits, may cause a battery to overheat during using. High temperature can cause burns to the animal or user. If the equipment becomes too hot to the touch, remove it from the animal and place aside until it cools. Then remove the battery from the equipment, and contact your service personnel to identify the cause of overheating.**

- **Replace the battery immediately once the "Critically Low Battery" alarm or "Low Battery" alarm message displays. If those conditions are not corrected, equipment shutdown and cessation of monitoring will result. After replacing the rechargeable lithium-ion battery, charge it in time. Do not store the lithium-ion battery whose batter power is depleted but is not charged yet.**
- **To eliminate the risk of electrical shock or burn, do not carry loose batteries on your person, such as placing the battery in clothing pockets.**

CAUTION

- **Remove the battery before transporting the equipment or if the equipment is not in use or is being stored.**
- **When the lithium-ion battery is depleted and after the equipment is turned off, take out the battery and charge it as soon as possible. If it is placed for a long time, the battery will be over discharged and cannot be charged.**
- **The equipment cannot be used for monitoring if the battery compartment is wet. Remove the batteries and wipe the compartment dry before continued monitoring.**
- **AA batteries should be removed from the equipment at the end of the battery's useful life to prevent leakage. In case of battery leakage, use caution to remove the batteries and clean the battery compartment. Install fresh AA batteries and check if the equipment can power on properly. If the equipment fails to power on, contact Customer Service Department or sales representative.**

NOTE

- **The service life of the lithium-ion battery may be reduced due to wireless signal interference, network coverage lower than specification , aging batteries, and frequent screen switches.**

9.3 Installing the Battery

For details about the installing methods for the battery, see ***3.3 Installing the Batteries***.

9.4 Checking the Battery Charge Status

The battery symbol displays on the top of main screen. The green part () represents the remaining battery capacity.

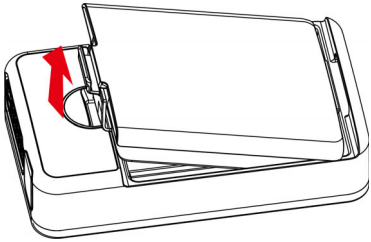
9.5 Removing the Battery

CAUTION

- **Avoid scraping the metal contact in the battery compartment while removing the lithium-ion battery or AA battery tray. Otherwise, the broken contact will affect the power supply performance.**
- **Remove the battery before transporting the equipment or if the equipment is not in use or is being stored.**

To remove a battery, follow this procedure:

1. Lift up the lithium-ion battery or AA battery tray.
2. Remove the lithium-ion battery or AA battery tray.



9.6 Charging the Rechargeable Lithium-ion Battery

WARNING

- **Only use the specified central charger to charge to the lithium-ion batteries.**
- **Only use the approved power cord with the grounded mains plug to firmly connect the central charger to a grounded AC mains socket. Never refit the mains plug to fit an ungrounded AC mains socket.**
- **Do not use the Multiple Portable Socket Outlets (MPSO) or AC mains extension cords. Use an IEC 60601-1 approved isolation / separation transformer, otherwise, it may result in leakage current. Ensure that the sum of the individual ground leakage currents does not exceed the allowable limits.**
- **Do not place any shield object (such as cloth or paper) to cover the central charger or batteries, and keep ventilated while charging the lithium-ion batteries.**

- **Do not use the central charger to charge the lithium-ion batteries at high temperature above 40°C.**

The central charger can charge 10 lithium-ion batteries at one time. It takes no more than 5 hours for the battery to be charged from 0% to 90%. For details about the central charger, see ***Central Charger Operator's Manual***.

9.7 Storing the Batteries

When storing batteries, make sure that the battery terminals do not come into contact with metallic objects. If you need to store the batteries for an extended period of time, place the batteries in a cool, dry place (ideally at 15°C or 60°F) with a partial charge of about 50% capacity. Storing batteries in a cool place can slow the aging process.

Stored batteries should be charged to about 50% of their capacity every six months. The battery should be fully charged prior to first use.

NOTE

- **Remove the lithium-ion battery from the equipment unit if the equipment is not used for a prolonged time (for example, several weeks), and keep the equipment in a clean place to avoid the dust or liquid entering the battery compartment.**
- **Storing batteries at high temperatures for an extended period of time will significantly shorten their life expectancy.**
- **Do not store the batteries in an environment above 60°C (122°F) or lower than -20°C (-4°F).**

NOTE

- **Replace the AA battery tray on the battery compartment after removing the AA batteries.**

9.8 Maintenance

The following table describes the battery maintenance activities and recommended frequency.

Activity	Recommended Frequency
Visual inspection	Before installing a battery.

Activity	Recommended Frequency
Charge the battery	Upon receipt, after use, a "Low Battery" or "Critically Low Battery" alarm occurs. To optimize performance, a fully or almost fully discharged battery must be charged immediately.
Clean the battery	At each animal discharge, or in case that the battery is exposed to contaminants.
Stored batteries should be charged to about 50% of their capacity every six months.	The equipment is not in use for an extended period of time.
Replace battery	"Battery Service Required" alarm message displayed the screen of the CMS.

The lifetime of a lithium-ion battery depends on how frequent and duration of use. With good maintenance, the useful life is approximately 500 complete charge-discharge cycles. Experience indicates that the incidence of failure may increase with battery service life due to the accumulated stresses of daily use. Therefore, Mindray Animal Medical strongly recommends that the lithium-ion battery should be replaced after two years or 500 complete charge-discharge cycles. Using the outdated battery may cause the device abnormality and unacceptable performance.

