# Operator's Manual

# Transmitter

ZM-520PA, ZM-521PA
ZM-530PA, ZM-531PA

0614-904743G

NIHON KOHDEN

# About This Manual

In order to use this product safely and fully understand all its functions, read this manual before using the product. Keep this manual near the instrument or in the reach of the operator and refer to it whenever the operation is unclear.

The manual is only included on the CD. We recommend printing a copy of the electronic data for reference in case of emergency. If you require printed version of the manual, contact your Nihon Kohden representative.



This product stores personal patient information. Manage the information appropriately.
Patient names on the screen shots and recording examples in this manual are fictional and any resemblance to any person living or dead is purely coincidental.
The contents of this manual are subject to change without notice. If you have any comments or suggestions on this manual, please contact us at: https://www.nihonkohden.com/

# Contents

# GENERAL HANDLING PRECAUTIONS

This device is intended for use only by qualified medical personnel.
Use only Nihon Kohden approved products with this device. Use of non-approved products or in a non-approved manner may affect the performance specifications of the device. This includes, but is not limited to, batteries, recording paper, pens, extension cables, electrode leads, input boxes and AC power.

**Please read these precautions thoroughly before attempting to operate the instrument.**

1. **To safely and effectively use the instrument, its operation must be fully understood.**

2. **When installing or storing the instrument, take the following precautions.**
   (1) Avoid moisture or contact with water, extreme atmospheric pressure, excessive humidity and temperatures, poorly ventilated areas, and dust, saline or sulphuric air.
   (2) Place the instrument on an even, level floor. Avoid vibration and mechanical shock, even during transport.
   (3) Avoid placing in an area where chemicals are stored or where there is danger of gas leakage.
   (4) The power line source to be applied to the instrument must correspond in frequency and voltage to product specifications, and have sufficient current capacity.
   (5) Choose a room where a proper grounding facility is available.

3. **Before Operation**
   (1) Check that the instrument is in perfect operating order. Check for cracks and breaks on the case.
   (2) Check that the instrument is grounded properly.
   (3) Check that all cords are connected properly.
   (4) Pay extra attention when the instrument is in combination with other instruments to avoid misdiagnosis or other problems.
   (5) All circuitry used for direct patient connection must be doubly checked.
   (6) Check that battery level is acceptable and battery condition is good when using battery-operated models.

4. **During Operation**
   (1) Both the instrument and the patient must receive continual, careful attention.
   (2) Turn power off or remove electrodes and/or transducers when necessary to assure the patient's safety.
   (3) Avoid direct contact between the instrument housing and the patient.
   (4) Avoid dropping the transmitter. This may damage the transmitter LCD display. When dropped, the LCD display may show no image (white screen) or a partial image.

5. **To Shutdown After Use**
   (1) Turn power off with all controls returned to their original positions.
   (2) Remove the cords gently; do not use force to remove them.
   (3) Clean the instrument together with all accessories for their next use.

6. **The instrument must receive expert, professional attention for maintenance and repairs. When the instrument is not functioning properly, it should be clearly marked to avoid operation while it is out of order.**

7. **The instrument must not be altered or modified in any way.**

8. **Maintenance and Inspection**
   (1) The instrument and parts must undergo regular maintenance inspection at the interval which is specified after the GENERAL HANDLING PRECAUTIONS section.
   (2) If stored for extended periods without being used, make sure prior to operation that the instrument is in perfect operating condition.
   (3) Technical information such as parts list, descriptions, calibration instructions or other information is available for qualified user technical personnel upon request from your Nihon Kohden representative.

9. **When the instrument is used with an electrosurgical instrument, pay careful attention to the application and/or location of electrodes and/or transducers to avoid possible burn to the patient.**

10. **When the instrument is used with a defibrillator, make sure that the instrument is protected against defibrillator discharge. If not, remove patient cables and/or transducers from the instrument to avoid possible damage.**

# WARRANTY POLICY

Nihon Kohden Corporation (NKC) shall warrant its products against all defects in materials and workmanship for one year from the date of delivery. However, consumable materials such as recording paper, ink, stylus and battery are excluded from the warranty.

NKC or its authorized agents will repair or replace any products which prove to be defective during the warranty period, provided these products are used as prescribed by the operating instructions given in the operator's and service manuals.

No other party is authorized to make any warranty or assume liability for NKC's products. NKC will not recognize any other warranty, either implied or in writing. In addition, service, technical modification or any other product change performed by someone other than NKC or its authorized agents without prior consent of NKC may be cause for voiding this warranty.

Defective products or parts must be returned to NKC or its authorized agents, along with an explanation of the failure. Shipping costs must be pre-paid.

This warranty does not apply to products that have been modified, disassembled, reinstalled or repaired without Nihon Kohden approval or which have been subjected to neglect or accident, damage due to accident, fire, lightning, vandalism, water or other casualty, improper installation or application, or on which the original identification marks have been removed.

In the USA and Canada other warranty policies may apply.

**CAUTION**

United States law restricts this device to sale by or on the order of a physician.

# Equipment Authorization Requirement

### Compliance with FCC Requirements

This device complies with Part 15 of the FCC (Federal Communications Commission) Rules. Operation is subject to the following two conditions:

(1) this device may not cause harmful interference, and

(2) this device must accept any interference received, including interference that may cause undesired operation.

This device complies with Part 95 Subpart H of the FCC Rules to be used in wireless medical telemetry service.

Operation of this equipment requires the prior coordination with a frequency coordinator designated by FCC for the Wireless Medical Telemetry Service.

**CAUTION**

To comply with the FCC radio frequency (RF) exposure compliance requirements, no change to the antenna or the device is permitted. Any change to the antenna or the device could result in the device, exceeding the RF exposure requirements and void user's authority to operate this device.

**NOTE**

- Use this device only indoors.
- This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment and meets the FCC radio frequency (RF) Exposure Guidelines as this equipment has very low levels of RF energy. This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.
- The devices require registration and deployment by an authorized frequency coordinator. The ASHE (American Society for Healthcare Engineering) has been designated by the FCC to manage the WMTS frequencies. This device has frequency bands which may not be used in some areas. For details, contact your Nihon Kohden representative. For details on the guidelines, refer to the ASHE home page.

## EMC RELATED CAUTION

This equipment and/or system complies with the International Standard IEC 60601-1-2 for electromagnetic compatibility for medical electrical equipment and/or system. However, an electromagnetic environment that exceeds the limits or levels stipulated in the IEC 60601-1-2, can cause harmful interference to the equipment and/or system or cause the equipment and/or system to fail to perform its intended function or degrade its intended performance. Therefore, during the operation of the equipment and/or system, if there is any undesired deviation from its intended operational performance, you must avoid, identify and resolve the adverse electromagnetic effect before continuing to use the equipment and/or system.

The following describes some common interference sources and remedial actions:

1. Strong electromagnetic interference from a nearby emitter source such as an authorized radio station or cellular phone
   Install the equipment and/or system at another location if it is interfered with by an emitter source such as an authorized radio station. Keep the emitter source such as cellular phone away from the equipment and/or system.

2. Effect of direct or indirect electrostatic discharge
   Make sure all users and patients in contact with the equipment and/or system are free from direct or indirect electrostatic energy before using it.

3. Electromagnetic interference with any radio wave receiver such as radio or television
   If the equipment and/or system interferes with any radio wave receiver, locate the equipment and/or system as far as possible from the radio wave receiver.

4. Electromagnetic interference with any radio wave receiver such as radio or television
   If the equipment and/or system interferes with any radio wave receiver, locate the equipment and/or system as far as possible from the radio wave receiver.

5. Interference of lightning
   When lightning occurs near the location where the equipment and/or system is installed, it may induce an excessive voltage in the equipment and/or system. In such a case, disconnect the AC power cord from the equipment and/or system and operate the equipment and/or system by battery power, or use an uninterruptible power supply.

6. Warning: Use with other equipment
   When the equipment and/or system is adjacent to or stacked with other equipment, the equipment and/or system may affect the other equipment. Before use, check that the equipment and/or system operates normally with the other equipment.

7. Warning: Use of unspecified accessory, transducer and/or cable
   When an unspecified accessory, transducer and/or cable is connected to this equipment and/or system, it may cause increased electromagnetic emission or decreased electromagnetic immunity. The specified configuration of this equipment and/or system complies with the electromagnetic requirements with the specified configuration. Only use this equipment and/or system with the specified configuration.

8. Use of unspecified configuration
   When the equipment and/or system is used with the unspecified system configuration different than the configuration of EMC testing, it may cause increased electromagnetic emission or decreased electromagnetic immunity. Only use this equipment and/or system with the specified configuration.

9. Measurement with excessive sensitivity
   The equipment and/or system is designed to measure bioelectrical signals with a specified sensitivity. If the equipment and/or system is used with excessive sensitivity, artifact may appear by electromagnetic interference and this may cause mis-diagnosis. When unexpected artifact appears, inspect the surrounding electromagnetic conditions and remove this artifact source.

10. Use with radiation therapy equipment
    When the equipment and/or system is used in a radiotherapy room, it may cause failure or malfunction due to electromagnetic radiation or corpuscular radiation. When you bring the equipment and/or system into a radiotherapy room, constantly observe the operation. Prepare countermeasures in case of failure or malfunction.

If the above suggested remedial actions do not solve the problem, consult your Nihon Kohden representative for additional suggestions.

## Conventions Used in this Manual and Instrument

### Warnings, Cautions and Notes

Warnings, cautions and notes are used in this manual to alert or signal the reader to specific information.

**WARNING**

A warning alerts the user to the possible injury or death associated with the use or misuse of the instrument.

**CAUTION**

A caution alerts the user to possible injury or problems with the instrument associated with its use or misuse such as instrument malfunction, instrument failure, damage to the instrument, or damage to other property.

**NOTE**

A note provides specific information, in the form of recommendations, prerequirements, alternative methods or supplemental information.

### Explanations of the Symbols in this Manual and Instrument

The following symbols found in this manual/instrument bear the respective descriptions as given.

On Panel

| Symbol | Description | Symbol | Description |
|---|---|---|---|
|  | Change screen |  | Defibrillation proof type BF applied part |
|  | Attention, consult operator's manual |  | Defibrillation proof type CF applied part |
|  | Moves cursor, scrolls data | SN | Serial number |
|  | Direction for attaching battery cover |  | Date of manufacture |
|  | Direction for inserting battery |  | RF transmitter<br>Non-ionizing radiation |
|  | Direct current |  | cCSAus mark |
|  | Call key | | |

On LCD

| Symbol | Description | Symbol | Description |
|---|---|---|---|
|  | Batteries are fully charged |  | Batteries are almost empty<br>Replace battery |
|  | Batteries are getting low |  | Alarm suspended |
|  | Batteries are low |  | QRS/pulse sync mark |

# Intended Use

## General

The ZM-520PA and ZM-521PA transmitters transmit ECG and respiration from a patient to a Nihon Kohden monitor for continuous monitoring. The front LCD displays ECG, numeric values of monitoring parameters, messages and battery condition.* They also display the compressed waveform and numeric data of the latest 10 minutes.

The ZM-530PA and ZM-531PA transmitters transmit ECG, respiration and pulse waveforms and $SpO_2$ from a patient to a Nihon Kohden monitor for continuous monitoring. The front LCD displays ECG (or pulse wave), numeric values of monitoring parameters, messages and battery condition.* They also display the compressed waveform and numeric data of the latest 10 minutes.

* Essential performance of this transmitter.

The difference between ZM-520PA/530PA and ZM-521PA/531PA is the transmission frequency range.

ZM-520PA/530PA:

608.0250 to 613.9750 MHz (channel number 9002 to 9478)

ZM-521PA/531PA:

1395.0250 to 1399.9750 MHz (channel number E002 to E398)

1427.0250 to 1431.9750 MHz (channel number E502 to E898)

**NOTE**

- The transmitter channel can be changed with a QI-901PK channel writer.
- Read the operator's manual for the receiving monitor together with this manual before use.

**WARNING**

Do not diagnose a patient based only on data acquired by the transmitter. Overall judgement must be performed by a physician who understands the features, limitations and characteristics of the transmitter and by reading the biomedical signals acquired by other instruments.

**WARNING**

Do not use the same transmitter for more than one patient at the same time. Do not connect different sensors from different patients to the same transmitter.

**CAUTION**

- Do not use the same channel for different patients. If the same channel is used for two patients, the two patients' data will be lost due to mutual modulation interference, or another patient's data may appear on the receiving monitor screen.
- Do not use two transmitters with adjacent channels in the same hospital. If transmitters with adjacent channels are used, their radio waves interfere with each other.

**CAUTION**

Signal loss and artifact may occur because of the multipath cancellation* when using a transmitter.

* Multipath Cancellation (Standing Wave Interference):
When a radio wave reflects off a surface, there may be some points in the room where the reflected and direct waves are exactly out of phase. At these points in the room, the reflected and direct waves cancel each other out so that the signal strength is decreased. Locations where signal loss occurs are called "null spots". If the transmitter is moving or nearby people or objects are moving, null spots can occur anytime and anywhere.

**NOTE**

- To prevent interference between channels, assign a channel administrator in the hospital and only he or she should manage channel assignment.
- Use Nihon Kohden parts and accessories to assure maximum performance from your instrument.
- For stable signal reception, it is recommended to use a diversity antenna system on the receiving monitor. Otherwise, spike noise from transient fading of electric field strength (for example, people moving) may interfere with the transmitter signal and may be mistaken as an arrhythmia on the receiving monitor.
- For details on antennas and antenna construction, contact your Nihon Kohden representative. You can also refer to the Telemetry System Installation Guide.
- To prevent damage, avoid dropping the transmitter. Dropping may damage the transmitter LCD display and may result in no image (white screen) or a partial image on the screen.

## Receiving Monitor

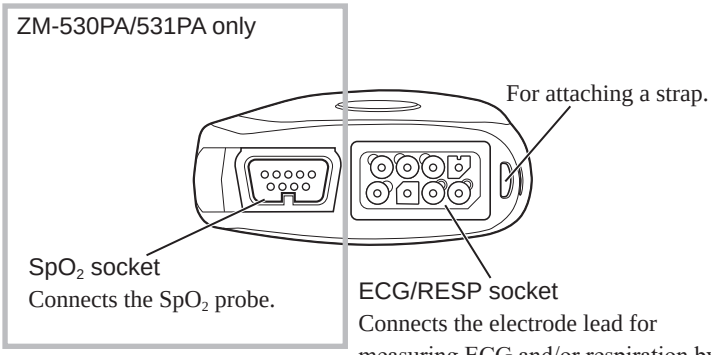
Any Nihon Kohden receiving monitor (central monitor with multiple patient receiver) can receive signals from this transmitter as long as the protocol version and channel setting are the same on the receiving monitor and transmitter.
If the transmitter LCD display is damaged, it may display no image (white screen) or a partial image. However, all features remain functional, including alarms and transmission of patient physiological data (ECG, respiration, $SpO_2$ and pulse waveform) to the multiple patient receivers, central monitors and/or bedside monitors.

**NOTE**

- For details on the receiving monitor and upgrade information, contact your Nihon Kohden representative.
- The transmitter does not give any alarm other than a “low battery” alarm. Alarms must be managed on the receiving monitor.
- To use protocol 51, an ORG-9100A or ORG-9110A multiple patient receiver software version 03-03 or later is required. For the protocol setting, refer to the “Changing SYSTEM SETUP Settings” section.

# Panel Description

## Top Panel




**WARNING**

Before defibrillation, all persons must keep clear of the bed and must not touch the patient or any equipment or cord connected to the patient. Failure to follow this warning may cause electrical shock or injury.

**WARNING**

When performing defibrillation, discharge as far as possible from electrodes, patches and any gel, cream or medicine on the chest of the patient. If there is a possibility that the defibrillator paddle could touch these materials, remove them from the patient. If the defibrillator paddle directly contacts these materials, the discharged energy may cause skin burn to the patient.

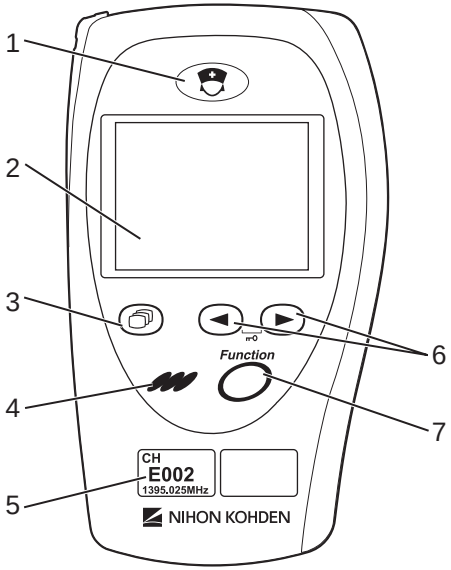
**WARNING**

When the transmitter is used with an electrosurgical unit (ESU), firmly attach the entire area of the ESU return plate. Otherwise, the current from the ESU flows into the electrodes of the transmitter, causing electrical burn where the electrodes are attached. For details, refer to the ESU manual.

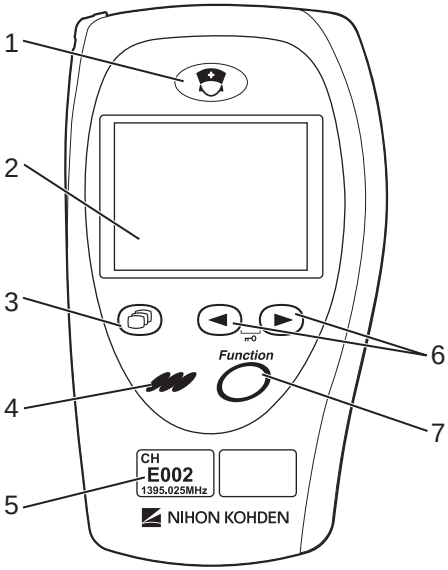
**CAUTION**

Do not shake or swing the transmitter while holding the leads or cables connected to the transmitter. The transmitter may come off and injure someone or damage surrounding instruments.

## Front Panel

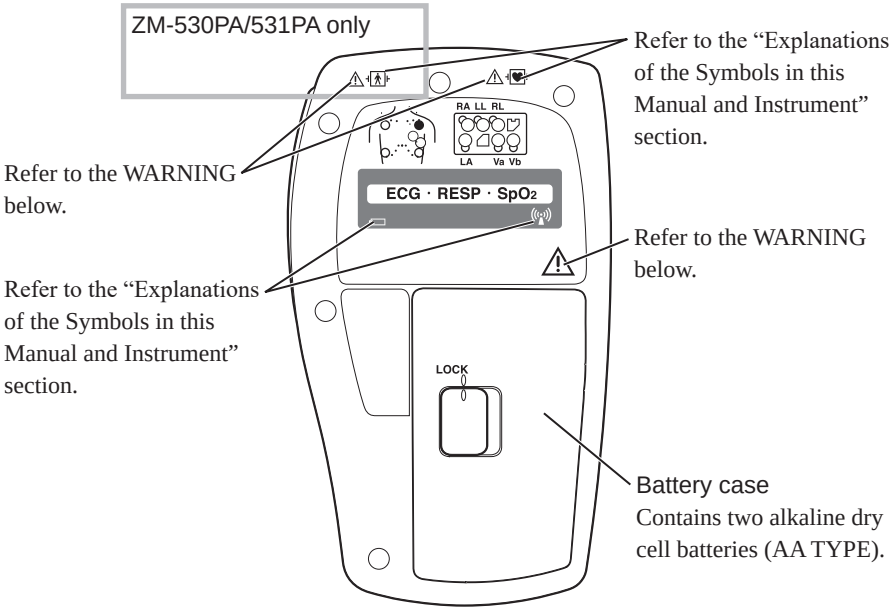



| No. | Name | Description |
|---|---|---|
| 1 | CALL key | When this key is pressed, a “peep” sounds at the transmitter, and “CALL” message appears at the monitor. Depending on the settings on the monitor, an ECG waveform is recorded when this key is pressed. |
| 2 | LCD | Displays numeric values, ECG or pulse wave, messages and battery status. For details, refer to the “Screen Descriptions” section. |
| 3 | Screen key | Toggles the screen in the following order.<br><br>After power on: Start up → Check electrodes → Numeric and waveform → Waveform review → Numeric review → Display off → Check electrodes …<br><br>After auto display off: Numeric and waveform → Waveform review → Numeric review → Display off → Check electrodes → Numeric and waveform …<br><br>On a SETUP or CHECK screen, this key cancels changing setting or exits the screen. |




| No. | Name | Description |
|---|---|---|
| 4 | Infrared receiver | Used for upgrading the transmitter software. |
| 5 | Channel number label | Indicates the channel number of the transmitter. |
| 6 | Lead/Scroll keys | On the numeric and waveform screen, these keys change the ECG lead.<br><br>On the waveform review screen, these keys scroll data.<br><br>On a SETUP screen, these keys move the cursor. |
| 7 | Function key | Depending on the setting on the transmitter, this key suspends alarms, pauses monitoring on the receiving monitor or transmits the “Patient confirmed” message.<br><br>On a SETUP screen, this key registers the selected setting and moves the cursor to the next setting item.<br><br>On a CHECK screen, this key starts or stops the maintenance test. |

## Rear Panel




**WARNING**

Close the battery case cover during operation. If the transmitter is used with the battery case cover open, anyone who touches the opened battery case may receive an electrical shock when defibrillation is performed. Touching the opened battery case may cause electrostatic discharge and intermittently interfere with the waveform or data.

**WARNING**

This transmitter is not waterproof. If detergent or liquid spills into the transmitter, stop using it and contact your Nihon Kohden representative. If a wet transmitter is used, the patient or operator may receive an electrical shock or injury.

# Important Safety Information

## General

**WARNING**

Never use the transmitter in the presence of any flammable anesthetic gas or high concentration oxygen atmosphere. Failure to follow this warning may cause explosion or fire.

**WARNING**

Never use the transmitter in a hyperbaric oxygen chamber. Failure to follow this warning may cause explosion or fire.

**WARNING**

Do not take this transmitter into the MRI test room. This transmitter is not designed to be used during MRI tests.

**WARNING**

When performing MRI test, remove all electrodes and probe from the patient which are connected to this transmitter. Failure to follow this warning may cause skin burn on the patient. For details, refer to the MRI manual.

**WARNING**

Before defibrillation, all persons must keep clear of the bed and must not touch the patient or any equipment or cord connected to the patient. Failure to follow this warning may cause electrical shock or injury.

**WARNING**

When performing defibrillation, discharge as far as possible from electrodes, patches and any gel, cream or medicine on the chest of the patient. If there is a possibility that the defibrillator paddle could touch these materials, remove them from the patient. If the defibrillator paddle directly contacts these materials, the discharged energy may cause skin burn to the patient.

**WARNING**

When the transmitter is used with an electrosurgical unit (ESU), firmly attach the entire area of the ESU return plate. Otherwise, the current from the ESU flows into the electrodes of the transmitter, causing electrical burn where the electrodes are attached. For details, refer to the ESU manual.

**WARNING**

Do not damage the transmitter by dropping it. This may result in no image (white screen) or a partial image on the LCD display of the transmitter.

**WARNING**

Do not use the same transmitter for more than one patient at the same time. Do not connect different sensors from different patients to the same transmitter.

**WARNING**

This transmitter is not waterproof. If detergent or liquid spills into the transmitter, stop using it and contact your Nihon Kohden representative. If a wet transmitter is used, the patient or operator may receive an electrical shock or injury.

**WARNING**

Close the battery case cover during operation. If the transmitter is used with the battery case cover open, anyone who touches the opened battery case may receive an electrical shock when defibrillation is performed. Touching the opened battery case may cause electrostatic discharge and intermittently interfere with the waveform or data.

**WARNING**

Do not diagnose a patient based only on data acquired by the transmitter. Overall judgement must be performed by a physician who understands the features, limitations and characteristics of the transmitter and by reading the biomedical signals acquired by other instruments.

**WARNING**

When the signal is unstable, keep the patient under close observation. When the signal is unstable, the monitoring and alarm are not reliable and the receiving monitor cannot detect a sudden change of the patient's condition. This may cause critical changes in the patient condition to be overlooked. Install an appropriate antenna system to ensure stable signal condition.

**WARNING**

When the patient returns to the bed, turn on the transmitter and check that the monitoring is resumed on the receiving monitor.

**WARNING**

If the transmitter is not turned off and monitoring continues for the selected interval, pause monitoring is canceled and monitoring continues. Check that the monitoring is resumed on the receiving monitor.

**WARNING**

While the "ALARMS SUSPENDED" message is displayed on the transmitter, all alarms on the receiving monitor are suspended so keep the patient under close observation.

**CAUTION**

Only use Nihon Kohden specified electrodes, electrode leads and $SpO_2$ probes. Otherwise, the maximum performance from the transmitter cannot be guaranteed.

**CAUTION**

Turn off the power of mobile phones, small wireless devices and other devices which produce strong electromagnetic interference around a patient (except for devices allowed by the hospital administrator). Radio waves from devices such as mobile phones or small wireless devices may be mistaken as pulse waves or respiration waves and the displayed data may be incorrect.

**CAUTION**

Signal loss and artifact may occur because of the multipath cancellation* when using a transmitter.

* Multipath Cancellation (Standing Wave Interference):
When a radio wave reflects off a surface, there may be some points in the room where the reflected and direct waves are exactly out of phase. At these points in the room, the reflected and direct waves cancel each other out so that the signal strength is decreased. Locations where signal loss occurs are called "null spots". If the transmitter is moving or nearby people or objects are moving, null spots can occur anytime and anywhere.

**CAUTION**

The measurement values and displayed waveforms on the transmitter and receiving monitor may be different due to timing delay of the display or difference in detection settings.

**CAUTION**

- Do not use the same channel for different patients. If the same channel is used for two patients, the two patients' data will be lost due to mutual modulation interference, or another patient's data may appear on the receiving monitor screen.
- Do not use two transmitters with adjacent channels in the same hospital. If transmitters with adjacent channels are used, their radio waves interfere with each other.

**CAUTION**

Do not shake or swing the transmitter while holding the leads or cables connected to the transmitter. The transmitter may come off and injure someone or damage surrounding instruments.

**CAUTION**

Do not reuse disposable parts and accessories.

**CAUTION**

When monitoring respiration is needed, measure respiration with an instrument. The transmitter calculates $SpO_2$ of arterial blood based on the principle of pulse oximeter and does not measure respiration.

**CAUTION**

When monitoring $SpO_2$ only, detection of arrhythmia and asystole is not available and arrhythmia alarms such as ASYSTOLE, VF or VT are not available. If the patient requires ECG monitoring, monitor the ECG.

**CAUTION**

When monitoring $SpO_2$ only (without ECG monitoring), turn on both the upper and lower limit alarms for PR and $SpO_2$ on the receiving monitor. If the patient's pulse is not detected during asystole or other condition, a "CANNOT DETECT PULSE" or "CHECK PROBE" alarm occurs instead of an $SpO_2$ limit alarm. Furthermore, if the patient has no pulse, noise from probe movement could be misjudged as a pulse and cause an incorrect PR or $SpO_2$ value to be displayed.

## Output Signal

**WARNING**

Do not use the output signal from the receiving monitor as the synchronization signal for other equipment such as IABP, MRI, echocardiography or defibrillator. There may be time delay between the monitor and the other equipment caused by waveform transmission delay and spike noise may interfere on the output signal and be mistaken as a trigger.

## Battery

**WARNING**

Do not use NiMH batteries for this transmitter. Some operating environments may cause NiMH batteries to produce gas and explode.

**CAUTION**

Do not handle the batteries with wet hands.

**CAUTION**

Refer to the battery manual for details on handling the batteries.

**CAUTION**

Battery replacement must be performed by the operator. When replacing the batteries of a transmitter that is currently used for a patient, disconnect the electrode leads from the transmitter before replacing batteries or do not touch the patient during replacement.

**CAUTION**

When the transmitter is not in use, remove the batteries. When the batteries are installed, battery power is consumed even when measurement is not performed.

## Transmitter Channel Management

**WARNING**

The following actions must be taken to properly receive the transmitter signal of the correct patient on the receiving instrument. Otherwise, there may be signal loss or signals may mix causing a serious accident, such as monitoring a different patient.

- Assign a channel administrator in the hospital and only he or she should manage channel assignment.
- The channel administrator must manage the channels in the facility so that there is no signal interference.
- When the transmitter channel is changed, the channel administrator must check that the channel on the receiving monitor is also changed and the signal is properly received.
- The channel administrator must replace the channel number label on the transmitter with the new one after changing the channel.

## For Patients Using Implantable Pacemaker

**WARNING**

The bioelectric impedance measurement sensor of a minute ventilation rate-adaptive implantable pacemaker may be affected by transmitter which is connected to the same patient. If this occurs, the pacemaker may pace at its maximum rate and the transmitter may give incorrect data to the monitor. If this occurs, disconnect the electrode leads from the patient or change the setting on the pacemaker by referring to the pacemaker's manual. For more details, contact your pacemaker representative or Nihon Kohden representative.

## ECG Monitoring

**WARNING**

After attaching the electrode to the patient and connecting the electrode lead to the transmitter, check that electrodes are attached to the patient and check that the electrode lead is connected to the transmitter properly. When the electrodes are removed from the patient, do not touch the metal part of the electrode with bare hands or let the metal part of the electrode contact the metal part of the bed or any other conductive parts. Failure to follow this warning may cause electrical shock or injury to the patient by discharged energy.

**WARNING**

The pacemaker pulse can be overlooked or detected as QRS. You cannot confirm the pacemaker operation only from the detected pacemaker pulse.

**WARNING**

The transmitter detects the pacemaker pulse and rejects the pacemaker pulse from the heart rate count. However, all of the pacemaker pulse might not be rejected. If the pacemaker pulse is not rejected, the pacemaker pulse is detected as QRS and false heart rate may be indicated. Keep pacemaker patients under close observation.

* For the pacemaker pulse rejection capability of the ZM-520PA/521PA/530PA/531PA transmitter refer to the "Specifications - ECG" section.

**CAUTION**

Only use Nihon Kohden specified electrodes and electrode leads. When other type of electrodes or electrode leads are used, the “CHECK ELECTRODES” message may be displayed and ECG monitoring may stop.

**CAUTION**

When the “CHECK ELECTRODES” message is displayed on the receiving monitor, ECG is not monitored properly and the ECG alarm does not function. Check the electrode, electrode leads, and if necessary, replace with new ones.

**CAUTION**

Hold the connector of the electrode lead when connecting/disconnecting the electrode lead. If you disconnect the electrode lead by pulling the lead, it damages the electrode lead.

## $SpO_2$ Monitoring

**WARNING**

$SpO_2$ measurement may be incorrect in the following cases.

- When the patient's carboxyhemoglobin or methemoglobin increases abnormally.
- When dye is injected in the blood.
- When using an electrosurgical unit.
- During CPR.
- When measuring at a site with venous pulse.
- When there is body movement.
- When the pulse wave is small (insufficient peripheral circulation).

**WARNING**

When monitoring $SpO_2$ of a patient who is receiving photodynamic therapy, the light from the finger probe sensor may cause a burn. Photodynamic therapy uses a photosensitizing agent that has a side effect of photosensitivity.

The $SpO_2$ probes manufactured by Nihon Kohden have two wavelengths with peaks in the range of 650 and 950 nm. The maximum light intensity is less than 5.5 mW.

**WARNING**

- When using the TL-201T finger probe, do not fasten the probe and cable to the finger by wrapping with tape. This may cause burn, congestion or pressure necrosis from poor blood circulation.
- When using probes other than the TL-201T finger probe, to avoid poor circulation, do not wrap the tape too tight. Check the blood circulation condition by observing the skin color and congestion at the skin peripheral to the probe attachment site. Even for short-term monitoring, there may be burn or pressure necrosis from poor blood circulation, especially on neonates or low birth weight infants whose skin is delicate. Accurate measurement cannot be performed on a site with poor peripheral circulation.

**WARNING**

Check the circulation condition by observing the skin color at the measurement site and pulse waveform. Change the measurement site every 8 hours for disposable probes and every 4 hours for reusable probes (every 8 hours for TL-631T series probe). The skin temperature may increase at the attached site by 2 or 3°C (4 or 5°F) and cause a burn or pressure necrosis. When using the probe on the following patients, take extreme care and change the measurement site more frequently according to symptoms and degree.

- Patient with a fever
- Patient with insufficient peripheral circulation
- Neonate or low birth weight infant with delicate skin

**WARNING**

When not monitoring $SpO_2$, disconnect the $SpO_2$ cable from the transmitter. Otherwise, noise from the probe sensor may interfere and incorrect data is displayed on the screen.

**CAUTION**

The disposable probe is not sterilized. Use the disposable probe only for a single patient. Never reuse the disposable probe for another patient because it causes cross infection.

**CAUTION**

Do not attach the probe to the same limb that is used for NIBP measurement or an IBP catheter. The $SpO_2$ measurement may be incorrect.

**CAUTION**

When a message indicates a faulty probe, stop monitoring and replace the probe with a new one.

**CAUTION**

Do not use a damaged or disassembled probe. It causes incorrect measurement and may injure the patient.

**CAUTION**

Refer to the probe instruction manual for details.

**CAUTION**

While a patient is on medication which causes vasodilation, the pulse waveform may change and in rare cases the $SpO_2$ value might not be displayed.

**CAUTION**

Normal external light does not affect monitoring but strong light such as a surgical light or sunlight may affect monitoring. If affected, cover the measuring site with a blanket.

**CAUTION**

Do not use a probe which is deteriorated by aging. Accurate measurement cannot be performed.

**CAUTION**

When the probe is attached on an appropriate site with sufficient circulation and the error message confirming the probe attachment repeatedly appears, the probe may be deteriorated. Replace it with a new one.

**CAUTION**

Failure to follow these instructions may cause cable discontinuity, short circuit, skin burn on the patient from the probe temperature increase due to the short circuit of the probe cable, and incorrect measurement data. If the probe is broken, replace it with a new one.

- Do not immerse any part of the probe cable other than the disposable probe in chemical solutions or water.
- Do not pull or bend the probe cable.
- Do not let caster feet run over the probe cable.

**CAUTION**

If the attachment site is dirty with blood or bodily fluids, clean the attachment site before attaching the probe. If there is nail polish on the attachment site, remove the polish. Otherwise, the amount of transmitted light decreases, and measured value may be incorrect or measurement cannot be performed.

**CAUTION**

If the skin gets irritated or redness appears on the skin from the probe, change the attachment site or stop using the probe. Take extreme care for the patients with delicate skin.

## Maintenance

**CAUTION**

This transmitter is not waterproof. If detergent or liquid spills into the transmitter, stop cleaning or disinfecting it and contact your Nihon Kohden representative. The transmitter needs to be checked for safety and function before use.

**CAUTION**

Do not immerse the electrode lead connector in liquid.

**CAUTION**

Never disassemble or repair the transmitter. If there is any problem with the transmitter, contact your Nihon Kohden representative.

**CAUTION**

Dispose of Nihon Kohden products according to your local laws and your facility's guidelines for waste disposal. Otherwise, it may affect the environment. If there is a possibility that the product may have been contaminated with infection, dispose of it as medical waste according to your local laws and your facility's guidelines for medical waste. Otherwise, it may cause infection.

# Preparation on Transmitter

## Batteries

### Handling Batteries

**WARNING**

Do not use NiMH batteries for this transmitter. Some operating environments may cause NiMH batteries to produce gas and explode.

**CAUTION**

Refer to the battery manual for details on handling the batteries.

**CAUTION**

Do not handle the batteries with wet hands.

**CAUTION**

When the transmitter is not in use, remove the batteries. When the batteries are installed, battery power is consumed even when measurement is not performed.

**NOTE**

Remove the batteries from the transmitter before disposing of it.

### Battery Lifetime

Use two AA (LR6) type alkaline dry cell batteries. With new Nihon Kohden recommended alkaline batteries, the transmitter can continuously measure for the following number of days at room temperature. Operation time depends on the thickness of the $SpO_2$ probe attachment site.

| Transmitter | Operating Time (Measuring parameters) | |
|---|---|---|
| | ECG, Resp, $SpO_2$ | ECG, Resp |
| ZM-520PA/ZM-530PA | 2.5 days | 3.5 days |
| ZM-521PA/ZM-531PA | 2.0 days | 2.5 days |

**Recommended Batteries**

Alkaline primary: Nihon Kohden Medipower (equivalent to Panasonic LR6 (G))

**NOTE**

- Use Nihon Kohden Medipower to ensure specified performance. Outdated, mismatched or poor-quality batteries can give unacceptable performance (e.g., insufficient low battery indication). The use of fresh high quality alkaline batteries is strongly recommended.
- When the display is on, it consumes battery power. Instruct the patient not to turn on the display during monitoring.

### Installing (Replacing) Batteries

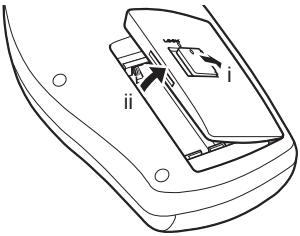
**CAUTION**

Battery replacement must be performed by the operator. When replacing the batteries of a transmitter that is currently used for a patient, disconnect the electrode leads from the transmitter before replacing batteries or do not touch the patient during replacement.

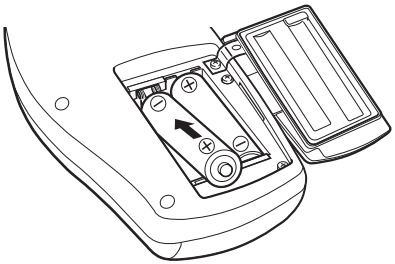
If electrode leads are attached to the patient and the person replacing batteries touches the patient during battery replacement, excess patient leakage current may flow into the patient.

**NOTE**

- Replace all batteries at the same time.
- Do not use different types of batteries together.
- Insert the batteries with the correct polarity (+ and –).

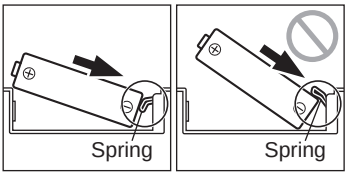



1. Open the battery case cover.



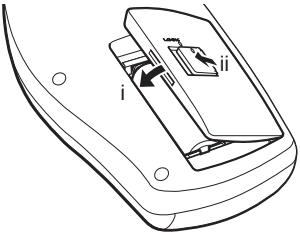
2. Insert two new batteries into the battery case observing the correct polarity.

   The transmitter is automatically turned on when the batteries are installed.




**NOTE**

- As shown in the diagram, slide each battery into the compartment so the negative terminal of the battery is pressing against the spring. Inserting a battery at the wrong angle may deform the spring and cause a short circuit or damage the battery compartment.
- Inserting the positive terminal first and then forcing the battery into the compartment may damage the battery or the transmitter.




3. Close the cover.

## Situations Requiring Battery Replacement

Replace the batteries when any of the following occurs.

- The transmitter displays the “BATTERY WEAK” message or icon.
- The transmitter generates a constant alarm (continuous “peep” sound).
- The transmitter LCD does not display anything when the power is turned on.
- The receiving monitor displays a battery replacement message.

## Battery Level Indication

The following icons on the LCD indicate the battery level. When “PROTOCOL” on the SYSTEM SETUP screen is set to 51, the battery level indication is transmitted to the receiving monitor. To use protocol 51, the ORG-9100A or ORG-9110A multiple patient receiver software version 03-03 or later is required.

| Indication | Battery Level | Message on the Receiving Monitor |
|---|---|---|
| | Batteries are fully charged. | There is no message on the monitor. |
| | Batteries are getting low. | |
| | Batteries are low. | |
| | Batteries are almost empty. Replace batteries. | Message requiring battery replacement is displayed. |
| No indication | Dead batteries | No signal can be transmitted to the monitor. There is no indication on the monitor. |

## Attaching a Strap to the Transmitter

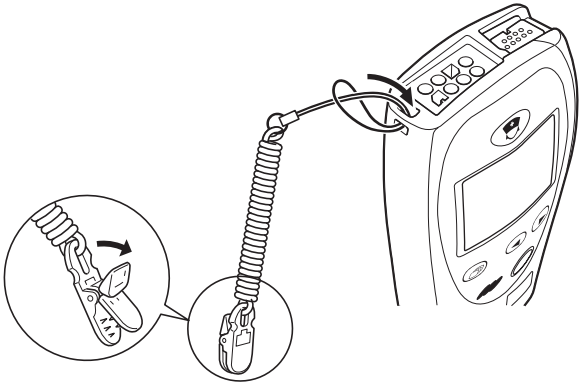
**NOTE**

Do not attach the clip to hard objects such as thick cloth or a zipper. It will break the clip.

Attach a strap to the transmitter and fasten the clip to the patient's clothes or bed sheets.

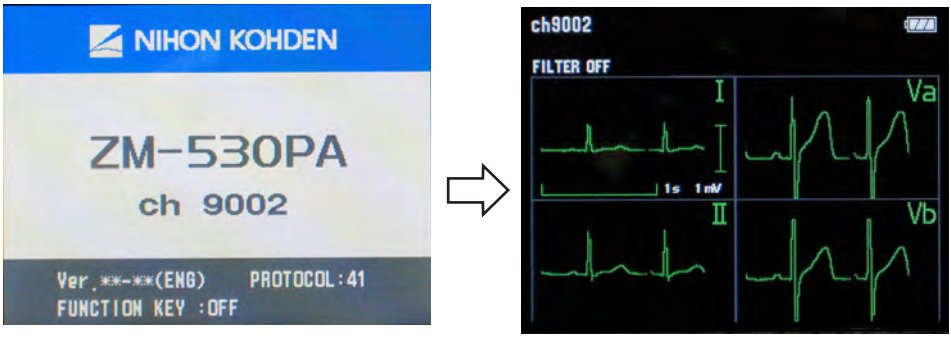
If the transmitter falls off, the transmitter may be damaged and the batteries may come out. If the patient touches the battery terminal when putting the batteries back in the transmitter, excess patient leakage current may flow into the patient.

If the transmitter falls into water or a toilet, stop using the transmitter and contact your Nihon Kohden representative.



## Turning On the Transmitter

When the batteries are installed correctly, the power is turned on. A “peep” sounds for one second, the startup screen appears, then the check electrodes screen appears. (There is no “peep” sound when there is no battery power.)




After checking that the ECG is stable on the check electrodes screen, press the Screen key to display the numeric and waveform screen.


For details on the screen, refer to the “Screen Descriptions” section.

### Check Items Before Use

Before turning on the transmitter power, check the following to confirm that the transmitter can be used in normal and safe condition.

**Appearance**

- There are no damaged or dirty parts on the outside of the transmitter (LCD, keys, sockets, battery case cover, battery case, etc.).
- The transmitter is completely dry.
- The electrodes, electrode lead and $SpO_2$ probe are not broken.

**Batteries**
- The battery polarity is correct.
- The battery case spring is firmly attached and the battery is not loose.
- The battery case cover is firmly closed.

**Channel Setting**
- The transmitter channel matches the receiving monitor channel.
- There is no nearby transmitter with the same channel.

**Other**
- When performing defibrillation, set the hum filter to ON on the receiving monitor. The waveform recovery may become slow due to electrode polarization when the hum filter is set to OFF.

## Check Items After Power On

After turning on the power, check the following.

**Power On**
- The transmitter generates a one second “peep” sound and the startup screen appears.
- The transmitter displays the check electrodes screen.
- The transmitter is not too hot.
- The transmitter does not display the “BATTERY WEAK” message.
- The transmitter does not interfere with the operation of other medical instruments.

**Daily Check**
- The “signal loss” message is not displayed on the receiving monitor when the transmitter is inside the receiving range of the monitor.
- The battery replacement message is not displayed on the monitor.
- The keys on the transmitter function properly.
- The LCD brightness is appropriate. To adjust brightness, refer to the “Changing SYSTEM SETUP Settings” section.

## Check Items After Use

To use the transmitter in safe and optimum condition for next time, check the following.

**Before Turning Power Off**
- Temporarily changed settings are changed back to the previous settings.
- There was no malfunction on the transmitter.

**Storage**
- ECG electrode leads and $SpO_2$ probe are cleaned and disinfected.
- If the transmitter got wet, liquid is wiped off and the transmitter is thoroughly dried.
- There are enough consumables, such as disposable electrodes.
- The transmitter power is turned off by removing batteries from the transmitter.
- Dead batteries are disposed of properly.

## Turning Off the Transmitter

To turn off the power, remove the batteries. When the power is turned off, the saved waveform and numeric data are deleted.

## Changing the Transmitter Channel

The channel of the transmitter can be changed with the optional QI-901PK channel writer.

**WARNING**

The following actions must be taken to properly receive the transmitter signal of the correct patient on the receiving instrument. Otherwise, there may be signal loss or signals may mix causing a serious accident, such as monitoring a different patient.

- Assign a channel administrator in the hospital and only he or she should manage channel assignment.
- The channel administrator must manage the channels in the facility so that there is no signal interference.
- When the transmitter channel is changed, the channel administrator must check that the channel on the receiving monitor is also changed and the signal is properly received.
- The channel administrator must replace the channel number label on the transmitter with the new one after changing the channel.

**NOTE**

- The software version of the QI-901PK channel writer must be 02-01 or later to change the channel on the transmitter.
- The channel writer must be used outside the patient environment.

The channel is displayed in the upper left corner of the screen.

# Changing Parameter and System Setup Settings

The initial settings on the PARAMETER SETUP and SYSTEM SETUP screens can only be changed before monitoring. Changing these settings during monitoring interrupts monitoring.

**NOTE**

Changing Parameter and System Setup settings must be done by qualified personnel.

## Changing PARAMETER SETUP Settings

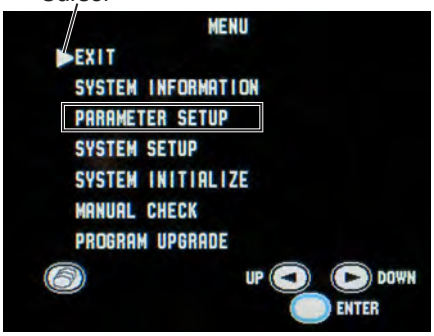
### Parameter Setup Setting List

The factory default settings are underlined.

| Setting Item | Description | Settings |
|---|---|---|
| ECG ELECTRODES | Select the electrode lead type. | IEC, AHA |
| LEAD TYPE | Select the type of ECG leads. | AUTO, 6 LEADS |
| ECG MEASUREMENT | Turn ECG monitoring on or off. When electrodes are attached to the patient and ECG leads are connected, ECG monitoring starts even when this setting is set to OFF. If this setting is set to OFF, the same setting on the receiving monitor must also be set to OFF.<br>**NOTE**<br>When "PROTOCOL" on the transmitter is set to 51 and the receiving monitor is able to receive protocol 51, ECG measurement on the receiving monitor is automatically set to OFF when this setting is set to OFF on the transmitter.<br>To use protocol 51, the ORG-9100A or ORG-9110A multiple patient receiver software version 03-03 or later is required. | ON, OFF |
| RESP MEASUREMENT | Turn respiration monitoring on or off.<br>When this setting is set to OFF, the same setting on the receiving monitor is automatically set to OFF. | ON, OFF |
| $SpO_2$ RESPONSE | Select the $SpO_2$ response mode. | FAST, NORMAL, SLOW |

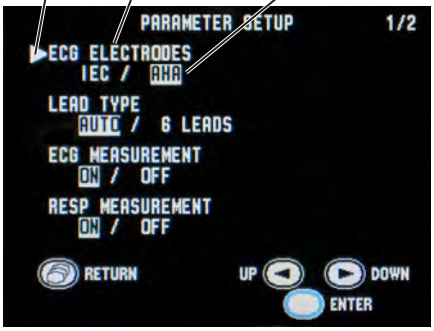
## Displaying the PARAMETER SETUP Screen

Cursor




MENU screen

Cursor Setting item Setting



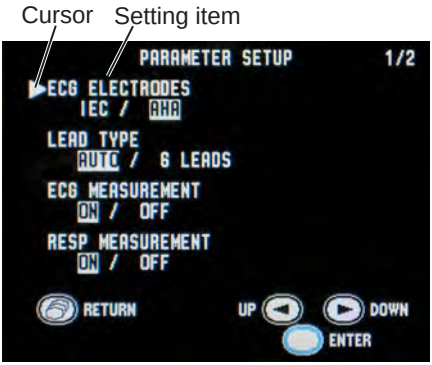

PARAMETER SETUP screen - page 1

1. Turn off the transmitter by removing one battery.
2. While pressing the Function key, turn on the transmitter (insert the battery). The MENU screen appears.
3. Press the ► key to move the cursor to “PARAMETER SETUP”.
4. Press the Function key to enter PARAMETER SETUP. The current settings are highlighted.
5. Change the settings:
   - To move the cursor and select the setting item, press the ◄ or ► key then press the Function key.
   - To select and register the setting, press the ◄ or ► key then press the Function key.
   - To cancel changing the setting of the selected item, press the Screen key.
6. When changing settings on the PARAMETER SETUP screen is complete, press the Screen key to return to the MENU screen.
7. Press the ◄ or ► key to move the cursor to “EXIT”.
8. Press the Function key. The numeric and waveform screen appears.