NOTE

- **The battery capacity decreases over time with the number of charge cycles. Toward the end of its useful life, the battery capacity may be reduced by 20% to 25%. If the reduced battery life is unacceptable for your equipment, It is recommended that the battery should be replaced.**

9.9 Disposing of the Batteries

9.9.1 Disposing of the Rechargeable Lithium battery

Properly dispose of the batteries according to local regulations. Discard the lithium-ion battery in the following situations:

- The battery has visual signs of damage.
- The battery is aged.
- The battery 's runtime is significantly less than that described in the specification.
- The battery has been used for more than two years or 500 complete chargedischarge circles.

9.9.2 Disposing of the AA Batteries

When the battery has reached its service life, dispose of it in accordance with local regulations.

10 Care and Cleaning

10.1 Overview

This chapter mainly describes how to clean and disinfect the equipment and its cables. For the cleaning and disinfection of other accessories, refer to their instructions for use.

10.2 Safety Information

WARNING

- **Use only Mindray Animal Medical approved cleaners, disinfectants and methods listed in this chapter to clean or disinfect your equipment or accessories. Warranty does not cover damage caused by unapproved substances or methods.**
- **Mindray Animal Medical makes no claims regarding the efficacy of the listed chemicals or methods as a means for controlling infection. For the method to control infection, consult your hospital's infection control officer or epidemiologist.**
- **The responsible hospital or institution shall carry out all cleaning and disinfection procedures specified in this chapter.**
- **Be sure to turn off the equipment before cleaning the equipment.**
- **Avoid use of cleaners, materials or chemicals that may damage equipment surfaces, labels, or cause equipment failures.**
- **In the process of cleaning and disinfection, using the wrong disinfectant and disinfection methods may cause damage to the equipment and its accessories, resulting in measurement failure.**
- **Dilute and use the cleaners or disinfectants according to the manufacturer's instructions.**
- **Never use abrasive materials (such as steel wool or silver polish), or erosive cleaners (such as acetone or acetone-based cleaners).**

CAUTION

- **Never immerse any part of the equipment or accessories in liquids or allow liquid to enter the interior.**

- **Do not pour or spray any liquid directly on the equipment or accessories or permit fluid to seep into connections or openings.**
- **If you spill liquid on the equipment or accessories, disconnect the power supply, dry the equipment, and contact Customer Service Department or sales representative.**
- **Take caution to clean the cables to avoid damage to the internal wire due to excessive bending and stretching.**
- **Do not clean or disinfect the metal parts of this equipment. Otherwise, metal part corrosion or product reliability deterioration could result.**
- **Frequent disinfection of the sensor can cause damage to it. It is recommend that the sensor assembly be disinfected only when necessary as determined by your hospital's policy.**

10.3 Cleaning the Telemetry Transmitter

CAUTION

- **The battery compartment is not water-proof. Do not touch the metal contact of the battery compartment when cleaning it.**
- **Only use the following recommended cleaning agents. Using the unrecommended cleaning agents may cause pollution or damage to the equipment, resulting in equipment failure.**

The equipment should be cleaned regularly. Especially in areas with severe environmental pollution or heavy wind and sand, the equipment should be clean more regularly. Before cleaning the equipment, consult your hospital's regulations for cleaning the equipment.

The following cleaning agents are available:

- Clean water
- Mild soap water

Perform the following preparations before cleaning the equipment:

- Install the lithium-ion battery or AA battery tray, and then firmly close battery compartment.
- Cover the SpO_2 port when SpO_2 is not in use.
- Plug the ECG leadwire to the ECG lead port of the equipment.

CAUTION

- **Never allow the cleaning agents to spill or enter the plug, connector or battery compartment.**

To clean the equipment, follow this procedure:

1. Shut down the equipment.
2. Dilute the mild soap water.
3. Use a soft cloth to absorb the cleaning agent.
4. Clean the display screen and exterior surface of the main with a soft cloth moistened with one of the cleaning agents.
5. Wipe off all the cleaning agent residue with a dry cloth.
6. Place the equipment in a ventilated and cool environment to air-dry.

10.4 Cleaning Accessories

The following cleaning agents are available:

- Clean water
- Mild soap water

To clean the accessories, follow this procedure:

1. Dilute the mild soap water.
2. Use a soft cloth to absorb the mild soap or clean water, and to wipe the SpO_2 sensor and its cable. Avoid wipe the SpO_2 port when wiping.
3. Wipe off all the cleaning agent residue with a dry cloth.
4. Place the SpO_2 sensor or its cable in a ventilated and cool environment to air-dry.

10.5 Cleaning Batteries and Battery Compartment

- Before and after each use, it is recommended to clean lithium battery and the surface of the AA battery tray.
- Use a soft cloth to absorb the mild soap or clean water, and to wipe the lithium battery and AA battery tray. Avoid scraping the metal contact in the battery compartment.
- Wipe off all the cleaning agent residue with a dry cloth.
- Place the lithium battery and AA battery tray in a ventilated and cool environment to air-dry.