## Changing Parameter Setup Settings

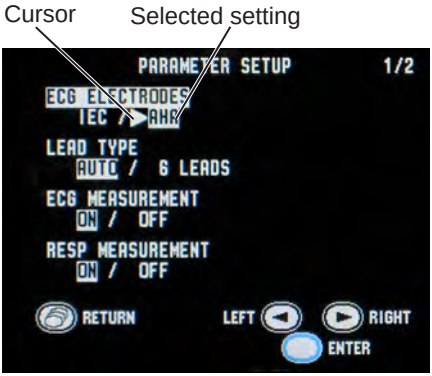
### ECG ELECTRODES

Select the electrode lead type.




1. On the PARAMETER SETUP screen, press the ► key to move the cursor to “ECG ELECTRODES”.

2. Press the Function key. The cursor moves to the selection item.




3. Press the ► key to select “IEC” or “AHA”.

4. Press the Function key to register the selected setting. The cursor returns to “ECG ELECTRODES”.

### LEAD TYPE

Select the type of ECG leads. In normal use, select “AUTO”. When using DIN type lead with 6 electrodes, select “6 LEADS”.

1. On the PARAMETER SETUP screen, press the ► key to move the cursor to “LEAD TYPE”.

2. Press the Function key.

3. Press the ► key to select “AUTO” or “6 LEADS”.

4. Press the Function key to register the selected setting. The cursor returns to “LEAD TYPE”.

**ECG MEASUREMENT**
Turn ECG monitoring on or off. When electrodes are attached to the patient and ECG leads are connected, ECG monitoring starts even when this setting is set to OFF.

If this setting is set to OFF, the same setting on the receiving monitor must also be set to OFF.

**NOTE**

When "PROTOCOL" on the transmitter is set to 51 and the receiving monitor is able to receive protocol 51, ECG measurement on the receiving monitor is automatically set to OFF when this setting is set to OFF on the transmitter. To use protocol 51, the ORG-9100A/ORG-9110A multiple patient receiver software version 03-03 or later is required.

1. On the PARAMETER SETUP screen, press the ► key to move the cursor to "ECG MEASUREMENT".

2. Press the Function key.

3. Press the ► key to select "ON" or "OFF".

4. Press the Function key to register the selected setting. The cursor returns to "ECG MEASUREMENT".

**RESP MEASUREMENT**
Turn respiration monitoring on or off. When this setting is set to OFF, the same setting on the receiving monitor is automatically set to OFF.

1. On the PARAMETER SETUP screen, press the ► key to move the cursor to "RESP MEASUREMENT".

2. Press the Function key.

3. Press the ► key to select "ON" or "OFF".

4. Press the Function key to register the selected setting. The cursor returns to "RESP MEASUREMENT".

**SpO2 RESPONSE**

Select the response mode from FAST, NORMAL or SLOW. For details on the response time, refer to the "Specifications - $SpO_2$ Measurement (ISO 9919: 2005 compliance)" section in this manual.

**NOTE**

When measurement condition is unstable due to strenuous movement of the patient, etc., response may become slower in all modes.


PARAMETER SETUP screen - page 2

1. On the PARAMETER SETUP screen, press the ► key to move the cursor to "SpO2 RESPONSE". "SpO2 RESPONSE" is on the second page of the PARAMETER SETUP screen.
2. Press the Function key.
3. Press the ► key to select "FAST", "NORMAL" or "SLOW".
4. Press the Function key to register the selected setting. The cursor returns to "SpO2 RESPONSE".

# Changing SYSTEM SETUP Settings

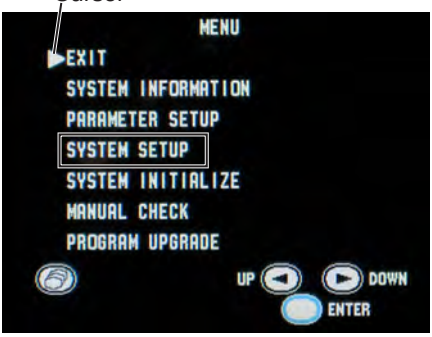
## System Setup Setting List

The factory default settings are underlined.

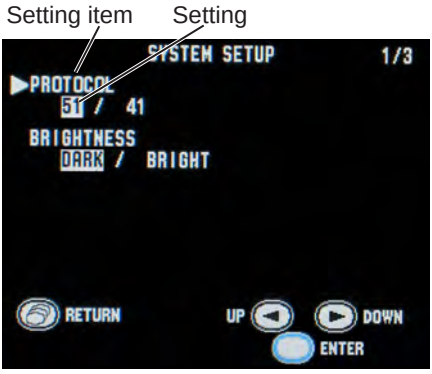
| Setting Item | Description | Settings |
|---|---|---|
| PROTOCOL | Select the transmitting protocol.<br>51: New protocol. A central monitor with an ORG-9100A or ORG-9110A multiple patient receiver whose software version 03-03 or later can receive this protocol.<br>41: Old protocol. A central monitor with an ORG-9100A, ORG-9110A or ORG-9700A multiple patient receiver can receive this protocol.<br>**NOTE**<br>When 51 is set, the receiving monitor must be able to receive protocol 51. Otherwise, signals from the transmitter cannot be received. To use protocol 51, an ORG-9100A or ORG-9110A multiple patient receiver software version 03-03 or later is required. | 51, 41 |
| BRIGHTNESS | Select the screen brightness. | DARK, BRIGHT |
| FUNCTION KEY | Select the function of the Function key.<br>SUSPEND ALARM & PAUSE:<br>Suspends alarm on the receiving monitor for 2 minutes. Pauses monitoring on the transmitter and receiving monitor.<br>SUSPEND ALARM:<br>Suspends alarm on the receiving monitor for 2 minutes.<br>CONFIRM:<br>Displays the “PATIENT CONFIRMED” message on the transmitter screen and transmits the message to the receiving monitor.<br>OFF: No function.<br>**NOTE**<br>“SUSPEND ALARM & PAUSE” and “CONFIRM” can only be set when PROTOCOL is set to 51. To use protocol 51, the ORG-9100A or ORG-9110A multiple patient receiver software version 03-03 or later is required. | SUSPEND ALARM & PAUSE, SUSPEND ALARM, CONFIRM, OFF |

| Setting Item | Description | Settings |
|---|---|---|
| AUTO RESUME AFTER PAUSE | Select the interval to resume monitoring after PAUSE. | 10 s, 30 s, 1 min, 2 min, 3 min |
| SELECTABLE SCREEN TIME OUT PERIOD (min) | Select the display time-out period. | 5, 10, 15, 30, 60, 120, 240 |

## Displaying the SYSTEM SETUP Screen




MENU screen




SYSTEM SETUP screen - page 1

1. Turn off the transmitter by removing one battery.
2. While pressing the Function key, turn on the transmitter by inserting the battery. The MENU screen appears.
3. Press the ► key to move the cursor to “SYSTEM SETUP”.
4. Press the Function key to enter SYSTEM SETUP. The current settings are highlighted.
5. Change the settings.
   - To move the cursor and select the setting item, press the ◄ or ► key then press the Function key.
   - To select and register the setting, press the ◄ or ► key then press the Function key.
   - To cancel changing the setting of the selected item, press the Screen key.

   The SYSTEM SETUP screen has two pages. To display the second page, press the ► key when the cursor is at “BRIGHTNESS”.
6. When changing settings on the SYSTEM SETUP screen is complete, press the Screen key to return to the MENU screen.
7. Press the ◄ or ► key to move the cursor to “EXIT”.
8. Press the Function key. The numeric and waveform screen appears.

## Changing System Setup Settings

**PROTOCOL**

Select the transmitting protocol. For differences between protocols, refer to the table below.

51: New protocol. A central monitor with an ORG-9100A or ORG-9110A multiple patient receiver whose software version 03-03 or later can receive this protocol.

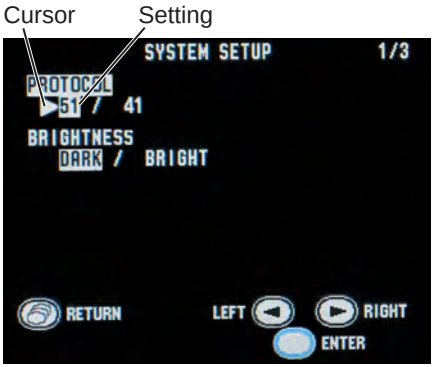
41: Old protocol. A central monitor with an ORG-9100A, ORG-9110A or ORG-9700A multiple patient receiver can receive this protocol.

**NOTE**

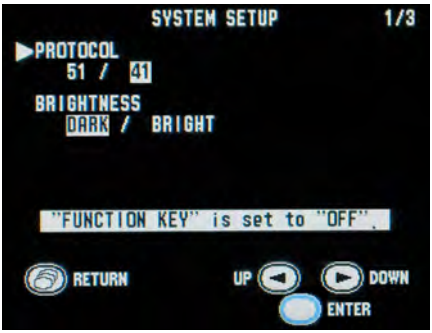
When 51 is set, the receiving monitor must be able to receive protocol 51. Otherwise, signals from the transmitter cannot be received.

**Differences Between Protocols**

| Function | Protocol 41 | Protocol 51 |
|---|---|---|
| Setting ECG MEASUREMENT to OFF on the transmitter automatically turns off the ECG measurement setting on the receiving monitor | No (ECG measurement must be turned off on the receiving monitor) | Yes |
| Pause monitoring on the receiving monitor from the transmitter | No | Yes |
| Transmit “PATIENT CONFIRMED” message | No | Yes |
| Display battery level of the transmitter on the receiving monitor | No | Yes |
| Transmit $SpO_2$ messages | Some messages (refer to the “Indication and Message List” section) | All messages |
| Transmit RESP message | No | Yes |




1. Press the ► key to move the cursor to “PROTOCOL”.
2. Press the Function key.
3. Press the ► key to select “51” or “41”.




**NOTE**

FUNCTION KEY (on the second page of the SYSTEM SETUP screen) can be set to “SUSPEND ALARM & PAUSE” or “CONFIRM” only when PROTOCOL is “51”. If PROTOCOL is changed to “41”, FUNCTION KEY is automatically changed to “OFF”.

4. Press the Function key to register the selected setting. The cursor returns to “PROTOCOL”.

**BRIGHTNESS**

Select the screen brightness.

1. Press the ► key to move the cursor to “BRIGHTNESS”.
2. Press the Function key.
3. Press the ► key to select “DARK” or “BRIGHT”.
4. Press the Function key to register the selected setting. The cursor returns to “BRIGHTNESS”.

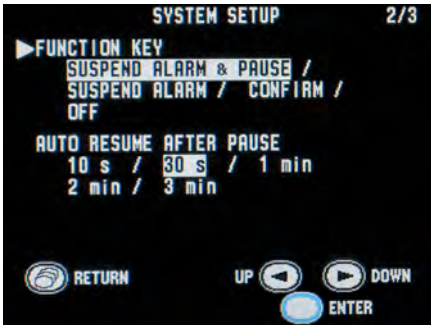
**FUNCTION KEY**

Select the function of the Function key. For details on using these functions, refer to “Basic Monitoring Operation” in the “Monitoring” section.

| | |
|---|---|
| SUSPEND ALARM & PAUSE: | Suspends alarm on the receiving monitor for 2 minutes. Pauses monitoring on the transmitter and receiving monitor. |
| SUSPEND ALARM: | Suspends alarm on the receiving monitor for 2 minutes. |
| CONFIRM: | Displays the “PATIENT CONFIRMED” message on the transmitter screen and transmits the message to the receiving monitor. |
| OFF: | No function. |

**NOTE**

“SUSPEND ALARM & PAUSE” and “CONFIRM” can only be set when PROTOCOL is set to 51.




SYSTEM SETUP screen - page 2

1. On the SYSTEM SETUP screen, press the ► key to move the cursor to "FUNCTION KEY". It is on the second page of the SYSTEM SETUP screen.
2. Press the Function key.
3. Press the ► key to select the function.
4. Press the Function key to register the selected setting. The cursor returns to "FUNCTION KEY".

**AUTO RESUME AFTER PAUSE**

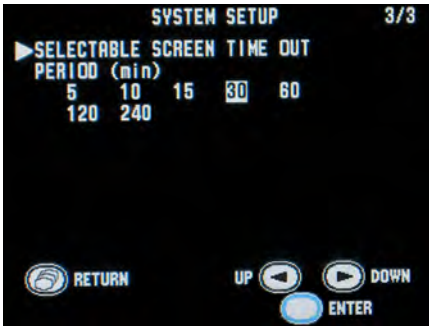
Select the interval to resume monitoring after PAUSE. When either of the following conditions is met, monitoring resumes on the receiving monitor.

- Heart rate is properly monitored for the selected interval
- $SpO_2$ is properly monitored for the selected interval

1. Press the ► key to move the cursor to "AUTO RESUME AFTER PAUSE". It is on the second page of the SYSTEM SETUP screen.
2. Press the Function key.
3. Press the ► key to select the interval.
4. Press the Function key to register the selected setting. The cursor returns to "AUTO RESUME AFTER PAUSE".

**SELECTABLE SCREEN TIME OUT PERIOD (min)**

Select the display time-out period. If no key is pressed for the selected time, the display is automatically turned off. The selected time is shown on the Select Screen Time Out Period screen. Refer to the "Turning the Display Off" section for details.



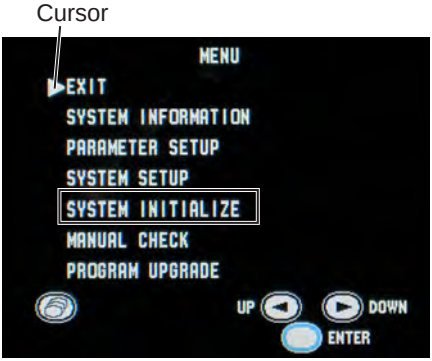

SYSTEM SETUP screen - page 3

1. Press the ► key to move the cursor to "SELECTABLE SCREEN TIME OUT PERIOD (min)". It is on the third page of the SYSTEM SETUP screen.
2. Press the Function key.
3. Press the ◄ or ► key to select time-out period.

4. Press the Function key to register the selected setting. The cursor returns to “SELECTABLE SCREEN TIME OUT PERIOD (min)”.

## Initializing Settings

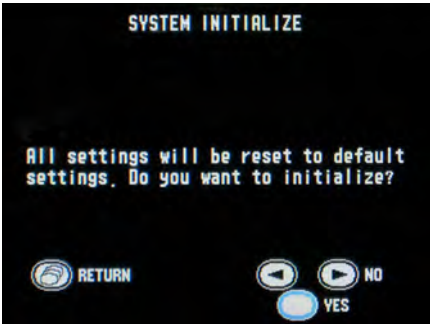
Do the following procedure to initialize all settings, except for channel, to the factory default settings.




1. Turn off the transmitter by removing a battery.
2. While pressing the Function key, turn on the transmitter by inserting the battery. The MENU screen appears.
3. Press the ► key to move the cursor to “SYSTEM INITIALIZE”.


4. Press the Function key to enter the SYSTEM INITIALIZE screen.
5. Press the Function key. A confirmation message appears.

   To return to the MENU screen, press the Screen key.




6. Press the Function key to initialize settings.

   To cancel initializing, press the ► key. The screen returns to the MENU screen.

# Attaching Electrodes and $SpO_2$ Probe to the Patient

## Attaching Electrodes

### Selecting Electrode Lead

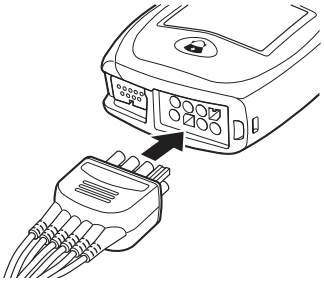
**CAUTION**

Only use Nihon Kohden specified electrodes and electrode leads. When other type of electrodes or electrode leads are used, the “CHECK ELECTRODES” message may be displayed and ECG monitoring may stop.

Select the disposable electrodes and electrode leads which are appropriate for the number of electrodes (leads). Refer to the “Options” section for details.

### Connecting the Electrode Lead to the Transmitter

Connect the electrode lead to the ECG/RESP socket on the transmitter.



**WARNING**

After attaching the electrode to the patient and connecting the electrode lead to the transmitter, check that electrodes are attached to the patient and check that the electrode lead is connected to the transmitter properly. When the electrodes are removed from the patient, do not touch the metal part of the electrode with bare hands or let the metal part of the electrode contact the metal part of the bed or any other conductive parts. Failure to follow this warning may cause electrical shock or injury to the patient by discharged energy.

**CAUTION**

Do not shake or swing the transmitter while holding the leads or cables connected to the transmitter. The transmitter may come off and injure someone or damage surrounding instruments.

**CAUTION**

Hold the connector of the electrode lead when connecting/disconnecting the electrode lead. If you disconnect the electrode lead by pulling the lead, it damages the electrode lead.

## Electrode Position

Follow the physician's instructions for electrode placement when available.

For ECG monitoring, electrodes are attached only on the chest to allow patient movement and obtain continuous stable ECG. The following leads are examples. When also monitoring respiration, refer to the "Electrode Position for Respiration Monitoring" section.

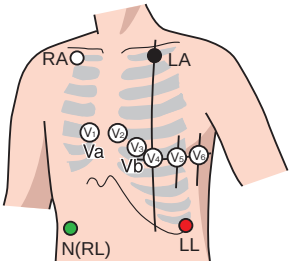
**NOTE**

The optimum electrode positions for ECG measurement are not always optimum for respiration measurement. Select positions that are suitable for both ECG and respiration measurement or positions which give priority to either ECG or respiration measurement.

**Electrode Positions for ECG Monitoring**

6-electrode Leads

Va and Vb can be any of the standard 12 leads $V_1$ to $V_6$.

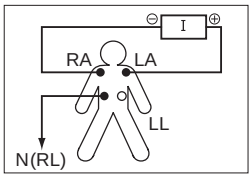



$V_1$: Fourth intercostal space at the right border of the sternum
$V_2$: Fourth intercostal space at the left border of the sternum
$V_3$: Halfway between $V_2$ and $V_4$
$V_4$: Fifth intercostal space on the left midclavicular line
$V_5$: Left anterior axillary line at the same level as $V_4$
$V_6$: Left midaxillary line at the same level as $V_4$

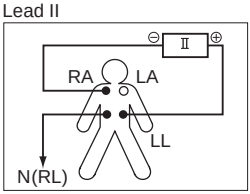
| Symbol | Electrode Lead | | Electrode Placement |
|---|---|---|---|
| | Lead Color | Clip or Hook Color | |
| RA | White | White | Right infraclavicular fossa |
| LA | Black | Black | Left infraclavicular fossa |
| LL | Red | Red | Lowest rib on the left anterior axillary line |
| N (RL) | Green | Green | Right anterior axillary line at the same level as LL |
| Va | Brown - Red | Red | Any two of the $V_1$ to $V_6$ positions |
| Vb | Brown - Green | Green | |

N is the electrical reference point.

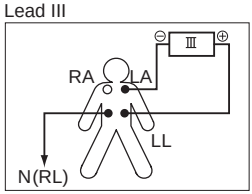
Lead I



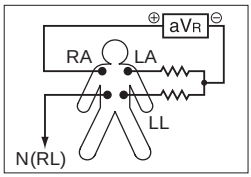

Lead II



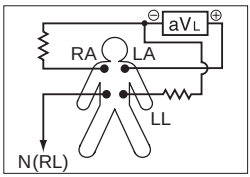

Lead III



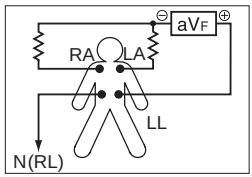

$aV_R$ lead



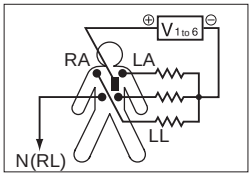

$aV_L$ lead



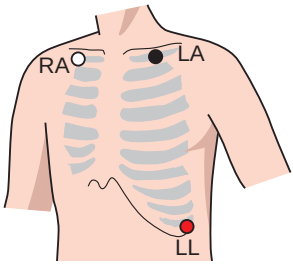

$aV_F$ lead




V1 to V6 leads

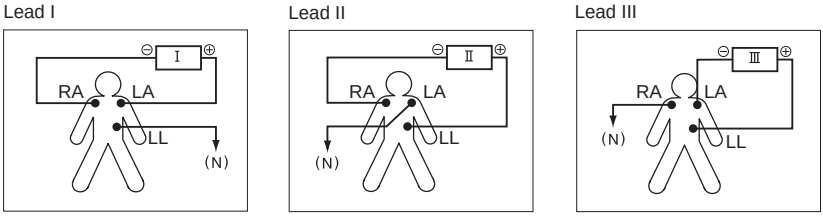



3-electrode Leads




| Symbol | Electrode Lead | | Electrode Placement |
|---|---|---|---|
| | Lead Color | Clip or Hook Color | |
| RA | White | White | Right infraclavicular fossa |
| LA | Black | Black | Left infraclavicular fossa |
| LL | Red | Red | Lowest rib on the left anterior axillary line |

N is the electrical reference point.

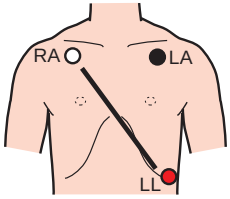



**Electrode Positions for Respiration Monitoring**

Place the RA and LL electrodes so that the lungs are between the electrodes.

Position 1

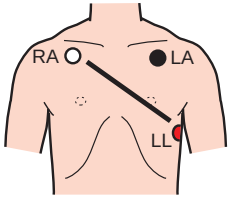
In this position, respiration measurement is available; however, there is a difference in amplitude between different patients.




| RA | LL |
|---|---|
| Right infraclavicular fossa | Fifth intercostal space on the left midclavicular line, $V_4$ |

Position 2

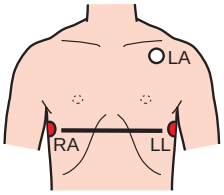
In this position, the waveform amplitude is usually large and the ECG lead is similar to Lead MII. This position can be generally recommended.




| RA | LL |
|---|---|
| Right infraclavicular fossa | Fifth intercostal space on the left midaxillary line, $V_6$ |

Position 3

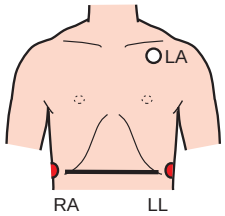
In this position, the respiration waveform is optimum, but the ECG lead is unusual.




| RA | LL |
|---|---|
| Right midaxillary at the horizontal level of $V_6$ | Fifth intercostal space on the left midaxillary line, $V_6$ |

Position 4

In this position, the respiration measurement is influenced by the impedance variation of the abdomen, so the cardiac pulse wave included in the respiration wave is reduced. Note that the waveform is inverted in phase compared with the chest movement (the waveform goes down during inspiration). It is difficult to measure the ECG at the same time.




| RA | LL |
|---|---|
| Lowest rib on the right anterior axillary line | Lowest rib on the left anterior axillary line |

## Attaching Electrodes to the Patient and Connecting the Electrode Leads to Disposable Electrodes

**Prepare the Patient Skin**

Shave off excessive body hair.