CAUTION

- **Do not immerse the lithium battery and AA battery tray. Do not clean them with erosive cleanser (such as acetone or undiluted bleaching solution).**

10.6 Disinfecting Telemetry Transmitter, Battery and Battery Tray

Disinfect the telemetry transmitter, battery, and battery tray according to your hospital's disinfection regulations. Perform the cleaning procedure before disinfecting.

Recommended disinfectants are as follows:

Name	Type	Manufacturer
Alpet® D2 Surface Sanitizing Wipes	Wipes	BEST SANITIZERS INC™.
CIDEX® OPA	Liquid	Gilag GmbH International Advanced Sterilization products
Clorox Dispatch® Hospital Cleaner Disinfectant Towels with Bleach	Wipes	Clorox professional products company
Clorox Healthcare® Bleach Germicidal Wipes	Wipes	Clorox professional products company
Clorox Healthcare® Hydrogen Peroxide Cleaner Disinfectant Wipes	Wipes	Clorox professional products company
Diversey Oxivir® TB Wipes	Wipes	Diversey Inc
Metrex CaviCide1™	Liquid, spray	METERX® RESEARCH
Metrex CaviWipes™	Wipes	METERX® RESEARCH
PDI Sani-Cloth® AF3 Germicidal Disposable Wipe	Wipes	PDI Inc.
PDI Sani-Cloth® Bleach Germicidal Disposable Wipe	Wipes	PDI Inc.
PDI Sani-Cloth® HB Germicidal Disposable Wipe	Wipes	PDI Inc.

Name	Type	Manufacturer
PDI Sani-Cloth® Plus Germicidal Disposable Wipe	Wipes	PDI Inc.
PDI Super Sani-Cloth® Germicidal Disposable Wipe	Wipes	PDI Inc.
VIRAGUARD® Hospital Surface Disinfectant Towelettle	Wipes	VERIDIEN corporation
Virex® II 256 (1:256)	Liquid	Diversey Inc
Virex® TB	Liquid, spray	Diversey Inc
JIAN ZHI SU Disinfectant Tablets	Tablet	Beijing ChangJiangMai Medical Science Technology Co. Ltd
JIAN ZHI SU Surface Disinfectant Spray	Liquid, spray	Beijing ChangJiangMai Medical Science Technology Co. Ltd
JIAN ZHI SU Disinfectant, Double-chain Quaternary Ammonium	Liquid	Beijing ChangJiangMai Medical Science Technology Co. Ltd
DIAN'ERKANG Surface Wipes	Wipes	Shanghai Likang Disinfectant Hi-Tech Co., Ltd
DIAN'ERKANG Surface Disinfectant	Liquid	Shanghai Likang Disinfectant Hi-Tech Co., Ltd
DIAN'ERKANG Disinfectant Spray	Liquid, spray	Shanghai Likang Disinfectant Hi-Tech Co., Ltd
Clinell® Universal Wipes	Wipes	GAMA Healthcare Ltd
Clinell ® Sporicidal Wipes	Wipes	GAMA Healthcare Ltd
Tristel Duo™	Liquid, foam	Tristel solutions Limited
Tristel Jet	Liquid, spray	Tristel solutions Limited
Tristel Fuse For Surfaces, 196ppm	Liquid	Tristel solutions Limited
Surfanios Premium, 0.25%	Liquid	ANIOS LABORATORIES

Name	Type	Manufacturer
Surfa 'safe	Liquid, spray	ANIOS LABORATORIES
Wip' Anios premium	Wipes	ANIOS LABORATORIES
Aniosurf ND premium, 0.25%	Liquid	ANIOS LABORATORIES
Mikrobac® Wipes	Wipes	BODE Chemie GmbH
Cleanisept® Wipes	Wipes	Dr. Schumacher GmbH
mikrozid® PAA Wipes	Wipes	Schülke & Mayr GmbH
mikrozid® Wipes	Wipes	Schülke & Mayr GmbH
Ecolab Incidin® Wipes	Wipes	Ecolab Deutschland GmbH
Glutaraldehyde, 2%	Liquid	/
Ethanol, 70%	Liquid	/
Isopropanol, 70%	Liquid	/
Sodium hypochloritebleach, 0.5%	Liquid	/
Hydrogen peroxide, 3%	Liquid	/
Rely+On™ Virkon® High Level surface Disinfectant	Powder	Antec International Ltd
1-Propanol, 50%	Liquid	/
Descosept® forte	Liquid	Dr. Schumacher GmbH
Descosept® AF	Liquid	Dr. Schumacher GmbH
Dismozon® plus, 0.4%	Powder	BODE Chemie GmbH
mikrozid® AF Wipes	Wipes	Schülke & Mayr GmbH
*Terralin® Liquid	Liquid	Schülke & Mayr GmbH

Name	Type	Manufacturer
*Perform® Classic Concentrate OXY, 0.5%	Powder	Schülke & Mayr GmbH

10.7 Disinfecting Accessories

Disinfect the SpO_2 sensor and its cable according to your hospital's disinfection regulations. Perform the cleaning procedure before disinfecting.