To reduce skin impedance, clean the electrode site with cream or with a cotton pad moistened with alcohol. Thoroughly dry the skin with a clean cotton pad.

**NOTE**

- For a patient with frequent body movement, rub the sites with skinPure skin preparation gel. However, do not use skinPure skin preparation gel on sensitive skin.
- Do not place electrodes on a wound or on an inflamed, wrinkled or uneven skin surface.

**Attaching Electrodes to the Patient**

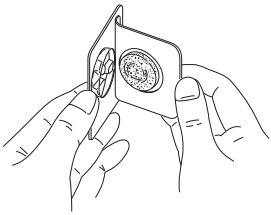
**CAUTION**

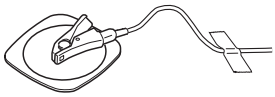
Do not reuse disposable parts and accessories.

**NOTE**

- To maintain good contact between the electrode and skin, check that the paste of the disposable electrode is not dry.
- When contact between the disposable electrode and skin becomes poor, replace electrodes with new ones immediately. Otherwise, contact impedance between the skin and the electrode increases and accurate ECG and respiration waveforms cannot be obtained.

Refer to the electrode operator's manual for details.





1. Carefully remove the backing paper from the electrode. Avoid touching the adhesive surface.
2. Place the electrode on the previously cleaned skin. Pay attention to the electrode lead color and symbol.
3. Clip the electrode lead to the electrode.
4. Fasten the electrode lead wire with surgical tape with an extra length of wire between the tape and the electrode. This lessens the movement of electrode leads by body movement and helps stable monitoring.

### Checking ECG on the Transmitter Screen

After attaching electrodes and connecting ECG leads, check that the electrodes are properly attached to the patient and the ECG waveform is acquired on the check electrodes screen. For details on the screen, refer to the "Screen Descriptions" section.

## Attaching the $SpO_2$ Probe

### Selecting the $SpO_2$ Probe

Select an appropriate probe for the patient.

**CAUTION**

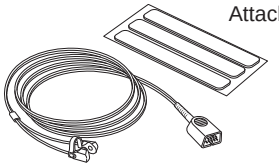
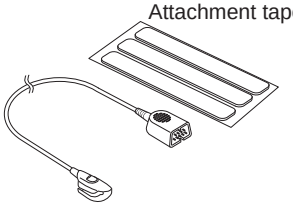
Only use Nihon Kohden specified electrodes, electrode leads and $SpO_2$ probes. Otherwise, the maximum performance from the transmitter cannot be guaranteed.

**CAUTION**

Do not use a damaged or disassembled probe. It causes incorrect measurement and may injure the patient.

**Reusable Probes**

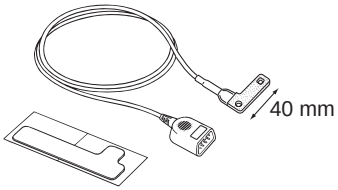
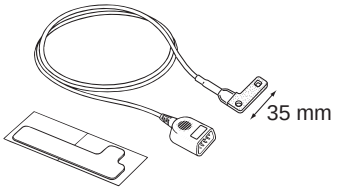
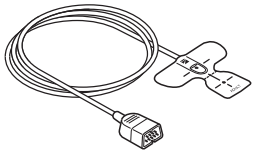
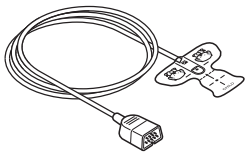
When using a TL-201T finger probe, choose the appropriate cable length for attachment.

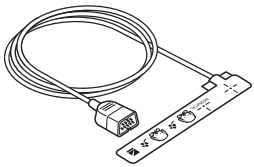
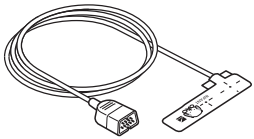
<table>
<tr><th>Probe</th><th>Cable Length</th><th>Patient</th><th>Attachment Site</th></tr>
<tr><td rowspan="2">Finger probe TL-201T<br>  </td><td>0.6 m</td><td rowspan="2">Adult or child<br>20 kg or more</td><td rowspan="2">Finger</td></tr>
<tr><td>1.6 m</td></tr>
<tr><td rowspan="2">Multi-site probe TL-220T<br>  </td><td>Adult or infant<br>3 kg or more</td><td>Finger or toe</td></tr>
<tr><td>Neonate<br>3 kg or less</td><td>Instep and sole</td></tr>
<tr><td rowspan="2">Finger probe<br>TL-631T1, TL-631T3<br>  </td><td>TL-631T1:<br>0.6 m</td><td rowspan="2">Adult or child<br>20 kg or more</td><td rowspan="2">Finger or toe</td></tr>
<tr><td>TL-631T3:<br>1.6 m</td></tr>
</table>

**Disposable Probes**

**CAUTION**

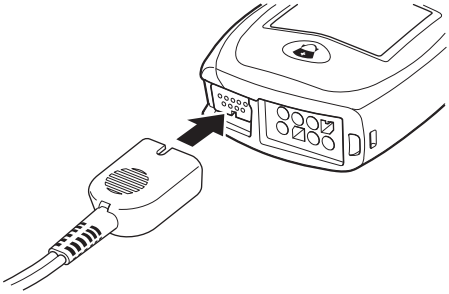
The disposable probe is not sterilized. Use the disposable probe only for a single patient. Never reuse the disposable probe for another patient because it causes cross infection.

| Probe | Patient | Attachment Site |
|---|---|---|
| TL-051S, TL-052S<br>  <br>Cable length TL-051S: 0.8 m<br>TL-052S: 1.6 m | Adult<br>50 kg or more | Finger |
| | Neonate<br>3 kg or less | Instep and sole |
| TL-061S, TL-062S<br>  <br>Cable length TL-061S: 0.8 m<br>TL-062S: 1.6 m | Adult or child<br>15 to 50 kg | Finger |
| | Chiled or infant<br>3 to 15 kg | Toe |
| TL-271T, TL-271T3<br>  <br>Cable length TL-271T: 0.8 m<br>TL-271T3: 1.6 m | Adult<br>30 kg or more | Finger or toe |
| TL-272T, TL-272T3<br>  <br>Cable length TL-272T: 0.8 m<br>TL-272T3: 1.6 m | Child<br>10 to 50 kg | |

| Probe | Patient | Attachment Site |
|---|---|---|
| TL-273T, TL-273T3<br>  <br>Cable length TL-273T: 0.8 m<br>TL-273T3: 1.6 m | Adult<br>40 kg or more | Finger or toe |
| | Neonate<br>3 kg or less | Instep and sole |
| TL-274T, TL-274T3<br>  <br>Cable length TL-274T: 0.8 m<br>TL-274T3: 1.6 m | Infant<br>3 to 20 kg | Finger or toe |

## Connecting the $SpO_2$ Probe to the Transmitter

Connect the probe to the $SpO_2$ socket on the transmitter.



**CAUTION**

Do not shake or swing the transmitter while holding the leads or cables connected to the transmitter. The transmitter may come off and injure someone or damage surrounding instruments.

**CAUTION**

Do not use a damaged or disassembled probe. It causes incorrect measurement and may injure the patient.

## Attaching the Probe to the Patient

Attach the probe to the patient by referring to the probe's manual. Make sure that the light emitter and photo detector of the probe face each other at the attachment site.

**WARNING**

- When using the TL-201T finger probe, do not fasten the probe and cable to the finger by wrapping with tape. This may cause burn, congestion or pressure necrosis from poor blood circulation.
- When using probes other than the TL-201T finger probe, to avoid poor circulation, do not wrap the tape too tight. Check the blood circulation condition by observing the skin color and congestion at the skin peripheral to the probe attachment site. Even for short-term monitoring, there may be burn or pressure necrosis from poor blood circulation, especially on neonates or low birth weight infants whose skin is delicate. Accurate measurement cannot be performed on a site with poor peripheral circulation.

**WARNING**

When monitoring $SpO_2$ of a patient who is receiving photodynamic therapy, the light from the finger probe sensor may cause a burn. Photodynamic therapy uses a photosensitizing agent that has a side effect of photosensitivity.

The $SpO_2$ probes manufactured by Nihon Kohden have two wavelengths with peaks in the range of 650 and 950 nm. The maximum light intensity is less than 5.5 mW.

**WARNING**

Check the circulation condition by observing the skin color at the measurement site and pulse waveform. Change the measurement site every 8 hours for disposable probes and every 4 hours for reusable probes (every 8 hours for TL-631T series probe). The skin temperature may increase at the attached site by 2 or 3°C (4 or 5°F) and cause a burn or pressure necrosis. When using the probe on the following patients, take extreme care and change the measurement site more frequently according to symptoms and degree.• Patient with a fever

- Patient with insufficient peripheral circulation
- Neonate or low birth weight infant with delicate skin

**CAUTION**

If the attachment site is dirty with blood or bodily fluids, clean the attachment site before attaching the probe. If there is nail polish on the attachment site, remove the polish. Otherwise, the amount of transmitted light decreases, and measured value may be incorrect or measurement cannot be performed.

**CAUTION**

When the probe is attached on an appropriate site with sufficient circulation and the error message confirming the probe attachment repeatedly appears, the probe may be deteriorated. Replace it with a new one.

**CAUTION**

If the skin gets irritated or redness appears on the skin from the probe, change the attachment site or stop using the probe. Take extreme care for the patients with delicate skin.

**CAUTION**

Do not use a probe which is deteriorated by aging. Accurate measurement cannot be performed.

**CAUTION**

Refer to the probe instruction manual for details.

**CAUTION**

The disposable probe is not sterilized. Use the disposable probe only for a single patient. Never reuse the disposable probe for another patient because it causes cross infection.

## Locking the Keys on the Transmitter

To prevent the patient from pressing the keys on the transmitter during monitoring, you can lock the keys.

To lock the keys:
Press the ◄ and ► keys at the same time and hold for more than 3 seconds. The “Key locked” screen appears.


When the screen time-out period is set to “1 min” (factory default), the “Key locked” screen is displayed for 5 seconds, then the display turns off if there is no key operation.

When the screen time-out period is set to a certain number of minutes, the “Key locked” screen is displayed for 5 seconds, then it changes to the numeric and waveform screen. If there is no key operation, the display turns off when the remaining time elapses. Refer to the “Turning the Display Off” section for details.

To unlock the keys:
Press the ◄ and ► keys at the same time and hold for more than 3 seconds.

**CAUTION**

The measurement values and displayed waveforms on the transmitter and receiving monitor may be different due to timing delay of the display or difference in detection settings.

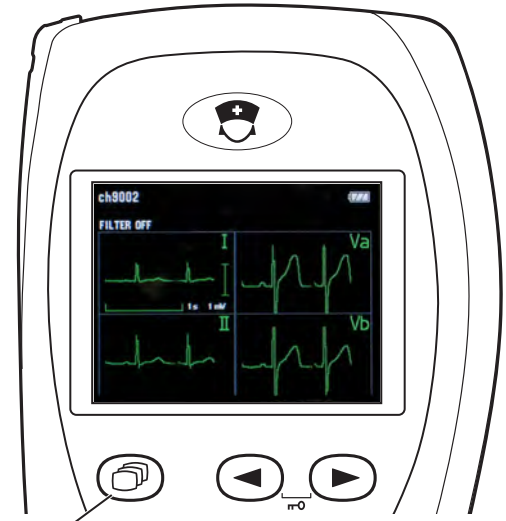
**NOTE**

Do not let the transmitter continuously contact the patient's skin directly. The transmitter heats up by 2 or 3°C (4 or 5°F) during operation and it may cause low temperature burn to the patient.

## Screen Descriptions

When the transmitter is turned on, the startup screen appears, then the check electrodes screen to check the electrode attachment appears.

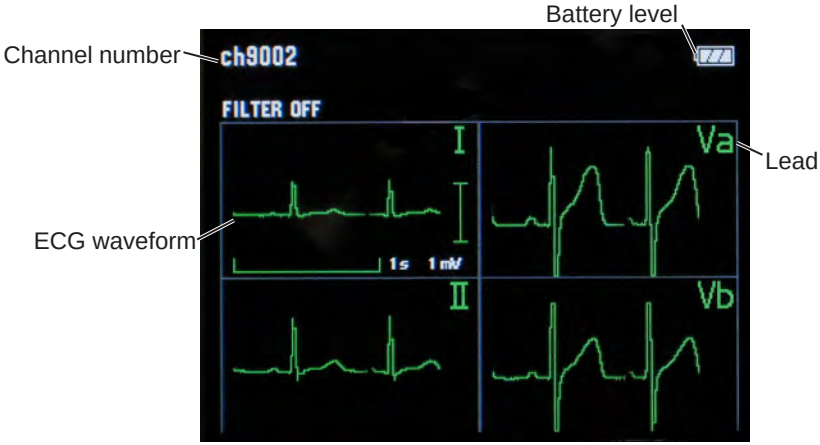
The screen changes in the following order when the Screen key is pressed.
Check electrodes → numeric and waveform → waveform review → numeric review → display off → check electrodes . . .



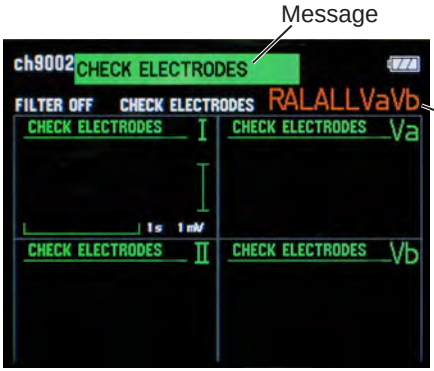
## Check Electrodes Screen

You can check whether the electrodes are properly attached to the patient and the ECG waveform is acquired.

When 6 leads are used, the I, II, Va and Vb lead waveforms are displayed.
When 3 leads are used, only the lead II waveform is displayed.




Filter: off
Sweep speed: 12.5 mm/s
Waveform sensitivity: 0.5 cm/1 mV



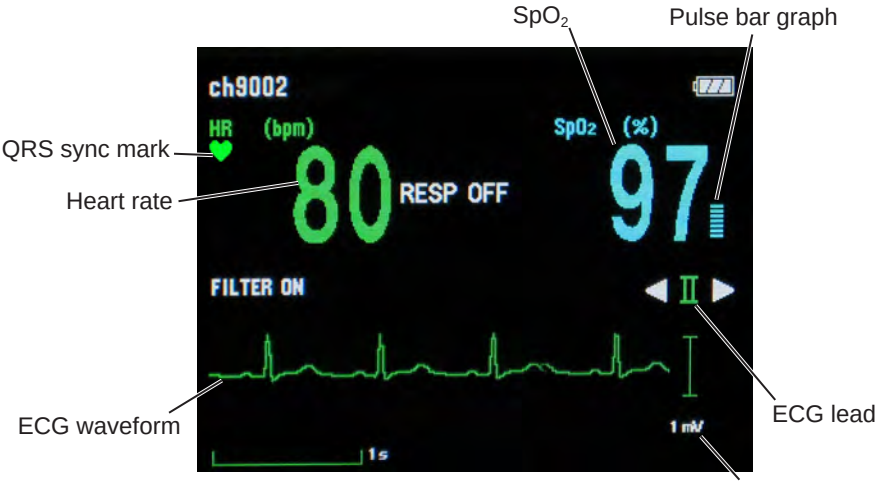

When electrodes are detached, the "CHECK ELECTRODES" message and detached electrode position appear on the screen.

**NOTE**

When ECG measurement is set to OFF on the PARAMETER SETUP screen, the check electrodes screen does not appear.

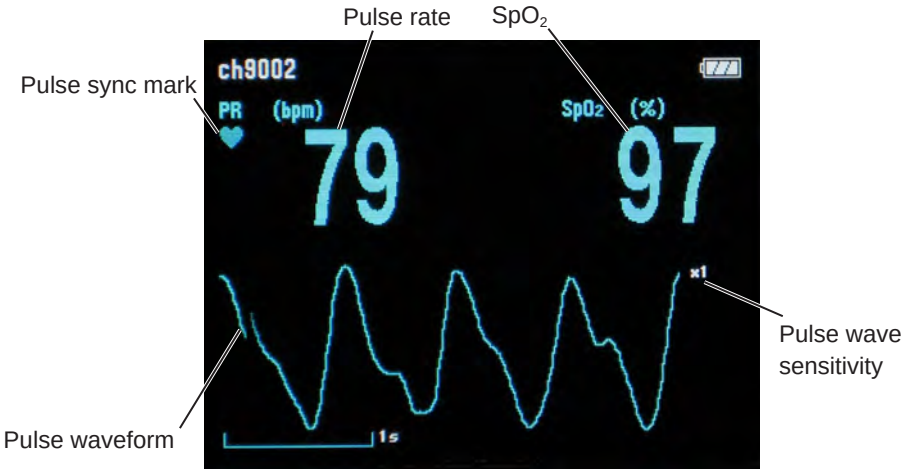
## Numeric and Waveform Screen

Numeric values and waveforms of the monitoring parameters are displayed. You can change the ECG lead with the ◄ and ► keys.




Filter: on
Sweep speed: 12.5 mm/s
Waveform sensitivity: auto

When ECG and respiration measurement is turned off




Sweep speed: 12.5 mm/s
Waveform sensitivity: auto

**NOTE**

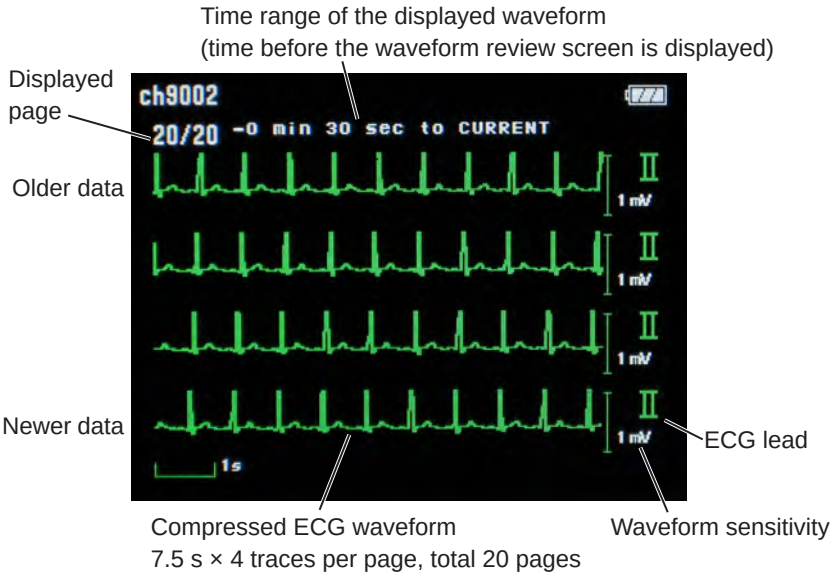
The pulse wave amplitude varies according to the ratio of the pulsation component to the entire transmitted IR signal. When the pulsation component ratio is 1%, the pulse wave amplitude is about 5 mm at ×1 sensitivity on the screen.

## Waveform Review Screen

ECG full disclosure for up to 10 minutes can be saved and reviewed. When ECG measurement is turned off and $SpO_2$ is monitored, the pulse waveform is saved.

When ECG lead is changed on the numeric and waveform screen, the ECG full disclosure of the changed lead is saved.

The saved data is deleted when the transmitter is turned off.

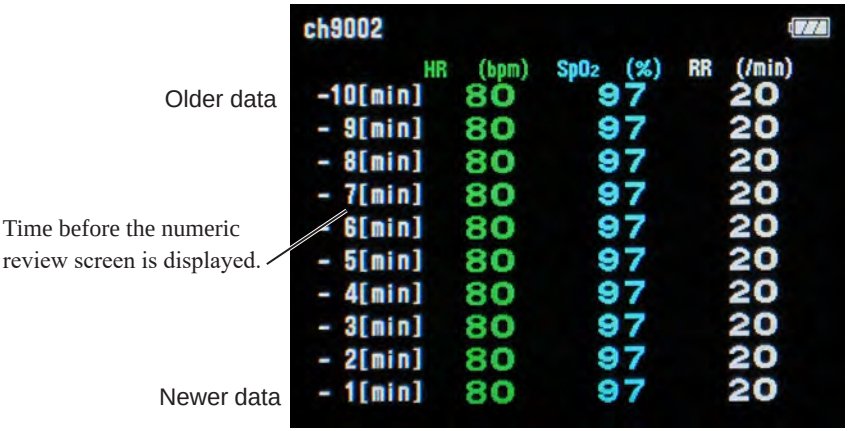



To scroll the waveform, press the ◄ or ► key. The waveform is scrolled by 30 seconds.

## Numeric Review Screen

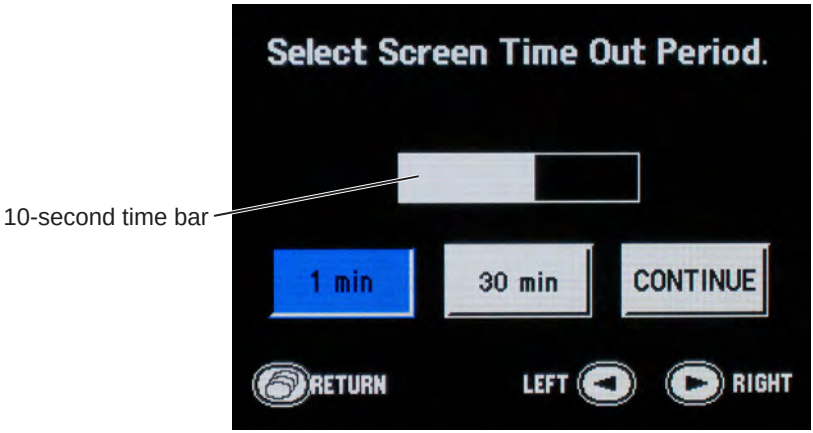
Numeric data of heart rate (or pulse rate when ECG is turned off), $SpO_2$ and respiration rate for up to 10 minutes are saved at 1 minute intervals.

The saved data is deleted when the transmitter is turned off.



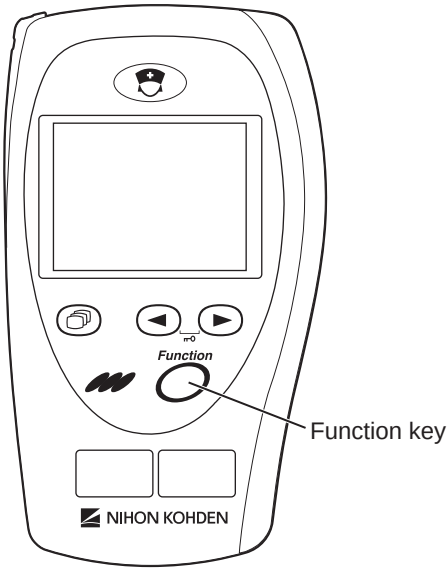

## Display Off

The display can be turned off any time. Refer to the “Turning the Display Off” section for details.



## Basic Monitoring Operation

### Using the Function Key




One of the following functions can be assigned to the Function key on the SYSTEM SETUP screen. Refer to the “Changing SYSTEM SETUP Settings” section.

| | |
|---|---|
| SUSPEND ALARM: | Suspends alarms on the receiving monitor, before they occur, for 2 minutes. |
| PAUSE: | Pauses monitoring on the transmitter and receiving monitor. |
| CONFIRM: | Transmits the signal that the patient is confirmed and displays the “PATIENT CONFIRMED” message on the transmitter. |

**NOTE**

To use the Function key for PAUSE or CONFIRM, you must set “PROTOCOL” on the SYSTEM SETUP screen of the transmitter to 51 and the receiving monitor must be able to receive protocol 51. To use protocol 51, an ORG-9100A or ORG-9110A multiple patient receiver software version 03-03 or later is required.

## Suspending Alarms on the Receiving Monitor

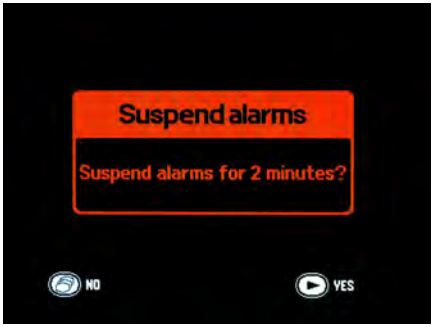
**WARNING**

While the "ALARMS SUSPENDED" message is displayed on the transmitter, all alarms on the receiving monitor are suspended so keep the patient under close observation.

When the FUNCTION KEY is set to “SUSPEND ALARM” or “SUSPEND ALARM & PAUSE” on the SYSTEM SETUP screen, alarms can be suspended for 2 minutes on the receiving monitor before they occur.

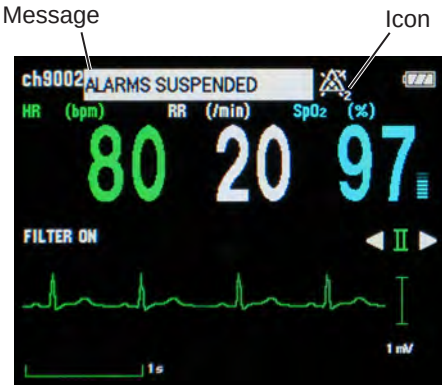
To suspend alarms:

1. Press the Function key. The “Suspend alarms” confirmation screen appears.



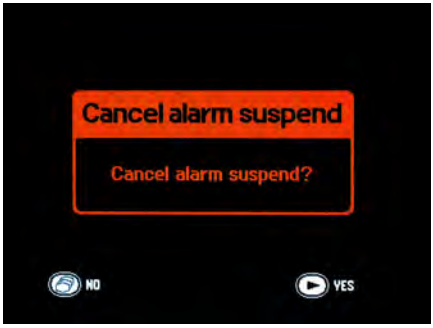

2. Press the ► key to suspend alarms.
   To cancel suspending alarms and return to the previous screen, press the Screen key.

When the alarms are suspended, the “ALARMS SUSPENDED” message and alarm suspended icon with the remaining minutes in alarm suspension appear on the transmitter screen.



To cancel suspending alarms during 2 minute alarm suspension:

1. Press the Function key while the “ALARMS SUSPENDED” message is displayed. The confirmation screen appears.




2. Press the ► key to cancel alarm suspension.
   Press the Screen key to not cancel alarm suspension.

## Pausing Monitoring

When FUNCTION KEY is set to “SUSPEND ALARM & PAUSE” on the SYSTEM SETUP screen, you can pause monitoring on the receiving monitor from the transmitter when the patient cannot be monitored, such as during X-ray examination.

**NOTE**

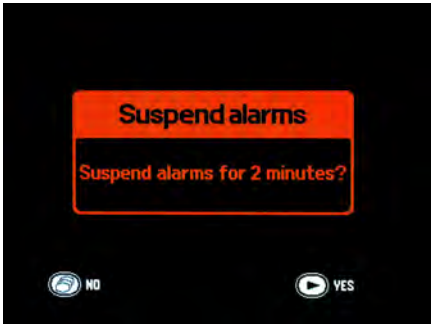
To use the Function key for PAUSE, you must set “PROTOCOL” on the SYSTEM SETUP screen of the transmitter to 51 and the receiving monitor must be able to receive protocol 51. To use protocol 51, an ORG-9100A or ORG-9110A multiple patient receiver software version 03-03 or later is required.

Monitoring on the receiving monitor resumes when one of the following conditions is met.
When OFF is selected for “AUTO RESUME AFTER PAUSE” on the SYSTEM SETUP screen, monitoring does not automatically resume.

- Heart rate is properly monitored on the transmitter for the interval selected for “AUTO RESUME AFTER PAUSE”.
- $SpO_2$ is properly monitored on the transmitter for the interval selected for “AUTO RESUME AFTER PAUSE”.

To pause monitoring:

1. Press the Function key. The “Suspend alarms” confirmation screen appears.




2. Press the Function key for 3 seconds to display the “Pause monitoring” confirmation screen.


3. Press the ► key to pause monitoring.
   To cancel pause monitoring, press the Screen key.

4. Wait about 5 seconds until the “Turn power off” screen appears.

5. Turn off the transmitter.

   If the transmitter is not turned off and monitoring continues for the interval set for “AUTO RESUME AFTER PAUSE” on the SYSTEM SETUP screen, pause monitoring is cancelled and monitoring continues.

## Resuming Monitoring after Pause

To resume monitoring after pause, check that the electrodes, electrode leads and probe are attached to the patient then turn on the transmitter.

**WARNING**

When the patient returns to the bed, turn on the transmitter and check that the monitoring is resumed on the receiving monitor.

**WARNING**

If the transmitter is not turned off and monitoring continues for the selected interval, pause monitoring is canceled and monitoring continues. Check that the monitoring is resumed on the receiving monitor.

## Confirming the Patient

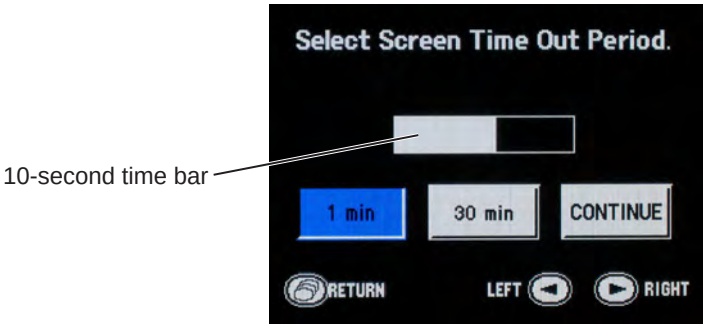
When the FUNCTION KEY is set to “CONFIRM” on the SYSTEM SETUP screen, pressing the Function key sends a signal to the receiving monitor to indicate that the patient or patient condition is confirmed by medical staff.

## Turning the Display Off

The display can be turned off any time.

To turn off the display:

1. Press the Screen key several times until the following screen appears.




2. Select the timing for turning off the display with the ◄ or ► key. The selected item is highlighted in blue. A 10 second countdown starts. You can select a different time within the 10 second countdown.

| | |
|---|---|
| 1 min (factory default): | Turns the display off 1 minute later. |
| 5, 10, 15, 30, 60, 120 or 240 min: | Turns the display off when the selected time elapses. To set the time, refer to “SELECTABLE SCREEN TIME OUT PERIOD (min)” in the “Changing System Setup Settings” section. |
| CONTINUE: | Keep the display turned on. |

**NOTE**

If longer than “1 min” is selected, it reduces the battery lifetime.

3. Wait 10 seconds until the countdown ends. When the countdown ends, the numeric and waveform screen appears.
   Or, press the Screen key before the countdown ends. The check electrodes screen appears.

   When the selected time elapses without any key operation, the display turns off automatically. If a key is pressed, the countdown resets.

- When displaying the check electrodes screen after selecting the time-out period, the screen automatically changes to the numeric and waveform screen 2 minutes later if there is no key operation, then the display turns off when the remaining time elapses.
- When displaying another screen after selecting the time-out period, the screen changes to the numeric and waveform screen 1 minute later if there is no key operation, then the display turns off when the remaining time elapses.
- When “1 min” is selected, the display turns off without changing to the numeric and waveform screen.

When the display is turned off automatically or the power is turned off, the setting returns to “1 min” (factory default).

### Turning the Display On after It was Turned Off

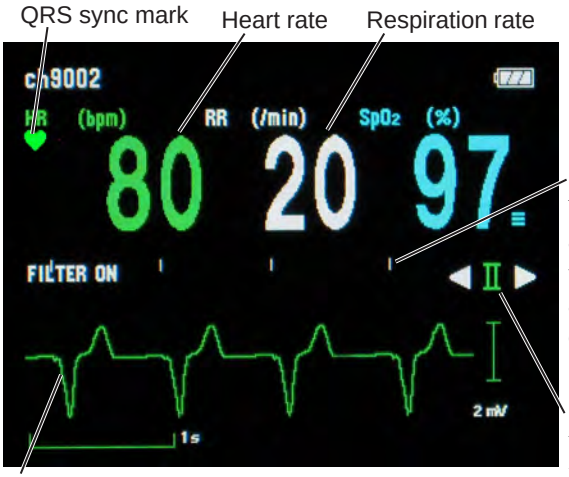
Press the Screen key. One of the following screen appears.

- The previous screen: The Screen key is pressed within 5 minutes after the display turned off.
- Numeric and waveform screen: The Screen key is pressed more than 5 minutes after the display turned off.
- “Key locked” screen: The Screen key is pressed after the display turned off and the “Key locked” screen was the last screen before the display turned off.

## ECG and Respiration Monitoring

When the electrodes are attached and the ECG leads are connected, the heart rate, ECG waveform, respiration rate and respiration waveform appear on the receiving monitor. Refer to the operator's manual of the receiving monitor for details.

When 6 leads are used on this transmitter, up to 8 leads (I, II, III, aVR, aVL, aVF, Va and Vb) of ECG waveforms can be displayed on the receiving monitor. The heart rate is also measured. When 3 leads are used, one channel ECG waveform of lead II can be displayed on the receiving monitor. Refer to the operator's manual of the monitor for details.




Filter: on
Sweep speed: 12.5 mm/s
Waveform sensitivity: auto

**CAUTION**

Turn off the power of mobile phones, small wireless devices and other devices which produce strong electromagnetic interference around a patient (except for devices allowed by the hospital administrator). Radio waves from devices such as mobile phones or small wireless devices may be mistaken as pulse waves or respiration waves and the displayed data may be incorrect.

**NOTE**

- ECG cannot be monitored on a neonate using this transmitter.
- When performing defibrillation, set the hum filter to ON on the receiving monitor. The waveform recovery may become slow due to electrode polarization when the hum filter is set to OFF.

**Use with a Pacemaker**

When monitoring a pacemaker patient, the transmitter detects pacemaker pulse and rejects the pacemaker pulse from the heart rate count.

**WARNING**

The bioelectric impedance measurement sensor of a minute ventilation rate-adaptive implantable pacemaker may be affected by transmitter which is connected to the same patient. If this occurs, the pacemaker may pace at its maximum rate and the transmitter may give incorrect data to the monitor. If this occurs, disconnect the electrode leads from the patient or change the setting on the pacemaker by referring to the pacemaker's manual. For more details, contact your pacemaker representative or Nihon Kohden representative.

**WARNING**

The transmitter detects the pacemaker pulse and rejects the pacemaker pulse from the heart rate count. However, all of the pacemaker pulse might not be rejected. If the pacemaker pulse is not rejected, the pacemaker pulse is detected as QRS and false heart rate may be indicated. Keep pacemaker patients under close observation.

* For the pacemaker pulse rejection capability of the ZM-520PA/521PA/530PA/531PA transmitter, refer to the "Specifications - ECG" section.

**WARNING**

The pacemaker pulse can be overlooked or detected as QRS. You cannot confirm the pacemaker operation only from the detected pacemaker pulse.

**NOTE**

- If an electric blanket is used and incorrect heart rate is displayed on the monitor, turn off the pacing spike detection on the monitor.

- Turn the pacing spike detection to ON on the receiving monitor when monitoring a pacemaker patient. Pacing pulse is detected by the transmitter and transmitted to the monitor. If the pacing spike detection is turned OFF, QRS and pacemaker spike might not be distinguished and pacemaker failure might not be recognized.

**Use with an Electrosurgical Unit**

For use with an electrosurgical unit (ESU), this transmitter has a circuit to protect the patient from skin burn and to reduce ESU interference on the ECG waveform. However, the effectiveness of this circuit depends on electrode position and transmitter setup. With an ESU, pay attention to the following points.

**WARNING**

When the transmitter is used with an electrosurgical unit (ESU), firmly attach the entire area of the ESU return plate. Otherwise, the current from the ESU flows into the electrodes of the transmitter, causing electrical burn where the electrodes are attached. For details, refer to the ESU manual.

**NOTE**

Noise generated from an electrosurgical unit may interfere on an ECG waveform, but will not damage it.

- Measure with 3-electrode lead
  Use the minimum number of electrodes. Use new electrodes.

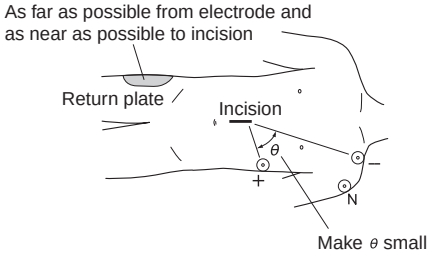
- Minimize noise

1. Select an ECG lead where the active ECG electrodes are located as far from the incision as possible.

2. Position the + and – electrodes as close as possible.

3. Select the leads where the angle (θ) between the active electrodes and the incision is as small as possible.

4. Set the electrosurgical return plate as close to the incision as possible.



## Turning ECG Measurement On/Off

ECG measurement can be turned on or off on the PARAMETER SETUP screen. When electrodes are attached to the patient and ECG leads are connected, ECG monitoring starts even when ECG is turned off.

**When PROTOCOL on the SYSTEM SETUP screen is set to 51:**
ECG measurement on the receiving monitor is automatically set to off.

**NOTE**

ECG measurement on the transmitter cannot be turned on or off from the receiving monitor.

**When PROTOCOL on the SYSTEM SETUP screen is set to 41:**
If ECG measurement is turned off on the transmitter, ECG measurement on the receiving monitor must also be turned off.

## Turning Respiration Measurement On/Off

Respiration measurement can be turned on or off on the PARAMETER SETUP screen. If respiration measurement is turned off, respiration measurement on the receiving monitor is also turned off.

## Electrode Detachment

In the following conditions, the “CHECK ELECTRODES” message is displayed on the transmitter and receiving monitor.

- Electrode is detached from skin.
- Electrode lead is disconnected from the electrode.
- Polarization voltage between the electrode and skin is excessively high.

In these cases, check the cause and if necessary, replace electrodes with new ones.

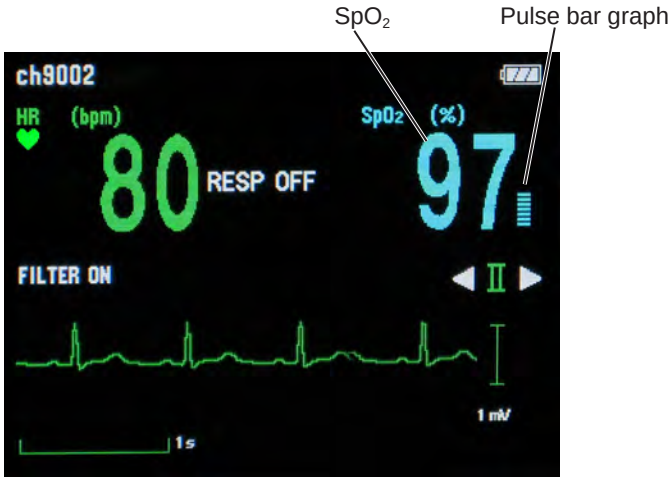
**CAUTION**

When the “CHECK ELECTRODES” message is displayed on the receiving monitor, ECG is not monitored properly and the ECG alarm does not function. Check the electrode, electrode leads, and if necessary, replace with new ones.

## $SpO_2$ Monitoring

The $SpO_2$ monitoring is only available on the ZM-530PA and ZM-531PA transmitter.

When monitoring starts, $SpO_2$ and the pulse waveform are sent to the receiving monitor and $SpO_2$ and the pulse level bar graph are displayed on the transmitter screen. When ECG is not measured, the pulse waveform and pulse rate are also displayed.




**NOTE**

During $SpO_2$ monitoring, the transmitter constantly checks the light intensity of the probe and adjusts the light intensity to maintain optimum measurement condition. During adjustment, the pulse wave becomes flat for about 0.5 seconds.

**WARNING**

$SpO_2$ measurement may be incorrect in the following cases.

- When the patient's carboxyhemoglobin or methemoglobin increases abnormally.
- When dye is injected in the blood.
- When using an electrosurgical unit.
- During CPR.
- When measuring at a site with venous pulse.
- When there is body movement.
- When the pulse wave is small (insufficient peripheral circulation).

**WARNING**

Check the circulation condition by observing the skin color at the measurement site and pulse waveform. Change the measurement site every 8 hours for disposable probes and every 4 hours for reusable probes (every 8 hours for TL-631T series probe). The skin temperature may increase at the attached site by 2 or 3°C (4 or 5°F) and cause a burn or pressure necrosis. When using the probe on the following patients, take extreme care and change the measurement site more frequently according to symptoms and degree.• Patient with a fever

- Patient with insufficient peripheral circulation
- Neonate or low birth weight infant with delicate skin

**WARNING**

When monitoring $SpO_2$ of a patient who is receiving photodynamic therapy, the light from the finger probe sensor may cause a burn. Photodynamic therapy uses a photosensitizing agent that has a side effect of photosensitivity.

**WARNING**

When not monitoring $SpO_2$, disconnect the $SpO_2$ cable from the transmitter. Otherwise, noise from the probe sensor may interfere and incorrect data is displayed on the screen.

The $SpO_2$ probes manufactured by Nihon Kohden have two wavelengths with peaks in the range of 650 and 950 nm. The maximum light intensity is less than 5.5 mW.

**CAUTION**

Turn off the power of mobile phones, small wireless devices and other devices which produce strong electromagnetic interference around a patient (except for devices allowed by the hospital administrator). Radio waves from devices such as mobile phones or small wireless devices may be mistaken as pulse waves or respiration waves and the displayed data may be incorrect.

**CAUTION**

Failure to follow these instructions may cause cable discontinuity, short circuit, skin burn on the patient from the probe temperature increase due to the short circuit of the probe cable, and incorrect measurement data. If the probe is broken, replace it with a new one.

- Do not immerse any part of the probe cable other than the disposable probe in chemical solutions or water.
- Do not pull or bend the probe cable.
- Do not let caster feet run over the probe cable.

**CAUTION**

Normal external light does not affect monitoring but strong light such as a surgical light or sunlight may affect monitoring. If affected, cover the measuring site with a blanket.

**CAUTION**

When the probe is attached on an appropriate site with sufficient circulation and the error message confirming the probe attachment repeatedly appears, the probe may be deteriorated. Replace it with a new one.

**CAUTION**

When a message indicates a faulty probe, stop monitoring and replace the probe with a new one.

**CAUTION**

While a patient is on medication which causes vasodilation, the pulse waveform may change and in rare cases the $SpO_2$ value might not be displayed.

**CAUTION**

Do not attach the probe to the same limb that is used for NIBP measurement or an IBP catheter. The $SpO_2$ measurement may be incorrect.

**NOTE**

- In order to maintain sufficient blood circulation, keep the measurement site warm by covering it with a blanket or something similar. Warming the site is effective, especially for a patient with a small pulse amplitude.
- When monitoring a patient who has an IABP and $SpO_2$ cannot be measured, monitor the patient on a wired monitor. If the monitor has a sensitivity mode, set the mode to “MAX”.

# Indications and Messages

## Indication

| Indication | Cause | Countermeasure |
|---|---|---|
|  | Batteries are fully charged. | — |
|  | Batteries are getting low. | |
|  | Batteries are low. | |
|  | Batteries are almost empty. | Replace the batteries. |
|  | Alarms on the receiving monitor were suspended by pressing the Function key on the transmitter. | Alarms resume when the suspend interval elapses. To cancel alarm suspension, press the Function key again. |

## Messages

When PROTOCOL on the SYSTEM SETUP screen is set to 51, all messages are transmitted.
When PROTOCOL is set to 41, the messages marked with * are not transmitted.

| Message | Cause | Countermeasure |
|---|---|---|
| ALARMS SUSPENDED | Alarms on the receiving monitor are suspended by pressing the Function key on the transmitter | Alarms resume when the 2-minute suspend interval elapses. To cancel alarm suspension, press the Function key again. |
| BATTERY WEAK | Dead batteries | Replace the batteries. |
| CANNOT DETECT PULSE* | Poor blood circulation for measuring the $SpO_2$ value | Check the patient condition, probe attachment or change the attachment site. |
| | The probe is attached too tightly and is obstructing the blood circulation | Reattach the probe. |
| | The probe is not attached to the patient properly | Attach the probe to the patient properly. |
| | “LIGHT INTERFERENCE”, “CHECK PROBE SITE” or “DETECTING PULSE” message is displayed for more than 30 seconds | Refer to the cause and countermeasure for each message in this Messages table and remove the cause. |

| Message | Cause | Countermeasure |
|---|---|---|
| CANNOT MEASURE* | Poor contact between the disposable electrode and skin | Replace electrodes with new ones immediately. |
| CHECK ELECTRODES | Electrode lead is disconnected from the electrode | Firmly connect the electrode lead to the electrode. |
| | Electrode lead is disconnected from the transmitter | Firmly connect the electrode lead to the transmitter. |
| | Electrode lead discontinuity | Replace the electrode lead with a new one. |
| | Electrode is not firmly attached to the skin | Replace the electrode with a new one. |
| | Polarization voltage is abnormally high | |
| CHECK PROBE | The probe is not attached to the patient properly | Attach the probe to the patient properly. |
| | The probe is not attached at the appropriate site | Attach the probe to an appropriate site indicated in the probe manual. |
| | The probe is disconnected from the transmitter | Connect the probe cable to the transmitter. |
| | The probe is past its expiration date | Replace the probe with a new one. |
| CHECK PROBE SITE* | The probe is not attached at the appropriate site | Attach the probe to an appropriate site indicated in the probe manual. |
| | The probe is deteriorated | Replace the probe with a new one. |
| | The probe is past its expiration date | |
| DETECTING PULSE | Searching for the correct pulse wave for $SpO_2$ monitoring | Wait until the pulse wave is detected. |
| | The $SpO_2$ value cannot be obtained because the waveform is unstable | Attach the probe to the patient properly. |
| | The probe is not attached to the patient properly | |
| LIGHT INTERFERENCE | The $SpO_2$ measurement site is under fluorescent light, surgical light, sunlight, or other strong light | Cover the measurement site with a blanket or cloth. |
|  | Considerable body movement | When the message is displayed frequently, check the patient condition and, if necessary, change the attachment site. |
| | The probe is not attached to the patient properly | |

| Message | Cause | Countermeasure |
|---|---|---|
| PATIENT CONFIRMED* | Function key is pressed and the "PATIENT CONFIRMED" signal is transmitted to the receiving monitor (when "PATIENT" is assigned as the function for the Function key on the SYSTEM SETUP screen) | — |
| PROBE FAILURE* | The probe is past its expiration date | Replace the probe with a new one. |
| | Probe is damaged or short-circuited | |
| | Transmitter failure | Contact your Nihon Kohden representative. |
| $SpO_2$ MODULE ERROR* | Transmitter failure | Contact your Nihon Kohden representative. |
| WEAK PULSE* | Poor peripheral circulation | Check the patient condition and change the probe attachment site. |
| | The probe is attached too tightly and is obstructing the blood circulation | Check the probe attachment condition and if necessary, reattach the probe. |
| RESP OFF | "RESP MEASUREMENT" on the PARAMETER SETUP screen is set to OFF | If respiration monitoring is necessary, set "RESP MEASUREMENT" to ON. |

## Message Display Priority

When more than one message condition occurs on the transmitter, only the message with the highest priority is displayed.

| Priority | Message |
|---|---|
| High | PATIENT CONFIRMED |
| ↑ | PROBE FAILURE |
| ↑ | CHECK ELECTRODES |
| ↑ | $SpO_2$ MODULE ERROR |
| ↑ | CHECK PROBE |
| ↑ | CHECK PROBE SITE |
| ↑ | CANNOT DETECT PULSE |
| ↑ | LIGHT INTERFERENCE |
| ↑ | CANNOT MEASURE |
| ↑ | DETECTING PULSE |
| ↑ | WEAK PULSE |
| ↑ | ALARMS SUSPENDED |
| Low | BATTERY WEAK |

# Troubleshooting

If a problem occurs, use the following tables to find and fix it. If the problem still remains after troubleshooting according to these tables, contact your Nihon Kohden representative.