10.7.1 Disinfectants of SpO_2 Sensor

Recommended disinfectants for SpO_2 sensor are as follows:

Name	Type	Manufacturer
CIDEX® OPA	Liquid	Gilag GmbH International Advanced Sterilization Products
Clorox Dispatch® Hospital Cleaner Disinfectant Towels with Bleach	Wipes	Clorox professional products company
Clorox Healthcare® Bleach Germicidal Wipes	Wipes	Clorox professional products company
Metrex CaviWipes™	Wipes	METERX® RESEARCH
PDI Sani-Cloth® Plus Germicidal Disposable Wipe	Wipes	PDI Inc.
PDI Super Sani-Cloth® Germicidal Disposable Wipe	Wipes	PDI Inc.
VIRAGUARD® Hospital Surface Disinfectant Towelettle	Wipes	VERIDIEN corporation
Mikrozid®Sensentive Wipes	Liquid	Schülke & Mayr GmbH
Glutaraldehyde, 2%	Liquid	/
Ethanol, 70%	Liquid	/
Isopropanol, 70%	Liquid	/
Propanol, 50%	Liquid	/
JIAN ZHI SU Surface Disinfectant Spray	Liquid, spray	Beijing ChangJiangMai Medical Science Technology Co. Ltd

Name	Type	Manufacturer
DIAN'ERKANG Surface Wipes	Wipes	Shanghai Likang Disinfectant Hi-Tech Co., Ltd
Alpet® D2 Surface Sanitizing Wipes	Wipes	BEST SANITIZERS INC™

10.7.2 Disinfectants of SpO_2 Cable

Recommended disinfectants for SpO_2 cable are as follows:

Name	Type	Manufacturer
CIDEX® OPA	Liquid	Gilag GmbH International Advanced Sterilization Products
Clorox Dispatch® Hospital Cleaner Disinfectant Towels with Bleach	Wipes	Clorox professional products company
Clorox Healthcare® Bleach Germicidal Wipes	Wipes	Clorox professional products company
Clorox Healthcare® Hydrogen Peroxide Cleaner Disinfectant Wipes	Wipes	Clorox professional products company
Diversey Oxivir® TB Wipes	Wipes	Diversey Inc.
PDI Super Sani-Cloth® Germicidal Disposable Wipe	Wipes	PDI Inc.
VIRAGUARD® Hospital Surface Disinfectant Towelette	Wipes	VERIDIEN corporation
Virex® TB	Liquid, spray	Diversey Inc.
Glutaraldehyde, 2%	Liquid	/
Ethanol, 70%	Liquid	/
Isopropanol, 70%	Liquid	/
Sodium hypochloritebleach,	Liquid	/
Hydrogen peroxide, 3%	Liquid	/

Name	Type	Manufacturer
Rely+On™ Virkon® High Level surface Disinfectant	Powder	Antec International Ltd
1-Propanol, 50%	Liquid	/

10.8 Sterilization

Sterilization is not recommended for this equipment, related products, accessories or supplies unless otherwise indicated in the Operating Instructions that accompany the accessories or supplies.

11 Maintenance

11.1 Overview

The equipment is designed for stable operation over long periods of time and under normal circumstances should not require technical maintenance beyond that described in this chapter. However, calibration and safety checks are recommended at least once a year or more often as required by local statutory or hospital administration practice.

11.2 Safety Information

WARNING

- **Individual hospital or institution employing the use of the equipment should implement a satisfactory maintenance schedule. Otherwise, device failure, unpredictable results or personnel injury may occur.**
- **The equipment does not contain user-serviceable components. If maintenance is required, contact Customer Service Department or sales representative.**
- **The safety checks or maintenance involving any disassembly of the equipment should be performed by service personnel. Otherwise, undue equipment failure and possible health hazards could result.**
- **When the equipment is accidentally wet, it should be placed in a dry and ventilated environment before being turned on.**
- **No modification of this equipment is allowed.**
- **Do not open housings of the central charger as you may suffer an electric shock.**
- **Only the personnel trained and authorized by Mindray Animal Medical are qualified to repair and upgrade the product.**
- **Only use components, accessories as well as consumables are provided or qualified by Mindray Animal Medical.**
- **If you discover problems of any equipment, contact Customer Service Department or sales representative.**
- **The service personnel must be properly qualified and thoroughly familiar with the equipment's operation.**

CAUTION

- **If necessary, contact Mindray Animal Medical for part lists, calibration instruction or other device maintenance information.**
- **The main unit and its accessories must be discarded according to local regulations when they reach the service life. If you have any problem concerning the disposable of the equipment, contact Mindray Animal Medical.**
- **When disposing of the packaging material, be sure to observe the applicable local waste control regulations.**
- **The equipment must be stored and used at the temperature and humidity specified in this manual.**

11.3 Regular Check

Perform a visual inspection before the equipment is first used every day. If any damage or abnormality is found, stop using the equipment immediately and contact equipment engineer of the hospital or Customer Service Department or sales representative.

Visual inspection includes the following items:

- The housing and display screen are free from cracks or other damages.
- All keys function properly.
- Connectors are not loose, cracked, or bent and cables have no cuts, nicks, or fraying.
- ECG leadwires are securely connected with the equipment.
- Battery is installed and has sufficient charge.

After your equipment has been used for 6 to 12 months, or whenever your equipment is repaired or upgraded, a thorough inspection should be performed by qualified service personnel to ensure the reliability.

Follow these guidelines when inspecting the equipment:

- Make sure that the environment and power supply meet the requirements.
- Inspect the devices and their accessories for mechanical damage.
- Inspect all connectors and leadwires for damage, and make sure that their insulation is in good condition.
- Make sure that only specified accessories are applied.
- Make sure that the battery meet the performance requirements.
- Make sure that the equipment is in good working condition.