## Transmitter

| Problem | Possible Cause | Action |
|---|---|---|
| Nothing is displayed on the LCD after turning the power on. | Batteries are not installed correctly. The battery polarity is wrong. | Install the batteries correctly. |
| | Batteries are completely discharged. | Replace the batteries with new ones. |
| LCD is difficult to see (too dark or too light). | LCD brightness is not appropriate. | Change the LCD brightness on the SYSTEM SETUP screen. Refer to the “Changing SYSTEM SETUP Settings” section. |
| LCD shows no image (white screen) or a partial image. | The LCD display or the electrical circuits for displaying images were damaged by dropping or impact. | Contact your Nihon Kohden representative. You can confirm transmission of patient physiological data (ECG, respiration, $SpO_2$ and pulse waveform) on the central monitors and/or bedside monitors. |
| Nothing is displayed on the receiving monitor after turning the transmitter power on. | The channel of the transmitter and monitor does not match. | Set the correct channel on the monitor. |
| | The software version of the multiple patient receiver or central monitor is old. | Upgrade the multiple patient receiver or central monitor software to receive signal from the transmitter. Contact your Nihon Kohden representative. |
| | Protocol on the transmitter and monitor does not match. | Set the same protocol on the transmitter and monitor. |
| | Protocol on the transmitter is set to 51 but the monitor cannot receive protocol 51. | Set the protocol on the transmitter to 41. Refer to the “System Setup Setting List” section. |

| Problem | Possible Cause | Action |
|---|---|---|
| Signal receiving condition is poor. | Another transmitter with the same channel is used nearby. | Turn the transmitter power off. If the monitor still receives a signal, there is a high probability that another transmitter of the same channel is used nearby. Follow the instruction of your channel administrator and use another transmitter with a different channel. |
| | Signals of another patient are mixing. | Follow the instructions of your channel administrator and use another transmitter of a different channel. |
| | The transmitter is damaged. | Contact your Nihon Kohden representative. |

## ECG/Respiration

| Problem | Possible Cause | Action |
|---|---|---|
| The heart rate is unstable. | Pacing detection setting on the monitor is not correct. | Turn off the pacing detection setting on the receiving monitor. When monitoring a pacemaker patient, turn on pacing detection. |
| The “CHECK ELECTRODES” message appears on the receiving monitor. | Electrode lead is disconnected from the electrode. | Firmly connect the electrode lead to the electrode. |
| | Electrode lead discontinuity. | Replace the electrode lead with a new one. |
| | Electrode is not firmly attached to the skin. | Replace the electrode with a new one. |
| | Polarization voltage is abnormally high. | Use Nihon Kohden specified electrodes. |
| ECG baseline is thick (AC hum). | The gel on the electrode is dried out. | Replace the electrode with a new one. |
| | The gel on the electrode is coming off. | |
| | An electric blanket is used. | Cover the blanket with a shield cover. |
| | The hum filter is set to OFF on the monitor. | Set the filter to ON. |

| Problem | Possible Cause | Action |
|---|---|---|
| The heart rate of a patient who is using an electric blanket is unstable on the receiving monitor. | Pacing pulse detection is turned ON on the receiving monitor. | Turn OFF the pacing pulse detection on the receiving monitor. |
| No heart rate or ECG is displayed. | “ECG MEASUREMENT” on the PARAMETER SETUP screen is set to OFF. | If ECG monitoring is necessary, set “ECG MEASUREMENT” to ON. |
| Respiration waveform measurement is unstable. | The gel on the electrode is dried out. | Replace the electrode with a new one. |
| | The gel on the electrode is coming off. | |
| No respiration rate is displayed. | “RESP MEASUREMENT” on the PARAMETER SETUP screen is set to OFF. | If respiration monitoring is necessary, set “RESP MEASUREMENT” to ON. |

## $SpO_2$

| Problem | Possible Cause | Action |
|---|---|---|
| $SpO_2$ data is unstable and not reliable. | The probe size is not appropriate for the patient. | Use the appropriate probe for the patient. |
| | Probe attachment condition is poor. The probe is partly detached from the skin. External light is entering the probe. | Firmly attach the probe according to the procedure in the probe operator’s manual. |
| | Measurement site is dirty. Patient is wearing nail polish. | Remove dirt and nail polish. |
| | The probe is attached to the same limb that is used for NIBP measurement. | Attach the probe to the opposite limb. Avoid a site where blood circulation condition changes greatly. |

# Maintenance

The transmitter contains parts which gradually deteriorate with use. Original performance might not be delivered if any part of the transmitter is deteriorated. Perform regular maintenance checks to assure continued safe operation. If the maintenance checks is not performed, degradation or loss of function may go unnoticed and lead to misdiagnosis. To use the transmitter in safe and optimum condition, perform maintenance check every six months.

The following units are necessary for some checking items.
- AX-410G medical instrument checker
- AX-300T $SpO_2$ checker
- Receiving monitor

**CAUTION**

Never disassemble or repair the transmitter. If there is any problem with the transmitter, contact your Nihon Kohden representative.

**NOTE**

- The measurement accuracy of the above units must be managed to perform accurate maintenance check.
- For details on the operation of the above units, refer to the manuals provided with these units.

A maintenance check sheet is provided at the end of this section. Make a copy of this check sheet before performing maintenance check.

## 1. External Check

- There is no damage or dirt on the outside of the transmitter.
- The battery case cover is not damaged, the spring is firmly attached and the battery case cover can be closed firmly.
- No keys are damaged.
- No electrode leads are damaged.
- There are no blood or chemicals on the transmitter.
- The springs in the battery compartment are not damaged or detached.
- Terminals in the battery case are not corroded.

## 2. Transmitter Channel

- The channel number label on the transmitter is not torn or removed.
- The channel of the transmitter matches the label.
  The transmitter channel is displayed in the upper left corner of the screen. The channel number also appears on the startup screen.


Startup screen

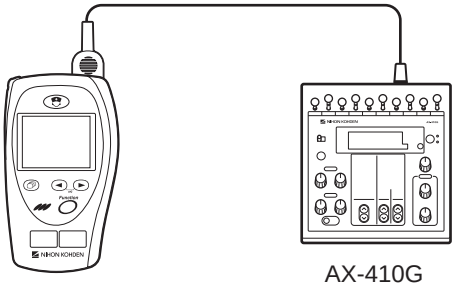
Channel numbers


Numeric and waveform screen

## 3. Transmitting/Receiving Signal

Use the AX-410G medical instrument checker and receiving monitor.

1. Connect the medical instrument checker to the transmitter only with the electrode leads.



AX-410G

2. Place the transmitter 2 to 3 m from the receiving monitor.
3. Set the channel on the receiving monitor to the channel of the transmitter.
4. Turn on the transmitter and medical instrument checker.
5. Check that the ECG of the transmitter appears on the receiving monitor.
6. Turn off the transmitter.
7. Check that the ECG disappears from the receiving monitor.

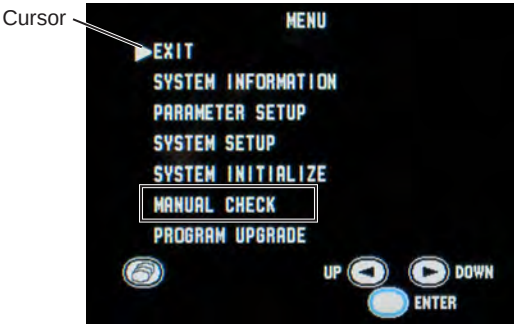
## 4. Display

Check that there are no dots missing on the screen.

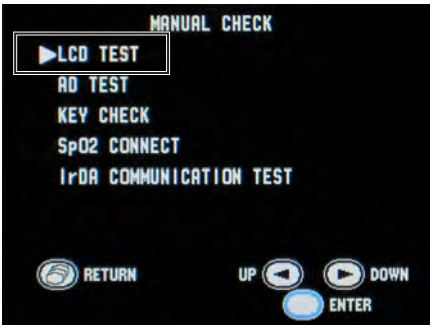
1. Turn off the transmitter.

2. While pressing the Function key, turn on the transmitter. The MENU screen appears.

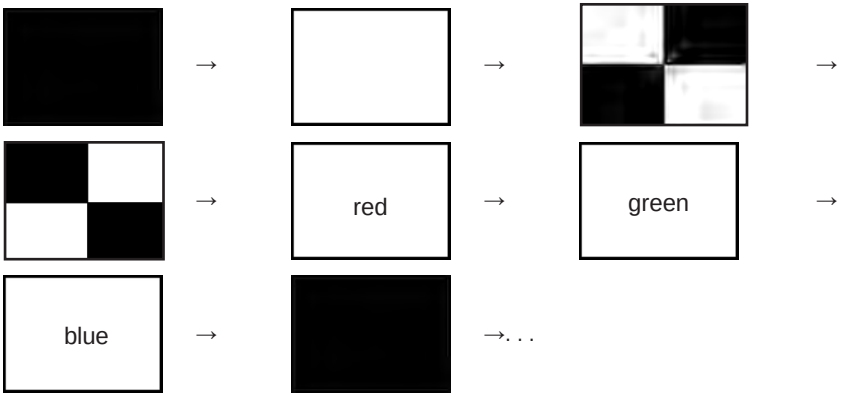
3. Press the ► key to move the cursor to “MANUAL CHECK” and press the Function key.




4. Press the ◄ or ► key to move the cursor to “LCD TEST” and press the Function key.




5. Each time the ► key is pressed, the screen changes as below. Check that no dots are missing.



6. Press the Screen key to return to the MANUAL CHECK screen.

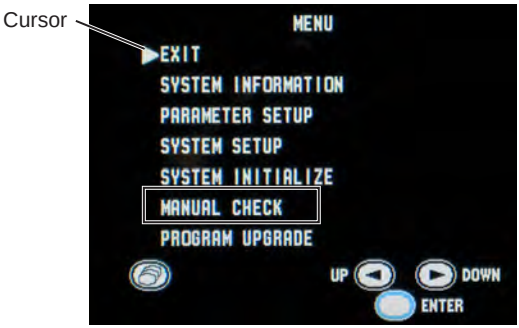
7. Press the Screen key again to return to the MENU screen.

## 5. Key Operation

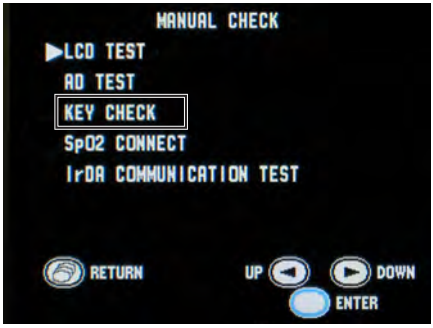
1. Turn off the transmitter.

2. While pressing the Function key, turn on the transmitter. The MENU screen appears.

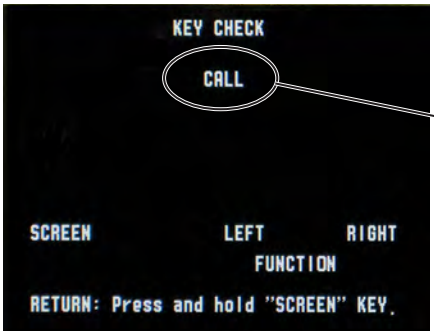
3. Press the ► key to move the cursor to “MANUAL CHECK” and press the Function key.




4. Press the ◄ or ► key to move the cursor to “KEY CHECK” and press the Function key.



5. Press each key one at a time and check that the pressed key is highlighted on the screen.

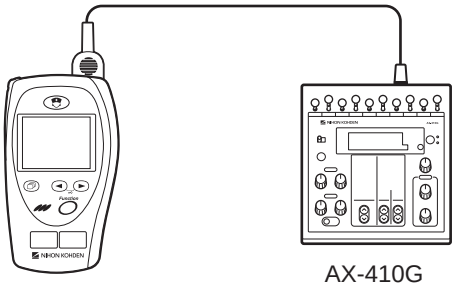



When the CALL key is pressed, the key name is highlighted.

6. After checking, press and hold the Screen key to return to the MANUAL CHECK screen.

## 6. ECG Check

1. Connect the medical instrument checker to the transmitter only with the electrode leads.



AX-410G

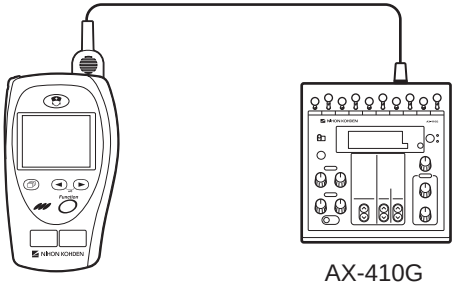
2. Place the transmitter 1 m from the receiving monitor.

3. Turn on the transmitter and medical instrument checker.

4. Check that the ECG of the transmitter appears on the receiving monitor.

## 7. Respiration Check

1. Connect the medical instrument checker to the transmitter only with the electrode leads.




2. Place the transmitter 1 m from the receiving monitor.

3. Turn on the transmitter and medical instrument checker.

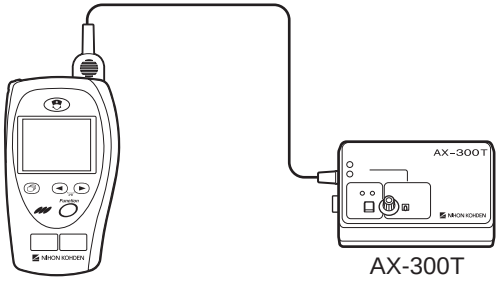
4. Check that the respiration waveform of the transmitter appears on the receiving monitor.

## 8. $SpO_2$ Check

$SpO_2$ can be checked with an $SpO_2$ checker or a medical instrument checker.

**With $SpO_2$ Checker**

1. Connect the $SpO_2$ checker to the transmitter only with the $SpO_2$ connection cable.




2. Place the transmitter 1 m from the receiving monitor.

3. Turn on the transmitter and $SpO_2$ checker.

4. Check that the pulse bar graph appears on the transmitter screen.

5. Check that $SpO_2$ and pulse rate on the transmitter is within the following range.

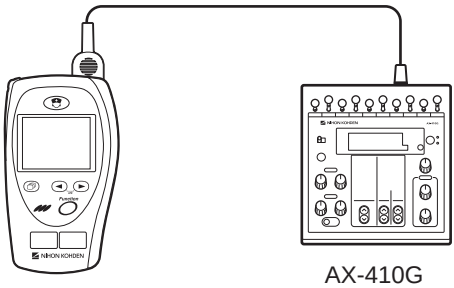
| $SpO_2$ on the $SpO_2$ Checker | | Range |
|---|---|---|
| $SpO_2$* | 97% | 95 to 99%$SpO_2$ (±2 digits) |
| | 80% | 78 to 82%$SpO_2$ (±2 digits) |
| | 70% | 66 to 74%$SpO_2$ (±4 digits) |
| Pulse rate | 60 beats/min | 57 to 63 beats/min (±3% ±1 beat/min) |
| | 120 beats/min | 115 to 125 beats/min (±3% ±1 beat/min) |

* The $SpO_2$ check with the $SpO_2$ checker is affected by the checker's tolerance to the $SpO_2$ measuring accuracy of the transmitter. (The measurement accuracy is described in the "Specifications" section.) For details, refer to the $SpO_2$ checker manual.

6. Check that the $SpO_2$ and pulse waveform of the transmitter appear on the receiving monitor.

**With Medical Instrument Checker**

1. Connect the medical instrument checker to the transmitter only with the $SpO_2$ connection cable.




AX-410G

2. Place the transmitter 1 m from the receiving monitor.

3. Turn on the transmitter and medical instrument checker.

4. Check that the pulse bar graph appears on the transmitter screen.

5. Check that $SpO_2$ and pulse rate on the transmitter is within the following range.

| Medical Instrument Checker | | Range |
|---|---|---|
| $SpO_2$* | 97% | 95 to 99%$SpO_2$ (±2 digits) |
| | 80% | 78 to 82%$SpO_2$ (±2 digits) |
| | 70% | 66 to 74%$SpO_2$ (±4 digits) |
| ECG | NORMAL 80 | 76 to 84 beats/min (±4 beats/min) |

* The $SpO_2$ check with the medical instrument checker is affected by the simulator's tolerance to the $SpO_2$ measuring accuracy of the transmitter. (The measurement accuracy is described in the "Specifications" section.) For details, refer to the medical instrument checker manual.

6. Check that the $SpO_2$ and pulse waveform of the transmitter appear on the receiving monitor.

## Maintenance Check Sheet

Hospital/Organization: _____

Service Personnel: _____

Instrument Name: Transmitter

Instrument Model: ZM-520PA / ZM-521PA / ZM-530PA / ZM-531PA

Instrument Serial Number: _____

Hardware Revision Number: _____

Software Revision Number: _____

| | | |
|---|---|---|
| 1. External Check | Pass | Fail |
| 2. Transmitter Channel | Pass | Fail |
| 3. Transmitting/Receiving Signal | Pass | Fail |
| 4. Display | Pass | Fail |
| 5. Key Operation | Pass | Fail |
| 6. ECG Check | Pass | Fail |
| 7. Respiration Check | Pass | Fail |
| 8. $SpO_2$ Check | Pass | Fail |

**Overall Judgement**

□ OK

□ Can be used but needs maintenance.

□ Maintenance required. Cannot be used.

# Lifetime and Disposal

**CAUTION**

Dispose of Nihon Kohden products according to your local laws and your facility's guidelines for waste disposal. Otherwise, it may affect the environment. If there is a possibility that the product may have been contaminated with infection, dispose of it as medical waste according to your local laws and your facility's guidelines for medical waste. Otherwise, it may cause infection.

## Disposing of Used Batteries

### Battery Lifetime

Replace the batteries when the battery replacement indication appears on the transmitter.

### Disposal

**NOTE**

Remove the batteries before disposing of the transmitter.

Before disposing of the batteries, check with your local solid waste officials for details in your area for proper disposal. It may be illegal to dispose of these batteries in the municipal waste stream.

## Disposing of Electrodes and $SpO_2$ Probes

Refer to the manual for each item.

## Disposing of Transmitter

Remove the batteries from the transmitter and dispose of the transmitter following your local laws for disposal.

# Cleaning, Disinfection and Sterilization

## Transmitter and Electrode Leads

**CAUTION**

This transmitter is not waterproof. If detergent or liquid spills into the transmitter, stop cleaning or disinfecting it and contact your Nihon Kohden representative. The transmitter needs to be checked for safety and function before use.

**NOTE**

The transmitter cannot be sterilized. Sterilizing the transmitter may damage it.

Before cleaning or disinfecting, remove the batteries from the transmitter. Be careful not to let any liquid get inside the transmitter.

### Cleaning

Wipe the transmitter and electrode leads with a soft cloth moistened with ethanol for disinfection (76.9 to 81.4% by vol) or neutral detergent diluted with water. After cleaning, dry them completely.

Use cotton swab moistened with neutral detergent diluted with water to clean inside the battery compartment.

### Disinfection

**CAUTION**

Do not immerse the electrode lead connector in liquid.

Wipe the outside surface of the transmitter and electrode lead with a non-abrasive cloth moistened with any of the disinfectants listed below. For details on the disinfectants, refer to the instruction provided with the disinfectants. Use the recommended concentration.

| Disinfectant | Concentration (%) |
|---|---|
| Glutaraldehyde solution | 2.0 |
| Alkyldiaminoethylglycine hydrochloride | 0.5 |
| Benzalkonium chloride | 0.2 |
| Benzethonium chloride solution | 0.2 |
| Chlorhexidine gluconate solution | 0.5 |
| Phtharal | 0.55 |
| Phenol | 1.56 |

### $SpO_2$ Probe

Refer to the probe manual.

## Periodic Replacement Schedule

To maintain the performance of the instrument, the following part must be periodically replaced.

| Name | Code No. | Expected Life Span |
|---|---|---|
| Silicon seal (for battery case cover) | 6114-918705 | 1 year |

## Repair Parts Availability Policy

Nihon Kohden Corporation (NKC) shall stock repair parts (parts necessary to maintain the performance of the instrument) for a period of 8 years from the date of delivery. In that period NKC or its authorized agents will repair the instrument. This period may be shorter than 8 years if a board or part necessary for the faulty section is not available.

# Specifications

## ZM-520PA/ZM-530PA

### Measured Parameters

| | |
|---|---|
| Waveforms: | ECG, impedance method respiration, pulse |
| Numeric data: | Heart rate, respiration rate, $SpO_2$, pulse rate |

### Transmitted Data

| | |
|---|---|
| Waveforms: | ECG, respiration, pulse wave |
| Numeric data: | $SpO_2$, pulse rate |
| Status information: | Battery replacement, battery level*, alarm suspended, pause monitoring*, patient confirmed*, ECG lead, pacing detection, electrode detachment, electrode impedance*, ECG off*, respiration method (impedance)*, $SpO_2$ status, respiration status*, channel ID, time constant (3.2 s), type of transmitter, transmitter code number*, transmitter serial number*<br>* Transmitted only when the protocol is “51”. |

### Display

| | |
|---|---|
| Display size: | 2.2 inch TFT color LCD |
| Viewing area: | 44.16 (H) × 33.12 (V) mm |
| Resolution: | 320 (H) × 240 (V) dots |

### Displayed Data

| | |
|---|---|
| Numeric and waveform screen: | ECG (one waveform from lead I, II, III, Va or Vb), heart rate, pulse rate, respiration rate, $SpO_2$, message, battery level, QRS/pulse sync mark, pulse bar graph, ECG lead |
| Waveform review screen: | ECG or pulse wave of past 10 minutes |
| Numeric review screen: | Heart rate or pulse rate, respiration rate and $SpO_2$ at 1 minute interval for past 10 minutes |
| Check electrodes screen: | ECG for checking electrode attachment |

### ECG

**ECG Measurement**

| | |
|---|---|
| Channels: | 4 |
| Input dynamic range: | ±10 mV or more |
| Electrode offset potential tolerance: | ±500 mV or more |
| Input impedance: | 5 MΩ or more |

| | |
|---|---|
| Common mode rejection ratio: | 95 dB or more<br>IEC 60601-2-27: 2005 50.102.10 complied |
| Pacing pulse detection: | amplitude ±2 to 700 mV, duration 0.1 to 2 ms<br>IEC 60601-2-27: 2005 complied<br>Based upon pacemaker pulse rejection capability |
| Defibrillation-proof: | ECG input protected against 400 Ws/DC 5 kV<br>IEC 60601-2-27 17.101 complied |
| ECG recovery time after defibrillation: | within 10 s |
| Electrode condition: | Displays CHECK ELECTRODES message |
| Tall T-wave rejection capability: | Complies with the heights of T-waves from 0 to 1.2 mV<br>IEC 60601-2-27: 2005 50.102.17 complied |
| Heart rate averaging: | Calculated by using the most recent 8 beats. |
| Heart rate meter accuracy and response to irregular rhythm: | |
| | Ventricular bigeminy (Test waveform name: aami3a*): 80 bpm<br>Slow alternating ventricular bigeminy (Test waveform name: aami3b*): 60 bpm<br>Rapid alternating ventricular bigeminy (Test waveform name: aami3c*): 108 bpm<br>Bidirectional systoles (Test waveform name: aami3d*): 88 bpm<br>* The test waveforms can be download at http://www.physionet.org |
| Response time of heart rate meter to change in heart rate: | |
| | HR change from 80 to 120 bpm: 4 to 8 seconds<br>HR change from 80 to 40 bpm: 11 to 15 seconds |
| Pacemaker pulse rejection capability, without overshoot: | |
| | Complies with the amplitudes of pacemaker pulses ±2 to ±700 mV and widths 0.1 to 2 ms (specified in IEC 60601-2-27: 2005 50.102.13) |
| Pacemaker pulse rejection capability, with overshoot: | |
| | Overshoot amplitudes and time constants of ±0.12 mV/100 ms to ±2 mV/4 ms (As defined by method B of IEC 60601-2-27: 2005 50.102.13, this corresponds to the pacemaker pulses amplitudes and widths of ±4 mV/2 ms to amplitudes ±80 mV/0.1 ms.) |

**ECG Display and Heart Rate Count**

| | |
|---|---|
| Frequency characteristic: | filter on: 1 to 18 Hz, filter off: 0.05 to 60 Hz |
| Heart rate detection method: | Average |
| QRS detection: | 70 to 120 ms: amplitude ≥ 0.5 mV, rate 30 to 200 beats/min<br>40 to 120 ms: amplitude ≥ 0.5 mV, rate 30 to 250 beats/min |

| | |
|---|---|
| Heart rate counting range: | 0, 15 to 300 beats/min |
| Heart rate counting accuracy*: | ±2 beats/min, (0, 15 to 300 beats/min) |

* Essential performance of this transmitter

## Respiration Measurement

| | |
|---|---|
| Measuring method: | Impedance method |
| Measuring lead: | Between R and F |
| Impedance range: | 220 to 2000 Ω |
| Excitor current: | 54 to 93 μAp-p, 48 kHz |
| Respiration rate measuring accuracy*: | ±2 counts/min (at 0 to 150 counts/min) |
| Respiration rate counting range: | 0 to 150 counts/min |

* Essential performance of this transmitter

## $SpO_2$ Measurement (ISO 9919: 2005 compliance)

| | |
|---|---|
| Measuring range: | 0 to 100%$SpO_2$ |
| Declared range: | 70 to 100%$SpO_2$ |
| Minimum display range: | 1%$SpO_2$ |
| Display update cycle: | Every 3 seconds |
| Measuring accuracy (rms)*: | Accuracy assurance temperature: 18 to 40ºC |
| Total accuracy including probe: | 80%$SpO_2$ ≤ %$SpO_2$ ≤ 100%$SpO_2$: ±2%$SpO_2$ |
| | 70%$SpO_2$ ≤ %$SpO_2$ < 80%$SpO_2$: ±3%$SpO_2$ |
| | under 70%$SpO_2$: not specified |
| Accuracy of the transmitter: | 80%$SpO_2$ ≤ %$SpO_2$ ≤ 100%$SpO_2$: ±1%$SpO_2$ |
| | 50%$SpO_2$ ≤ %$SpO_2$ < 80%$SpO_2$: ±2%$SpO_2$ |
| | under 50%$SpO_2$: not specified |
| Pulse rate declared range: | 30 to 300 bpm |
| Pulse rate display range: | 30 to 300 bpm |
| Pulse rate accuracy (rms)*: | ±3% ±1 bpm |

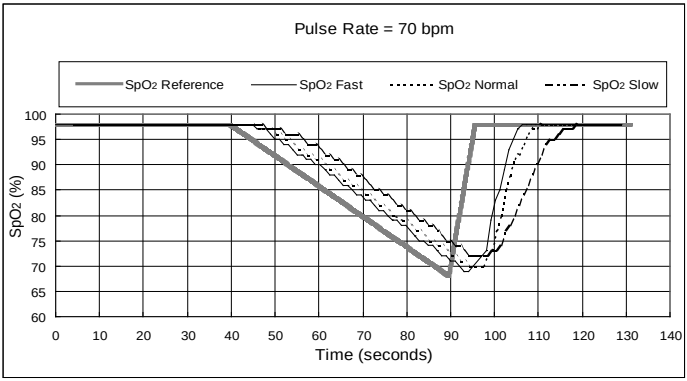
* Essential performance of this transmitter

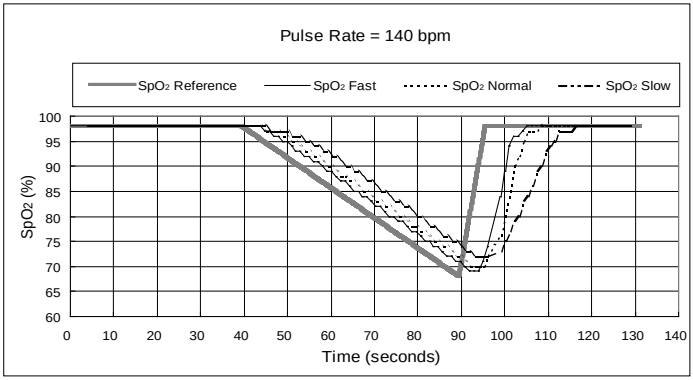
**NOTE**

- The $SpO_2$ measuring accuracy was tested using the TL-201T, TL-260T, TL-271T and TL-631T $SpO_2$ probes. The testing was performed during induced hypoxia on healthy volunteers (Ethnicity: 10 Caucasians, 2 Africans, 1 Asian and 3 Indians), (Skin: 8 light, 4 medium, 4 dark), (Age: 21 to 34), (5 women and 11 men) under the condition of no motion. Arterial blood was sampled and measured by a CO-oximeter. The difference between $SpO_2$ measured by the $SpO_2$ probe and functional $SaO_2$ measured by a CO-oximeter was calculated using the root-mean-square (rms) method according to ISO 9919: 2005. This measurement accuracy figure represents 2/3 of all test measurements.
- A pulse oximeter tester that generates simulated signals can be used to check the difference from the design specification, but it cannot be used as a replacement for

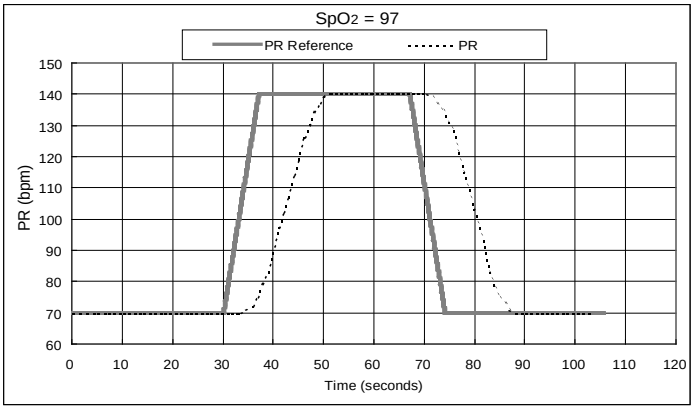
human signals for testing accuracy.

Response time: Selectable from “Slow”, “Normal” and “Fast”.
The following graphs show response time for 0.6%/s $SpO_2$ change.



The following graph shows response time for 10 bpm/s pulse rate change.




## Transmitter

| | |
|---|---|
| FCC regulation: | FCC part 95 Subpart H<br>Wireless Medical Telemetry Service (WMTS) |
| Field strength limits: | ≤ 200 mV/m (at 3 m) |
| Undesired emissions: | |
| FCC part 95 95.2379 (a), (b): | ≤ 960 MHz: 200 μV/m (at 3 m)<br>≥ 960 MHz: 500 μV/m (at 3 m) |
| Antenna: | Internal |
| Transmission channel: | Indicated on the transmitter |
| Transmission frequency range: | 608.0250 to 613.9750 MHz |
| Channel spacing: | 50 kHz or 37.5 kHz (12.5 kHz when interleaved) |
| Modulation: | FSK (frequency shift keying) |
| Type of emission: | F1D |
| Occupied bandwidth: | 12 to 18 kHz |
| Effective radiated power: | 1.0 mW |

## Power Requirements

| | |
|---|---|
| Rated voltage: | 3.0 V |
| Shutdown voltage: | 1.4 to 1.75 V |
| Operating voltage: | Shutdown voltage to 3.2 V |
| Battery type: | Two AA (LR6) type alkaline dry cell primary batteries |
| Battery lifetime (with alkaline batteries, at room temperature): | |
| ZM-520PA: | approximately 3.5 days |
| ZM-530PA: | approximately 2.5 days (measuring ECG, respiration and $SpO_2$) |
| | approximately 3.5 days (measuring ECG and respiration) |

## Dimension and Weight

| | |
|---|---|
| Dimension: | 78 W × 137 H × 36 D (mm) |
| Weight: | about 230 g (excluding batteries and other accessories) |
| | about 280 g (including batteries, excluding other accessories) |

## Environment

**Operating environment**

| | |
|---|---|
| Temperature: | 5 to 40°C (41 to 104°F) |
| Humidity: | 30 to 85% (noncondensing) |
| Atmospheric pressure: | 700 to 1060 hPa |

**Storage and transport environment**

| | |
|---|---|
| Temperature: | −20 to +65°C (−4 to +149°F) |
| Humidity: | 10 to 95% |
| Atmospheric pressure: | 700 to 1060 hPa |

**Water resistance**

Water does not get inside the transmitter when immersed in water up to 30 cm deep for 3 minutes.

## Safety Standards

| | |
|---|---|
| Safety standard: | CAN/CSA-C22.2 No. 601-1 M90 |
| | CAN/CSA-C22.2 No. 601-1. 1S1-94 |
| | CAN/CSA-C22.2 No. 601-1. 1B-90 |
| | CAN/CSA-C22.2 No. 60601-2-49-04 |
| | CAN/CSA-C22.2 No. 60601-2-27-06 |
| | IEC 60601-1: 1988 |
| | IEC 60601-1 Amendment 1: 1991 |
| | IEC 60601-1 Amendment 2: 1995 |
| | IEC 60601-2-27: 2005 |
| | IEC 60601-2-49: 2001 |
| | ISO 9919: 2005 |
| | UL 60601-1: 2003 |

Type of protection against electrical shock:
INTERNALLY POWERED EQUIPMENT
Degree of protection against electrical shock:
ECG and impedance method respiration:
DEFIBRILLATION-PROOF TYPE CF APPLIED PART
$SpO_2$: DEFIBRILLATION-PROOF TYPE BF APPLIED PART
Degree of protection against harmful ingress of water:
IPX0 (non-protected)
Degree of safety of application in the presence of a FLAMMABLE ANAESTHETIC MIXTURE WITH AIR, OR WITH OXYGEN OR NITROUS OXIDE:
Equipment not suitable for use in the presence of FLAMMABLE ANAESTHETIC MIXTURE WITH AIR, OR WITH OXYGEN OR NITROUS OXIDE
Mode of operation: CONTINUOUS OPERATION
ME EQUIPMENT type: HAND-HELD and PORTABLE

## Electromagnetic Compatibility

IEC 60601-1-2: 2001
IEC 60601-1-2 Amendment 1: 2004

## Electromagnetic Emissions

This model (ZM-520PA/ZM-530PA) is intended for use in the electromagnetic environment specified below. The customer or the user of ZM-520PA or ZM-530PA should assure that it is used in such an environment.

| Emissions test | Compliance | Electromagnetic environment - guidance |
|---|---|---|
| RF emissions<br>CISPR 11 | Group 1 | ZM-520PA/ZM-530PA 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<br>CISPR 11 | Class B | ZM-520PA/ZM-530PA is suitable for use in all establishments, including domestic establishments. |
| Harmonic emissions<br>IEC 61000-3-2 | Not applicable | |
| Voltage fluctuations/ flicker emissions<br>IEC 61000-3-3 | Not applicable | |

## Electromagnetic Immunity

This model ZM-520PA/ZM-530PA is intended for use in the electromagnetic environment specified below. The customer or the user of ZM-520PA or ZM-530PA 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 | ±6 kV contact<br>±8 kV air | ±6 kV contact<br>±8 kV air | Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%. |
| Electrical fast transient/burst IEC 61000-4-4 | ±2 kV for power supply lines<br>±1 kV for input/ output lines | Not applicable | — |
| Surge IEC 61000-4-5 | ±1 kV differential mode<br>±2 kV common mode | Not applicable | — |
| Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11 | <5% $U_T$ (>95% dip in $U_T$) for 0.5 cycles<br><br>40% $U_T$ (60% dip in $U_T$) for 5 cycles<br><br>70% $U_T$ (30% dip in $U_T$) for 25 cycles<br><br><5% $U_T$ (>95% dip in $U_T$) for 5 s | Not applicable | — |
| Power frequency (50/60 Hz) magnetic field 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. | | | |

**Avoiding Electromagnetic Interference (Impedance Respiration)**

Impedance respiration measurement is very sensitive and affected by electromagnetic interference. Technological limitations do not allow immunity levels higher than 1 V/m for radiated RF electromagnetic fields. Electromagnetic fields with field strengths above 1 V/m may cause measurement error. Do not use electrically radiating equipment near the impedance respiration measurements.

| Immunity test | IEC 60601 test level | Compliance level | Electromagnetic environment - guidance |
|---|---|---|---|
| | | | Portable and mobile RF communications equipment should be used no closer to any part of ZM-520PA/ZM-530PA, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.<br><br>**Recommended separation distance** |
| Conducted RF<br>IEC 61000-4-6 | 3 Vrms<br>150 kHz to 80 MHz | 3 Vrms | $d = 1.2\sqrt{P}$ |
| Radiated RF<br>IEC 61000-4-3 | 3 V/m<br>80 MHz to 2.5 GHz | 3 V/m 80 MHz to 2.5 GHz<br><br>(1 V/m 80 MHz to 2.5 GHz for respiration) | $d = 1.2\sqrt{P}$ 80 MHz to 800 MHz<br>$d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz<br><br>($d = 3.5\sqrt{P}$ 80 MHz to 800 MHz for respiration<br>$d = 7.0\sqrt{P}$ 800 MHz to 2.5 GHz for respiration)<br><br>where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m).<br><br>Field strengths from fixed RF transmitters, as deter mined by an electromagnetic site survey*[1], should be less than the compliance level in each frequency range*[2].<br><br>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.

*[1] 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 ZM-520PA/ZM-530PA is used exceeds the applicable RF compliance level above, ZM-520PA/ZM-530PA should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating ZM-520PA/ZM-530PA.

*[2] Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 1 V/m for respiration and 3 V/m for all other functions.

## Recommended Separation Distances between Portable and Mobile RF Communications Equipment

The ZM-520PA/ZM-530PA is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of ZM-520PA/ZM-530PA can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and ZM-520PA/ZM-530PA as recommended below, according to the maximum output power of the communications equipment.

| Rated maximum output power of transmitter (W) | Separation distance according to frequency of transmitter (m) | | |
|---|---|---|---|
| | 150 kHz to 80 MHz<br>$d = 1.2\sqrt{P}$ | 80 MHz to 800 MHz<br>$d = 1.2\sqrt{P}$<br><br>(For respiration:<br>$d = 3.5\sqrt{P}$) | 800 MHz to 2.5 GHz<br>$d = 2.3\sqrt{P}$<br><br>(For respiration:<br>$d = 7.0\sqrt{P}$) |
| 0.01 | 0.12 | 0.12 (0.35*) | 0.23 (0.7*) |
| 0.1 | 0.38 | 0.38 (1.1*) | 0.73 (2.2*) |
| 1 | 1.2 | 1.2 (3.5*) | 2.3 (7.0*) |
| 10 | 3.8 | 3.8 (11*) | 7.3 (22*) |
| 100 | 12 | 12 (35*) | 23 (70*) |

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be estimated 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.

(* For respiration)

NOTE 1: At 80 MHz and 800 MHz, the separation distance for 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.

## Recovery Time after Defibrillation

The transmitter returns to the normal operating mode within 10 seconds after defibrillation. The stored settings are not affected.

## System Composition for EMC Test

The ZM-520PA/ZM-530PA transmitter is tested to comply with IEC 60601-1-2: 2001 and Amendment 1: 2004 with the following composition.

| Units | Cable Length |
|---|---|
| ZM-520PA/ZM-530PA transmitter | — |
| BR-906P ECG electrode lead | 0.8 m |
| TL-201T finger probe | 1.6 m |

# ZM-521PA/ZM-531PA

## Measured Parameters

| | |
|---|---|
| Waveforms: | ECG, impedance method respiration, pulse |
| Numeric data: | Heart rate, respiration rate, $SpO_2$, pulse rate |

## Transmitted Data

| | |
|---|---|
| Waveforms: | ECG, respiration, pulse wave |
| Numeric data: | $SpO_2$, pulse rate |
| Status information: | Battery replacement, battery level*, alarm suspended, pause monitoring*, patient confirmed*, ECG lead, pacing detection, electrode detachment, electrode impedance*, ECG off*, respiration method (impedance)*, $SpO_2$ status, respiration status*, channel ID, time constant (3.2 s), type of transmitter, transmitter code number*, transmitter serial number*<br>* Transmitted only when the protocol is “51”. |

## Display

| | |
|---|---|
| Display size: | 2.2 inch TFT color LCD |
| Viewing area: | 44.16 (H) × 33.12 (V) mm |
| Resolution: | 320 (H) × 240 (V) dots |

## Displayed Data

| | |
|---|---|
| Numeric and waveform screen: | ECG (one waveform from lead I, II, III, Va or Vb), heart rate, pulse rate, respiration rate, $SpO_2$, message, battery level, QRS/pulse sync mark, pulse bar graph, ECG lead |
| Waveform review screen: | ECG or pulse wave of past 10 minutes |
| Numeric review screen: | Heart rate or pulse rate, respiration rate and $SpO_2$ at 1 minute interval for past 10 minutes |
| Check electrodes screen: | ECG for checking electrode attachment |

## ECG

**ECG Measurement**

| | |
|---|---|
| Channels: | 4 |
| Input dynamic range: | ±10 mV or more |
| Electrode offset potential tolerance: | ±500 mV or more |
| Input impedance: | 5 MΩ or more |
| Common mode rejection ratio: | 95 dB or more<br>IEC 60601-2-27: 2005 50.102.10 complied |
| Pacing pulse detection: | amplitude ±2 to 700 mV, duration 0.1 to 2 ms<br>IEC 60601-2-27: 2005 complied<br>Based upon pacemaker pulse rejection capability |

| | |
|---|---|
| Defibrillation-proof: | ECG input protected against 400 Ws/DC 5 kV<br>IEC 60601-2-27 17.101 complied |
| ECG recovery time after defibrillation: | within 10 s |
| Electrode condition: | Displays CHECK ELECTRODES message |
| Tall T-wave rejection capability: | Complies with the heights of T-waves from 0 to 1.2 mV<br>IEC 60601-2-27: 2005 50.102.17 complied |
| Heart rate averaging: | Calculated by using the most recent 8 beats. |
| Heart rate meter accuracy and response to irregular rhythm: | |
| | Ventricular bigeminy (Test waveform name: aami3a*): 80 bpm<br>Slow alternating ventricular bigeminy (Test waveform name: aami3b*): 60 bpm<br>Rapid alternating ventricular bigeminy (Test waveform name: aami3c*): 108 bpm<br>Bidirectional systoles (Test waveform name: aami3d*): 88 bpm<br>* The test waveforms can be download at http://www.physionet.org |
| Response time of heart rate meter to change in heart rate: | |
| | HR change from 80 to 120 bpm: 4 to 8 seconds<br>HR change from 80 to 40 bpm: 11 to 15 seconds |
| Pacemaker pulse rejection capability, without overshoot: | |
| | Complies with the amplitudes of pacemaker pulses ±2 to ±700 mV and widths 0.1 to 2 ms (specified in IEC 60601-2-27: 2005 50.102.13) |
| Pacemaker pulse rejection capability, with overshoot: | |
| | Overshoot amplitudes and time constants of ±0.12 mV/100 ms to ±2 mV/4 ms (As defined by method B of IEC 60601-2-27: 2005 50.102.13, this corresponds to the pacemaker pulses amplitudes and widths of ±4 mV/2 ms to amplitudes ±80 mV/0.1 ms.) |

**ECG Display and Heart Rate Count**

| | |
|---|---|
| Frequency characteristic: | filter on: 1 to 18 Hz, filter off: 0.05 to 60 Hz |
| Heart rate detection method: | Average |
| QRS detection: | 70 to 120 ms: amplitude ≥ 0.5 mV, rate 30 to 200 beats/min<br>40 to 120 ms: amplitude ≥ 0.5 mV, rate 30 to 250 beats/min |
| Heart rate counting range: | 0, 15 to 300 beats/min |
| Heart rate counting accuracy*: | ±2 beats/min, (0, 15 to 300 beats/min) |

* Essential performance of this transmitter

## Respiration Measurement

| | |
|---|---|
| Measuring method: | Impedance method |
| Measuring lead: | Between R and F |
| Impedance range: | 220 to 2000 Ω |
| Excitor current: | 54 to 93 μAp-p, 48 kHz |
| Respiration rate measuring accuracy*: | ±2 counts/min (at 0 to 150 counts/min) |
| Respiration rate counting range: | 0 to 150 counts/min |

* Essential performance of this transmitter

## $SpO_2$ Measurement (ISO 9919: 2005 compliance)

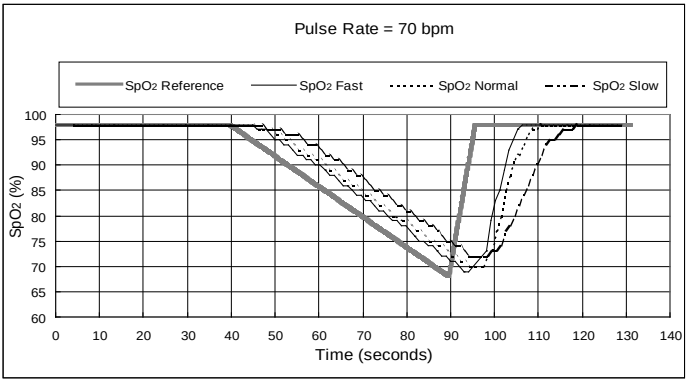
| | |
|---|---|
| Measuring range: | 0 to 100%$SpO_2$ |
| Declared range: | 70 to 100%$SpO_2$ |
| Minimum display range: | 1%$SpO_2$ |
| Display update cycle: | Every 3 seconds |
| Measuring accuracy (rms)*: | Accuracy assurance temperature: 18 to 40ºC |
| Total accuracy including probe: | 80%$SpO_2$ ≤ %$SpO_2$ ≤ 100%$SpO_2$: ±2%$SpO_2$ |
| | 70%$SpO_2$ ≤ %$SpO_2$ < 80%$SpO_2$: ±3%$SpO_2$ |
| | under 70%$SpO_2$: not specified |
| Accuracy of the transmitter: | 80%$SpO_2$ ≤ %$SpO_2$ ≤ 100%$SpO_2$: ±1%$SpO_2$ |
| | 50%$SpO_2$ ≤ %$SpO_2$ < 80%$SpO_2$: ±2%$SpO_2$ |
| | under 50%$SpO_2$: not specified |
| Pulse rate measuring range: | 30 to 300 bpm |
| Pulse rate display range: | 30 to 300 bpm |
| Pulse rate accuracy (rms)*: | ±3% ±1 bpm |

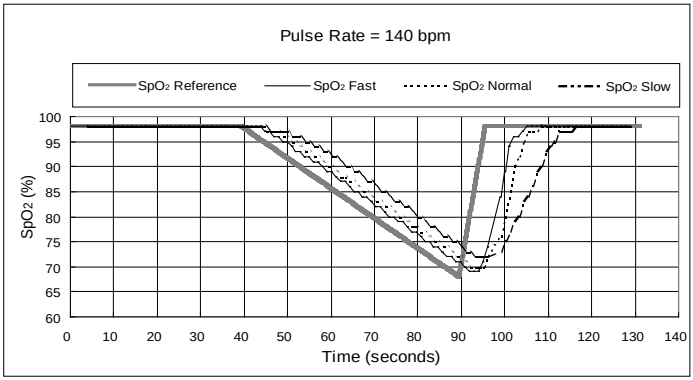
* Essential performance of this transmitter

**NOTE**

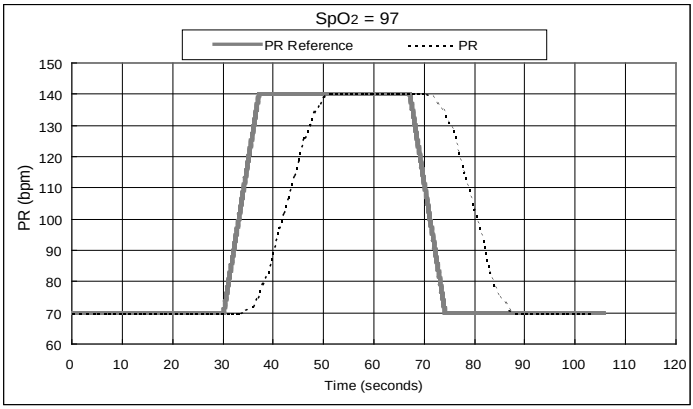
- The $SpO_2$ measuring accuracy was tested using the TL-201T, TL-260T, TL-271T and TL-631T $SpO_2$ probes. The testing was performed during induced hypoxia on healthy volunteers (Ethnicity: 10 Caucasians, 2 Africans, 1 Asian and 3 Indians), (Skin: 8 light, 4 medium, 4 dark), (Age: 21 to 34), (5 women and 11 men) under the condition of no motion. Arterial blood was sampled and measured by a CO-oximeter. The difference between $SpO_2$ measured by the $SpO_2$ probe and functional $SaO_2$ measured by a CO-oximeter was calculated using the root-mean-square (rms) method according to ISO 9919: 2005. This measurement accuracy figure represents 2/3 of all test measurements.
- A pulse oximeter tester that generates simulated signals can be used to check the difference from the design specification, but it cannot be used as a replacement for human signals for testing accuracy.