11.4 Maintenance Plan

The following maintenance and tests, except for visual inspection, power-on test, and battery check, shall be carried out by the specified service personnel only. If maintenance is required, contact Customer Service Department or sales representative. Make sure to clean and disinfect the equipment before any test and maintenance.

Check Items		Recommended Frequency
Visual inspection		When the equipment is first installed or reinstalled.
Power-on test		1. When the equipment is first installed or reinstalled. 2. Following any repairs or replacement of relevant component.
ECG Test	Performance test	1. If the user suspects that the measurement is incorrect. 2. Following any repairs or replacement of relevant module. 3. At least twice a year.
	Module calibration	
SpO_2 test		
Electrical safety inspection Tests required by IEC 60601-1		1. Following any repairs or replacement of power supply. 2. At least twice a year or as needed.
Network print test		1. When the equipment is first installed. 2. Whenever the printer is serviced or replaced.
Battery check	Functionality test	1. When the equipment is first installed. Whenever a battery is replaced.
	Performance test	Once every two month or when the lithium-ion battery run time is reduced significantly.

11.4.1 Power-on test

The equipment performs a self-test during startup. For details, see ***3.4 Turning On the Equipment***.

11.4.2 Battery Check

For details about the battery charge check and maintenance, see ***9.6 Charging the Rechargeable Lithium-ion Battery***.

11.5 Viewing System Information

To view the system information, follow this procedure:

1. On the main screen, hold and press  and  for 2 seconds to view the system information.

2. On the system information screen, press key to browse the system information upward and press key to browse the system information downward.

Hold and press and simultaneously for 2 seconds to exit the system information screen and return to the main screen.

11.6 Dispose of the Equipment

Once the device has reached its service life, dispose of it in accordance with local regulations.

WARNING

- **Dispose of this equipment and accessories in accordance with local regulations for the disposal of hospital waste.**

12 Accessories

The accessories listed in this chapter comply with the requirements of IEC 60601-1-2 when in use with the equipment. For details about the accessories, refer to the instructions for use provided with the accessory.

WARNING

- **The accessories listed in this chapter must be used in conjunction with Mindray Animal Medical monitoring equipment.The operator shall be responsible for understanding this manual (Including the accessories) or consulting with us to confirm the compatibility of this equipment and accessories. Otherwise, animal injury may occur.**
- **Use accessories specified in this chapter. Using other accessories may cause damage to the equipment or not meet the claimed specifications.**
- **Single-use accessories can only be used once. Repeated use may lead to performance deterioration or cross infection.**
- **If you find any damage to the packaging or accessories, do not use the accessories.**
- **Use the accessories before the expiry date if their expiry date is indicated.**
- **The disposable accessories shall be disposed of according to the hospital's regulations.**

12.1 ECG Accessories

Name	Model	Description	Type
ECG Electrodes	EY6316B	3-lead, AHA, Snap, 24"	Reusable
	EY6305B	3-lead, AHA, Snap, 36"	Reusable
	EY6307B	3-lead, IEC, Snap, 24"	Reusable
	EY6308B	3-lead, IEC, Snap, 36"	Reusable
Veterinary ECG Elecrtodes	EB6900 Vet	Disposable ECG Elecrtodes	Disposable
	EB6901 Vet	Metal Elecrtode (Vet)	Reusable

Name	Model	Description	Type
Veterinary Telemetry Pouch	/	Veterinary Telemetry Pouch (XS, 3-5kg)	Reusable
	/	Veterinary Telemetry Pouch (S, 5-10kg)	Reusable
	/	Veterinary Telemetry Pouch (M, 10-20kg)	Reusable
	/	Veterinary Telemetry Pouch (L, 20-40kg)	Reusable

12.2 SpO_2 Accessories

Name	Model	Description	Type
Extension Cables	563B	Telemetry Extension Cables	Reusable
SpO_2 Sensor	551B	Veterinary SpO_2 Sensor (Separable, reusable, clip)	Reusable

Wavelength emitted by the sensors is between 600 nm and 1000 nm. The maximum photic output consumption of the sensor is less than 18 mW. The information about the wavelength range and maximum photic output consumption can be especially useful to clinicians, for example, when photodynamic therapy is performed.

A Product Specifications

NOTE

- **For the product specifications about the central charger, see Central Charger Operator's Manual.**

A.1 Classifications

The equipment is classified, according to IEC 60601-1:

Degree of protection against electrical shock	Telemetry transmitter: internal power supply AP: information technology equipment, class III
Type of protection against electrical shock (telemetry transmitter)	Type CF defibrillation proof for ECG and SpO_2
Mode of operation	Continuous
Degree of protection against harmful ingress of water	Telemetry transmitter (without battery compartment): IPX7 AP: IPX1
Degree of protection against hazard of dropping	No damage by dropping from a height of 1.5 m.

The equipment can not be used in the presence of flammable anesthetics mixed with air, or flammable anesthetics mixed with oxygen or nitrous oxide.

For the recommended disinfection and sterilization methods, see ***10 Care and Cleaning***.

A.2 Environmental Specifications

WARNING

- **If the equipment is stored or used beyond the specified temperature and humidity range, its performance may be compromised.**

Item	Operating conditions	Storage conditions
Temperature	0 °C ~ 40 °C	-20 °C ~ 60 °C
Relative humidity (noncondensing)	15% ~ 95%	10% ~ 95%
Atmospheric pressure	57.0 kPa ~ 107.4 kPa	16.0 kPa ~ 107.4 kPa

A.3 Power Supply Specifications

A.3.1 Telemetry Transmitter Battery Specifications

Battery type	AA batteries or lithium battery
AA battery voltage	1.5 V x 3
Lithium battery	3.8 V
Capacity for lithium battery	3600 mAh
Runtime	A new fully charged lithium-ion battery, 25°C, typical configuration: at least 180 h (on the working mode that the screen is off, it does not display waveform and parameters, and only sends data to the CMS). A new 3 AA batteries, 25°C, typical configuration: at least 115h (on the working mode that the screen is off, it does not display waveform and parameters, and only sends data to the CMS).
Low battery prompt	At least 15 minutes after the low battery alarm first occurs.

NOTE

- **The working hours of the lithium-ion batteries listed in the above table are typical working hours. They are affected by the wireless signal interference, battery aging, frequent screen switches, and SpO_2 accessory wearing differences. The actual working hours will be different.**

A.3.2 AP External Power Supply Specifications

Input voltage	36-57 VDC
Input current	0.35-0.1A, PoE supply

A.4 Physical Specifications

Parts	Weight	Dimensions
Telemetry transmitter (with lithium-ion battery)	≤170 g	≤99 mm X 60 mm X 24 mm
AP	1000 g	≤300 mm X 300 mm X 60 mm

A.5 Telemetry Transmitter Hardware Specifications

Display screen	
Screen type	Color screen
Screen size	1.54 inch
Resolution	240 pixels × 240 pixels
Button	
Manual event key	1
Power on/off and screen off key	1
Main menu key	1
External Interfaces	
ECG port	1
SPO_2 port	1

A.6 Wi-Fi Specifications

WARNING

- **All network functions related to data communication must be performed in a closed network environment.**

A.6.1 WMTS Specifications

Protocol	Private protocol
Operating frequency	608 ~ 630 MHz
Data security	Private protocol
Transmission delay	Data delay time of the telemetry transmitter transmitting to central monitoring system: ≤3 s
System capacity	Maximum capacity by a single AP: 3-lead, 16 devices
Wireless coexistence	The TMS30 Vet and its co-channel interference power works properly when the value is -85 dBm. The TMS30 Vet and its adjacent channel interference power works properly at -40 dBm.
Network interruption alarm	When the network is interrupted, the CMS triggers a related alarm no more than 8s. After the network recovers, the wireless connection can be restored automatically.

A.7 Measurement Specifications

A.7.1 ECG Specifications

ECG	
Compatible with	IEC 60601-2-27
Leadset	3-lead: I, II, III

Frequency characteristics(display and recording)	Monitor mode: 0.5 Hz ~ 40 Hz (+0.4 dB -3.0 dB) ST mode: 0.05 Hz ~ 40 Hz (+0.4 dB -3.0 dB) Running mode:1Hz~20 Hz (+0.4 dB -3.0 dB)
Notch filter	Provides 50 Hz/60 Hz notch filter Rejection capacity ≥ 20 dB
Input signal range	The -8 mV ~ +8 mV positive and negative polarity detection signals can be detected, and the heart rate value is displayed.
Common mode rejection ratio	Monitor mode: >105 dB ST mode: >105 dB Running mode: >105 dB
DC bias voltage	±500 mV
Lead-off detection current	Measuring electrode: <0.1 μA Drive electrode: <1 μA
Defibrillation recovery time	<5s
System noise	The noise level converted to the input end should not be greater than 30 μV.(Peak-to-peak value)
Calibration signal	1 mV (peak-to-peak value) Accuracy±5%
Input impedance	≥ 5 MΩ
Polarization voltage range	±500 mV
HR	
Measurement Range	15 bpm ~ 350 bpm
Resolution	1 bpm
Accuracy	3-Lead: ±1 bpm or ±1%, whichever is greater

HR averaging method	In compliance with the requirements of IEC 60601-2-27. The following method is used: If the last 3 consecutive RR intervals are greater than 1200 ms, the 4 most recent RR intervals are averaged to compute the HR. Otherwise, heart rate is computed by subtracting the maximum and minimum ones from the most recent 12 RR intervals and then averaging them. The HR value displayed on the monitor screen is updated no more than one second.
Response to irregular rhythm	In compliance with the requirements of IEC 60601-2-27. The heart rate after 20 seconds of stabilization is displayed as follows: Waveform 3a (ventricular bigeminy): 80 ±1 bpm Waveform 3b (slow alternating ventricular bigeminy): 60 ±1 bpm Waveform 3b (rapid alternating ventricular bigeminy): 120 ±1 bpm Waveform 3d (bidirectional systoles): 90 ±2 bpm
Response time to heart rate change	In compliance with the requirements of IEC 60601-2-27. From 80 to 120 bpm: less than 11s From 80 to 40 bpm: less than 11s
Time to alarm * for tachycardia	In compliance with the requirements in of IEC 60601-2-27. 4ah - range: < 11s 4a - range: < 11s 4ad - range: < 11s 4bh - range: < 11s 4b - range: < 11s 4bd - range: < 11s
Tall T-wave rejection capability	When the test is performed based on IEC 60601-2-27, the heart rate calculation will reject for QRS of amplitude lower than 1.2 mV and 100 ms duration, T-wave duration of 180 ms and QT interval of 350 ms.
*: tachycardia alarm displays at the CMS	

A.7.2 SpO_2 Specification

Mindray SpO_2	
Standard	ISO 80601-2-61

Measurement Range	0% ~ 100%
Resolution	1%
Accuracy	70% ~ 100%: ±2% 0% ~ 69%: not specified
Data update rate	≤ 2s
Defibrillation recovery time	< 15s
Perfusion indicator (PI)	
Measurement Range	0.05% ~20%
Minimum resolution	0.01%, use 3 significant digits
PR	
Measurement Range	20 bpm ~ 300 bpm
Accuracy	±3 bpm
Resolution	1 bpm

B EMC and Radio Regulatory Compliance

B.1 EMC

The device meets the requirements of IEC 60601-1-2: 2014.

NOTE

- **Use of accessories, transducers and cables other than those specified or provided by the manufacturer of this device could result in increased electromagnetic emissions or decreased electromagnetic immunity of this device and result in improper operation.**
- **Use of this device adjacent to or stacked with other device should be avoided because it could result in improper operation. If necessary, this device and the other device should be observed to verify that they are operating normally.**
- **The device needs special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided below.**
- **Other devices may interfere with this device even though they meet the requirements of CISPR.**
- **When the input signal is below the minimum amplitude provided in technical specifications, erroneous measurements could result.**
- **Portable and mobile communication devices affect the performance of this device.**
- **Other devices that contain RF emissions may affect this device (e.g., mobile phones, PAD, wireless computers).**

Guidance and Declaration - Electromagnetic Emissions		
The device is intended for use in the electromagnetic environment specified below. The customer or the user of the device should assure that it is used in such an environment.		
Emissions test	**Compliance**	**Electromagnetic environment-guidance**
RF emissions CISPR 11	Group 1	The device uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.

RF emissions CISPR 11	Class B	The device is suitable for use in all establishments, including domestic and those directly connected to the public low-voltage power supply network.
RF emissions CISPR 11	Class A	The device is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Not applicable.	
Voltage fluctuations/ flicker emissions IEC 61000-3-3	Not applicable.	

WARNING

- **The equipment is intended for use only by clinical professionals or under their guidance. It must only be used by persons who have received adequate training in its use. Anyone unauthorized or untrained must not perform any operation on it. The device may be disrupted by the electromagnetic interference of nearby equipment. It may be necessary to take mitigation measures, such as re-orienting or relocating the non-ME EQUIPMENT or shielding the location.**

If the device is operated within the electromagnetic environment listed in Table Guidance and declaration - electromagnetic immunity, the device will provide the following essential performance:

- Mode of operation
- Accuracy
- Function
- Accessories identification
- Network connection and transmission

Guidance and Declaration - Electromagnetic Immunity
The device is intended for use in the electromagnetic environment specified below. The customer or the user of the device should assure that it is used in such an environment.

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment - guidance
Electrostatic discharge (ESD) IEC 61000-4-2	±8 kV contact ±15 kV air	±8 kV contact ±15 kV air	Floors should be wood, concrete or ceramic tile. floors are covered with synthetic material, relative humidity should be at least 30%
Electrical fast transient/ burst (EFT) IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/ output lines	±2 kV for power supply lines ±1 kV for input/ output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	±1 kV line(s) to line(s) ±2 kV line(s) to earth	±1 kV line(s) to line(s) ±2 kV line(s) to earth	
Voltage dips and voltage interruptions IEC 61000-4-11	0% U_T for 0,5 cycle 0% U_T for 1 cycle and 70% U_T for 25/30 cycles 0% U_T for 250/300 cycle	0% U_T for 0,5 cycle 0% U_T for 1 cycle and 70% U_T for 25/30 cycles 0% U_T for 250/300 cycle	Mains power quality should be that of a typical commercial or hospital environment. If the user of our device requires continued operation during power interruptions, it is recommended that our device be powered from an uninterruptible power supply or a battery.
RATED power frequency magnetic fields (50/60Hz) IEC 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.
Note: U_T is the AC mains voltage prior to application of the test level.			

Guidance and Declaration - Electromagnetic Immunity			
The device is intended for use in the electromagnetic environment specified below. The customer or the user of the device should assure that it is used in such an environment.			
Immunity test	**IEC60601 Test level**	**Compliance level**	**Electromagnetic environment - guidance**
Conduced RF IEC 61000-4-6	3 V (valid value) 150 kHz ~ 80 MHz	3 Vrms	Portable and mobile RF communications equipment should be used no closer to any part of the device, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. Recommended separation distance: 150 kHz ~ 80 MHz $d = \left[\frac{3.5}{V}\right] \times \sqrt{P}$

Radiated RF EM fields IEC 61000-4-3	3 V/m 80 MHz ~ 2.7 GHz	3 V/m	Recommended separation distance: 80 MHz ~ 800 MHz: $d = \left[\frac{3.5}{E}\right] \times \sqrt{P}$ 800 MHz ~ 2.7 GHz: $d = \left[\frac{7}{E}\right] \times \sqrt{P}$ Where: P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer. d is the recommended separation distance in meters (m)[b]. Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey[c], should be less than the compliance level in each frequency range[d]. Interference may occur in the vicinity of equipment marked with the following symbol: 

Note 1: At 80 MHz and 800 MHz, the higher frequency range applies.

Note 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

Note 3: This device is used to receive the RF electromagnetic energy. Although it is exempt from the requirement of RF-related performance in the occupied band (2395.825MHz-2487.645MHz), bur remains safe.

a. Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the device is used exceeds the applicable RF compliance level above, the device should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the device.

b. Over the frequency ranges 150 KHz to 80 MHz, field strengths should be less than 3V/m.

WARNING

- **This device is equipped with an wireless network interface for receiving radio frequency electromagnetic energy for operation. Therefore, other devices may interfere with this device even though they meet the requirements of CISPR.**

It is recommended to maintain the distance between the portable/ and mobile RF communication devices and this device.

The equipment is intended for use in an electromagnetic environment in which radiated RF disturbance are controlled. The customer or the user of this device can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and this device as recommended below, according to the maximum output power of the communication equipment.

Rated Maximum Output Power of Transmitter Watts (W)	**Separation Distance According to Frequency of Transmitter (m)**		
	150 kHz ~ 80 MHz $d=\left[\frac{3.5}{V}\right]\times\sqrt{P}$	80 MHz ~ 800 MHz $d=\left[\frac{3.5}{E}\right]\times\sqrt{P}$	800 MHz ~ 2.7 GHz $d=\left[\frac{7}{E}\right]\times\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.38	0.38	0.73
1	1.20	1.20	2.30
10	3.80	3.80	7.30
100	12.00	12.00	23.00

For transmitters at a maximum output power not listed above, the recommended separation distanced in meters (m) can be determined using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

Note 1: At 80 MHz and 800 MHz, the higher frequency range applies.

Note 2: These guidelines may apply to all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

B.2 Radio Regulatory Compliance

The radio device used in this product is in compliance with the essential requirements and other relevant provisions of Directive 2014/53/EU.

This device complies with part 15 of the FCC Rules. Operation is subject to the condition that this device does not cause harmful interference.

This device must accept any interference received, including interference that may cause undesired operation.

WARNING

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

C Abbreviations

Abbreviation	In Full
AAMI	Association for Advancement of Medical Instrumentation
AC	alternating current
AHA	American Heart Association
ANSI	American National Standard Institue
ARR	arrhythmia
ART	arterial
AUX	Auxiliary output
aVF	left foot augmented lead
aVL	left arm augmented lead
aVR	right arm augmented lead
CISPR	International Special Commmittee on Radio Interferennce
CMS	central monitoring system
ECG	electrocardiograph
EEC	European Economic Community
EMC	electromagnetic compatibility
err	error
ES	electrosuigical
ESU	electrosuigical unit
HT	height
IEC	International Electrotechnical Commission
ISO	International organization for standardization
LA(L)	left arm
LED	light emitting diode
LL(F)	left leg

Abbreviation	In Full
MPAN	Mindray Personal Area Network
MRI	magnetic resonance imaging
M, MEAN	mean pressure
P	power
PD	photodetector
PR	pulse rate
PVCs	premature ventricular contraction
QRS	interval of ventricular depolarization (QRS complex)
RA (R)	right arm
RL (N)	right leg
SpO_2	arterial oxygen saturation from pulse oximetry
S, SYS	systolic pressure
V (C)	precordial lead (Chest)

Caution:

This device complies with Part 15 and Part 95 of the FCC rules and Industry Canada license-exempt RSS standard(s). 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. Any changes or modifications to this equipment not expressly approved by Shenzhen Mindray Animal Medical Technology Co., Ltd. may cause harmful radio frequency interference and void your authority to operate this equipment.

Installation of this telemetry device is permitted in hospitals and health care facilities only. This device shall not be operated in mobile vehicles (including ambulances and other vehicles associated with health care facilities). The installer/user of this device shall ensure that it is at least 80 km from the radio astronomy observatories listed below.
(i) National Astronomy and Ionosphere Center, Arecibo, Puerto Rico: 18° －20′ －38.28′ North Latitude, 66° －45′ －09.42′ West Longitude;
(ii) National Radio Astronomy Observatory, Socorro, New Mexico: 34° －04′ －43′ North Latitude, 107° －37′ －04′ West Longitude; or
(iii) National Radio Astronomy Observatory, Green Bank, West Virginia: 38° －26′ －08′ North Latitude, 79° －49′ －42′ West Longitude.
For medical telemetry systems not meeting this 80 km separation (e.g. the Okanagan Valley, British Columbia) the installer/ user must coordinate with, and obtain the written concurrence of, the National Science Foundation (NSF) before the equipment can be installed or operated. The National Science Foundation (NSF) point of contact for coordination is: Division of Astronomical Sciences, Electromagnetic Spectrum Management Unit, 2415 Eisenhower Avenue, Alexandria, VA 22314; Email: esm@nsf.gov.

The manufacturer is not responsible for any radio or TV interference caused by unauthorized modifications or change to this equipment. Such modifications or change could void the user’s authority to operate the equipment.
This radio transmitter (identify the device by certification number or model number if Category II) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 and Part 95 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.

The device has been evaluated to meet general RF exposure requirement.

To maintain compliance with FCC's RF exposure guidelines, this equipment should be installed and operated with a minimum distance of 5mm between the radiator and your body.