Response time: Selectable from “Slow”, “Normal” and “Fast”.
The following graphs show response time for 0.6%/s $SpO_2$ change.



The following graph shows response time for 10 bpm/s pulse rate change.




## Transmitter

| | |
|---|---|
| FCC regulation: | FCC part 95 Subpart H<br>Wireless Medical Telemetry Service (WMTS) |
| Field strength limits: | ≤ 740 mV/m (at 3 m) |
| Undesired emissions: | |
| FCC part 95 95.2379 (a), (b): | ≤ 960 MHz: ≤ 200 μV/m (at 3 m)<br>≥ 960 MHz: ≤ 500 μV/m (at 3 m) |
| Antenna: | Internal |
| Transmission channel: | Indicated on the transmitter |
| Transmission frequency range: | 1395.0250 to 1399.9750 MHz<br>1427.0250 to 1431.9750 MHz |
| Channel spacing: | 50 kHz or 37.5 kHz (12.5 kHz when interleaved) |
| Modulation: | FSK (frequency shift keying) |
| Type of emission: | F1D |
| Occupied bandwidth: | 12 to 18 kHz |
| Effective radiated power: | 5.0 mW<br>Can be changed to 1.0 mW if required |

## Power Requirements

| | |
|---|---|
| Rated voltage: | 3.0 V |
| Shutdown voltage: | 1.4 to 1.75 V |
| Operating voltage: | Shutdown voltage to 3.2 V |
| Battery type: | Two AA (LR6) type alkaline dry cell primary batteries |
| Battery lifetime (with alkaline batteries, at room temperature): | |
| ZM-521PA: | approximately 2.5 days |
| ZM-531PA: | approximately 2 days (measuring ECG, respiration and $SpO_2$) |
| | approximately 2.5 days (measuring ECG and respiration) |

## Dimension and Weight

| | |
|---|---|
| Dimension: | 78 W × 137 H × 36 D (mm) |
| Weight: | about 230 g (excluding batteries and other accessories) |
| | about 280 g (including batteries, excluding other accessories) |

## Environment

**Operating environment**

| | |
|---|---|
| Temperature: | 5 to 40°C (41 to 104°F) |
| Humidity: | 30 to 85% (noncondensing) |
| Atmospheric pressure: | 700 to 1060 hPa |

**Storage and transport environment**

| | |
|---|---|
| Temperature: | −20 to +65°C (−4 to +149°F) |
| Humidity: | 10 to 95% |
| Atmospheric pressure: | 700 to 1060 hPa |

**Water resistance**

Water does not get inside the transmitter when immersed in water up to 30 cm deep for 3 minutes.

## Safety Standards

| | |
|---|---|
| Safety standard: | CAN/CSA-C22.2 No. 601-1 M90 |
| | CAN/CSA-C22.2 No. 601-1. 1S1-94 |
| | CAN/CSA-C22.2 No. 601-1. 1B-90 |
| | CAN/CSA-C22.2 No. 60601-2-49-04 |
| | CAN/CSA-C22.2 No. 60601-2-27-06 |
| | IEC 60601-1: 1988 |
| | IEC 60601-1 Amendment 1: 1991 |
| | IEC 60601-1 Amendment 2: 1995 |
| | IEC 60601-2-27: 2005 |
| | IEC 60601-2-49: 2001 |
| | ISO 9919: 2005 |
| | UL 60601-1: 2003 |

Type of protection against electrical shock:
INTERNALLY POWERED EQUIPMENT
Degree of protection against electrical shock:
ECG and impedance method respiration:
DEFIBRILLATION-PROOF TYPE CF APPLIED PART
$SpO_2$: DEFIBRILLATION-PROOF TYPE BF APPLIED PART
Degree of protection against harmful ingress of water:
IPX0 (non-protected)
Degree of safety of application in the presence of a FLAMMABLE ANAESTHETIC MIXTURE WITH AIR, OR WITH OXYGEN OR NITROUS OXIDE:
Equipment not suitable for use in the presence of FLAMMABLE ANAESTHETIC MIXTURE WITH AIR, OR WITH OXYGEN OR NITROUS OXIDE
Mode of operation: CONTINUOUS OPERATION
ME EQUIPMENT type: HAND-HELD and PORTABLE

## Electromagnetic Compatibility

IEC 60601-1-2: 2001
IEC 60601-1-2 Amendment 1: 2004

## Electromagnetic Emissions

This Model ZM-521PA/ZM-531PA is intended for use in the electromagnetic environment specified below. The customer or the user of ZM-521PA/ZM-531PA should assure that it is used in such an environment.

| Emissions test | Compliance | Electromagnetic environment - guidance |
|---|---|---|
| RF emissions<br>CISPR 11 | Group 1 | ZM-521PA/ZM-531PA 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<br>CISPR 11 | Class B | ZM-521PA/ZM-531PA is suitable for use in all establishments, including domestic establishments. |
| Harmonic emissions<br>IEC 61000-3-2 | Not applicable | |
| Voltage fluctuations/<br>flicker emissions<br>IEC 61000-3-3 | Not applicable | |

## Electromagnetic Immunity

This model ZM-521PA/ZM-531PA is intended for use in the electromagnetic environment specified below. The customer or the user of ZM-521PA/ZM-531PA 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 | ±6 kV contact<br>±8 kV air | ±6 kV contact<br>±8 kV air | Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%. |
| Electrical fast transient/burst IEC 61000-4-4 | ±2 kV for power supply lines<br>±1 kV for input/ output lines | Not applicable | — |
| Surge IEC 61000-4-5 | ±1 kV differential mode<br>±2 kV common mode | Not applicable | — |
| Voltage dips, short interruptions and voltage variations on power supply input lines IEC 61000-4-11 | <5% $U_T$ (>95% dip in $U_T$) for 0.5 cycles<br><br>40% $U_T$ (60% dip in $U_T$) for 5 cycles<br><br>70% $U_T$ (30% dip in $U_T$) for 25 cycles<br><br><5% $U_T$ (>95% dip in $U_T$) for 5 s | Not applicable | — |
| Power frequency (50/60 Hz) magnetic field 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. | | | |

**Avoiding Electromagnetic Interference (Impedance Respiration)**

Impedance respiration measurement is very sensitive and affected by electromagnetic interference. Technological limitations do not allow immunity levels higher than 1 V/m for radiated RF electromagnetic fields. Electromagnetic fields with field strengths above 1 V/m may cause measurement error. Do not use electrically radiating equipment near the impedance respiration measurements.

| Immunity test | IEC 60601 test level | Compliance level | Electromagnetic environment - guidance |
|---|---|---|---|
| | | | Portable and mobile RF communications equipment should be used no closer to any part of ZM-521PA/ZM-531PA, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.<br><br>**Recommended separation distance** |
| Conducted RF<br>IEC 61000-4-6 | 3 Vrms<br>150 kHz to 80 MHz | 3 Vrms | $d = 1.2\sqrt{P}$ |
| Radiated RF<br>IEC 61000-4-3 | 3 V/m<br>80 MHz to 2.5 GHz | 3 V/m 80 MHz to 2.5 GHz<br><br>(1 V/m 80 MHz to 2.5 GHz for respiration) | $d = 1.2\sqrt{P}$ 80 MHz to 800 MHz<br>$d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz<br><br>($d = 3.5\sqrt{P}$ 80 MHz to 800 MHz for respiration<br>$d = 7.0\sqrt{P}$ 800 MHz to 2.5 GHz for respiration)<br><br>where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m).<br><br>Field strengths from fixed RF transmitters, as deter mined by an electromagnetic site survey*[1], should be less than the compliance level in each frequency range*[2].<br><br>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.

*1 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 ZM-521PA/ZM-531PA is used exceeds the applicable RF compliance level above, ZM-521PA/ZM-531PA should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating ZM-521PA/ZM-531PA.

*2 Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 1 V/m for respiration and 3 V/m for all other functions.

## Recommended Separation Distances between Portable and Mobile RF Communications Equipment

ZM-521PA/ZM-531PA is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of ZM-521PA/ZM-531PA can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and ZM-521PA/ZM-531PA as recommended below, according to the maximum output power of the communications equipment.

| Rated maximum output power of transmitter (W) | Separation distance according to frequency of transmitter (m) | | |
|---|---|---|---|
| | 150 kHz to 80 MHz<br>$d = 1.2\sqrt{P}$ | 80 MHz to 800 MHz<br>$d = 1.2\sqrt{P}$<br><br>(For respiration:<br>$d = 3.5\sqrt{P}$) | 800 MHz to 2.5 GHz<br>$d = 2.3\sqrt{P}$<br><br>(For respiration:<br>$d = 7.0\sqrt{P}$) |
| 0.01 | 0.12 | 0.12 (0.35*) | 0.23 (0.7*) |
| 0.1 | 0.38 | 0.38 (1.1*) | 0.73 (2.2*) |
| 1 | 1.2 | 1.2 (3.5*) | 2.3 (7.0*) |
| 10 | 3.8 | 3.8 (11*) | 7.3 (22*) |
| 100 | 12 | 12 (35*) | 23 (70*) |

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be estimated 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.

(* For respiration)

NOTE 1: At 80 MHz and 800 MHz, the separation distance for 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.

## Recovery Time after Defibrillation

The transmitter returns to the normal operating mode within 10 seconds after defibrillation. The stored settings are not affected.

## System Composition for EMC Test

The ZM-521PA/ZM-531PA transmitter is tested to comply with IEC 60601-1-2: 2001 and Amendment 1: 2004 with the following composition.

| Units | Cable Length |
|---|---|
| ZM-521PA/ZM-531PA transmitter | — |
| BR-906P ECG electrode lead | 0.8 m |
| TL-201T finger probe | 1.6 m |

# Standard Accessories

| Name | Model | Q'ty | Supply Code |
|---|---|---|---|
| Strap | — | 1 | Y233 |

# Options

**CAUTION**

Only use Nihon Kohden specified electrodes, electrode leads and $SpO_2$ probes. Otherwise, the maximum performance from the transmitter cannot be guaranteed.

## Transmitter

QI-901PK channel writer

## ECG/RESP

| Name | Type | Length (m) | Model | Qty | Supply Code |
|---|---|---|---|---|---|
| Electrode lead | 3 electrodes, AHA, clip type | 0.8 | BR-903PA | 1 | K911A |
| | 3 electrodes, AHA, clip type | 0.8 | BR-933PA | 1 | K903B |
| | 3 electrodes, AHA, hook type | 0.8 | BR-943PA | 1 | K904B |
| | 6 electrodes, AHA, clip type | 0.8 | BR-936PA | 1 | K903D |
| | 6 electrodes, AHA, hook type | 0.8 | BR-946PA | 1 | K904D |

## $SpO_2$

| Name | Cable Length (m) | Model | Qty | Supply Code |
|---|---|---|---|---|
| Finger probe (reusable) | 0.6 | TL-201T | 1 | P225H |
| | 1.6 | | | P225F |
| Multi-site probe (reusable) | 1.6 | TL-220T | 1 | P225G |
| Finger probe (reusable) | 0.6 | TL-631T1 | 1 | P311A |
| | 1.6 | TL-631T3 | 1 | P311C |
| $SpO_2$ probe (for adult, disposable) | 0.8 | TL-271T | 24 | P203A |
| | 1.6 | TL-271T3 | 24 | P203E |
| $SpO_2$ probe (for child, disposable) | 0.8 | TL-272T | 24 | P203B |
| | 1.6 | TL-272T3 | 24 | P203F |
| $SpO_2$ probe (for neonate/adult, disposable) | 0.8 | TL-273T | 24 | P203C |
| | 1.6 | TL-273T3 | 24 | P203G |
| $SpO_2$ probe (for child/infant, disposable) | 0.8 | TL-274T | 24 | P203D |
| | 1.6 | TL-274T3 | 24 | P203H |
| $SpO_2$ probe (for adult/neonate, disposable) | 0.8 | TL-051S | 5 | P228A |
| | 1.6 | TL-052S | 5 | P228B |
| $SpO_2$ probe (for child/infant, disposable) | 0.8 | TL-061S | 5 | P229A |
| | 1.6 | TL-062S | 5 | P229B |
| COTTONY tape | — | — | 20 | P259 |
| Foam tape for TL-051S/052S/ 061S/062S | — | — | 4 × 25 packages | P260 |
| Attachment tape for TL-220T/631T | — | — | 3 × 30 packages | P263 |
| Probe fastener | — | YS-093P2 | 30 | P267 |

# Transmission Frequencies

Channel: 9002 to 9478

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 608.0250 | 9002 |
| 608.0375 | 9003 |
| 608.0500 | 9004 |
| 608.0625 | 9005 |
| 608.0750 | 9006 |
| 608.0875 | 9007 |
| 608.1000 | 9008 |
| 608.1125 | 9009 |
| 608.1250 | 9010 |
| 608.1375 | 9011 |
| 608.1500 | 9012 |
| 608.1625 | 9013 |
| 608.1750 | 9014 |
| 608.1875 | 9015 |
| 608.2000 | 9016 |
| 608.2125 | 9017 |
| 608.2250 | 9018 |
| 608.2375 | 9019 |
| 608.2500 | 9020 |
| 608.2625 | 9021 |
| 608.2750 | 9022 |
| 608.2875 | 9023 |
| 608.3000 | 9024 |
| 608.3125 | 9025 |
| 608.3250 | 9026 |
| 608.3375 | 9027 |
| 608.3500 | 9028 |
| 608.3625 | 9029 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 608.3750 | 9030 |
| 608.3875 | 9031 |
| 608.4000 | 9032 |
| 608.4125 | 9033 |
| 608.4250 | 9034 |
| 608.4375 | 9035 |
| 608.4500 | 9036 |
| 608.4625 | 9037 |
| 608.4750 | 9038 |
| 608.4875 | 9039 |
| 608.5000 | 9040 |
| 608.5125 | 9041 |
| 608.5250 | 9042 |
| 608.5375 | 9043 |
| 608.5500 | 9044 |
| 608.5625 | 9045 |
| 608.5750 | 9046 |
| 608.5875 | 9047 |
| 608.6000 | 9048 |
| 608.6125 | 9049 |
| 608.6250 | 9050 |
| 608.6375 | 9051 |
| 608.6500 | 9052 |
| 608.6625 | 9053 |
| 608.6750 | 9054 |
| 608.6875 | 9055 |
| 608.7000 | 9056 |
| 608.7125 | 9057 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 608.7250 | 9058 |
| 608.7375 | 9059 |
| 608.7500 | 9060 |
| 608.7625 | 9061 |
| 608.7750 | 9062 |
| 608.7875 | 9063 |
| 608.8000 | 9064 |
| 608.8125 | 9065 |
| 608.8250 | 9066 |
| 608.8375 | 9067 |
| 608.8500 | 9068 |
| 608.8625 | 9069 |
| 608.8750 | 9070 |
| 608.8875 | 9071 |
| 608.9000 | 9072 |
| 608.9125 | 9073 |
| 608.9250 | 9074 |
| 608.9375 | 9075 |
| 608.9500 | 9076 |
| 608.9625 | 9077 |
| 608.9750 | 9078 |
| 608.9875 | 9079 |
| 609.0000 | 9080 |
| 609.0125 | 9081 |
| 609.0250 | 9082 |
| 609.0375 | 9083 |
| 609.0500 | 9084 |
| 609.0625 | 9085 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 609.0750 | 9086 |
| 609.0875 | 9087 |
| 609.1000 | 9088 |
| 609.1125 | 9089 |
| 609.1250 | 9090 |
| 609.1375 | 9091 |
| 609.1500 | 9092 |
| 609.1625 | 9093 |
| 609.1750 | 9094 |
| 609.1875 | 9095 |
| 609.2000 | 9096 |
| 609.2125 | 9097 |
| 609.2250 | 9098 |
| 609.2375 | 9099 |
| 609.2500 | 9100 |
| 609.2625 | 9101 |
| 609.2750 | 9102 |
| 609.2875 | 9103 |
| 609.3000 | 9104 |
| 609.3125 | 9105 |
| 609.3250 | 9106 |
| 609.3375 | 9107 |
| 609.3500 | 9108 |
| 609.3625 | 9109 |
| 609.3750 | 9110 |
| 609.3875 | 9111 |
| 609.4000 | 9112 |
| 609.4125 | 9113 |
| 609.4250 | 9114 |
| 609.4375 | 9115 |
| 609.4500 | 9116 |
| 609.4625 | 9117 |
| 609.4750 | 9118 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 609.4875 | 9119 |
| 609.5000 | 9120 |
| 609.5125 | 9121 |
| 609.5250 | 9122 |
| 609.5375 | 9123 |
| 609.5500 | 9124 |
| 609.5625 | 9125 |
| 609.5750 | 9126 |
| 609.5875 | 9127 |
| 609.6000 | 9128 |
| 609.6125 | 9129 |
| 609.6250 | 9130 |
| 609.6375 | 9131 |
| 609.6500 | 9132 |
| 609.6625 | 9133 |
| 609.6750 | 9134 |
| 609.6875 | 9135 |
| 609.7000 | 9136 |
| 609.7125 | 9137 |
| 609.7250 | 9138 |
| 609.7375 | 9139 |
| 609.7500 | 9140 |
| 609.7625 | 9141 |
| 609.7750 | 9142 |
| 609.7875 | 9143 |
| 609.8000 | 9144 |
| 609.8125 | 9145 |
| 609.8250 | 9146 |
| 609.8375 | 9147 |
| 609.8500 | 9148 |
| 609.8625 | 9149 |
| 609.8750 | 9150 |
| 609.8875 | 9151 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 609.9000 | 9152 |
| 609.9125 | 9153 |
| 609.9250 | 9154 |
| 609.9375 | 9155 |
| 609.9500 | 9156 |
| 609.9625 | 9157 |
| 609.9750 | 9158 |
| 609.9875 | 9159 |
| 610.0000 | 9160 |
| 610.0125 | 9161 |
| 610.0250 | 9162 |
| 610.0375 | 9163 |
| 610.0500 | 9164 |
| 610.0625 | 9165 |
| 610.0750 | 9166 |
| 610.0875 | 9167 |
| 610.1000 | 9168 |
| 610.1125 | 9169 |
| 610.1250 | 9170 |
| 610.1375 | 9171 |
| 610.1500 | 9172 |
| 610.1625 | 9173 |
| 610.1750 | 9174 |
| 610.1875 | 9175 |
| 610.2000 | 9176 |
| 610.2125 | 9177 |
| 610.2250 | 9178 |
| 610.2375 | 9179 |
| 610.2500 | 9180 |
| 610.2625 | 9181 |
| 610.2750 | 9182 |
| 610.2875 | 9183 |
| 610.3000 | 9184 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 610.3125 | 9185 |
| 610.3250 | 9186 |
| 610.3375 | 9187 |
| 610.3500 | 9188 |
| 610.3625 | 9189 |
| 610.3750 | 9190 |
| 610.3875 | 9191 |
| 610.4000 | 9192 |
| 610.4125 | 9193 |
| 610.4250 | 9194 |
| 610.4375 | 9195 |
| 610.4500 | 9196 |
| 610.4625 | 9197 |
| 610.4750 | 9198 |
| 610.4875 | 9199 |
| 610.5000 | 9200 |
| 610.5125 | 9201 |
| 610.5250 | 9202 |
| 610.5375 | 9203 |
| 610.5500 | 9204 |
| 610.5625 | 9205 |
| 610.5750 | 9206 |
| 610.5875 | 9207 |
| 610.6000 | 9208 |
| 610.6125 | 9209 |
| 610.6250 | 9210 |
| 610.6375 | 9211 |
| 610.6500 | 9212 |
| 610.6625 | 9213 |
| 610.6750 | 9214 |
| 610.6875 | 9215 |
| 610.7000 | 9216 |
| 610.7125 | 9217 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 610.7250 | 9218 |
| 610.7375 | 9219 |
| 610.7500 | 9220 |
| 610.7625 | 9221 |
| 610.7750 | 9222 |
| 610.7875 | 9223 |
| 610.8000 | 9224 |
| 610.8125 | 9225 |
| 610.8250 | 9226 |
| 610.8375 | 9227 |
| 610.8500 | 9228 |
| 610.8625 | 9229 |
| 610.8750 | 9230 |
| 610.8875 | 9231 |
| 610.9000 | 9232 |
| 610.9125 | 9233 |
| 610.9250 | 9234 |
| 610.9375 | 9235 |
| 610.9500 | 9236 |
| 610.9625 | 9237 |
| 610.9750 | 9238 |
| 610.9875 | 9239 |
| 611.0000 | 9240 |
| 611.0125 | 9241 |
| 611.0250 | 9242 |
| 611.0375 | 9243 |
| 611.0500 | 9244 |
| 611.0625 | 9245 |
| 611.0750 | 9246 |
| 611.0875 | 9247 |
| 611.1000 | 9248 |
| 611.1125 | 9249 |
| 611.1250 | 9250 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 611.1375 | 9251 |
| 611.1500 | 9252 |
| 611.1625 | 9253 |
| 611.1750 | 9254 |
| 611.1875 | 9255 |
| 611.2000 | 9256 |
| 611.2125 | 9257 |
| 611.2250 | 9258 |
| 611.2375 | 9259 |
| 611.2500 | 9260 |
| 611.2625 | 9261 |
| 611.2750 | 9262 |
| 611.2875 | 9263 |
| 611.3000 | 9264 |
| 611.3125 | 9265 |
| 611.3250 | 9266 |
| 611.3375 | 9267 |
| 611.3500 | 9268 |
| 611.3625 | 9269 |
| 611.3750 | 9270 |
| 611.3875 | 9271 |
| 611.4000 | 9272 |
| 611.4125 | 9273 |
| 611.4250 | 9274 |
| 611.4375 | 9275 |
| 611.4500 | 9276 |
| 611.4625 | 9277 |
| 611.4750 | 9278 |
| 611.4875 | 9279 |
| 611.5000 | 9280 |
| 611.5125 | 9281 |
| 611.5250 | 9282 |
| 611.5375 | 9283 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 611.5500 | 9284 |
| 611.5625 | 9285 |
| 611.5750 | 9286 |
| 611.5875 | 9287 |
| 611.6000 | 9288 |
| 611.6125 | 9289 |
| 611.6250 | 9290 |
| 611.6375 | 9291 |
| 611.6500 | 9292 |
| 611.6625 | 9293 |
| 611.6750 | 9294 |
| 611.6875 | 9295 |
| 611.7000 | 9296 |
| 611.7125 | 9297 |
| 611.7250 | 9298 |
| 611.7375 | 9299 |
| 611.7500 | 9300 |
| 611.7625 | 9301 |
| 611.7750 | 9302 |
| 611.7875 | 9303 |
| 611.8000 | 9304 |
| 611.8125 | 9305 |
| 611.8250 | 9306 |
| 611.8375 | 9307 |
| 611.8500 | 9308 |
| 611.8625 | 9309 |
| 611.8750 | 9310 |
| 611.8875 | 9311 |
| 611.9000 | 9312 |
| 611.9125 | 9313 |
| 611.9250 | 9314 |
| 611.9375 | 9315 |
| 611.9500 | 9316 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 611.9625 | 9317 |
| 611.9750 | 9318 |
| 611.9875 | 9319 |
| 612.0000 | 9320 |
| 612.0125 | 9321 |
| 612.0250 | 9322 |
| 612.0375 | 9323 |
| 612.0500 | 9324 |
| 612.0625 | 9325 |
| 612.0750 | 9326 |
| 612.0875 | 9327 |
| 612.1000 | 9328 |
| 612.1125 | 9329 |
| 612.1250 | 9330 |
| 612.1375 | 9331 |
| 612.1500 | 9332 |
| 612.1625 | 9333 |
| 612.1750 | 9334 |
| 612.1875 | 9335 |
| 612.2000 | 9336 |
| 612.2125 | 9337 |
| 612.2250 | 9338 |
| 612.2375 | 9339 |
| 612.2500 | 9340 |
| 612.2625 | 9341 |
| 612.2750 | 9342 |
| 612.2875 | 9343 |
| 612.3000 | 9344 |
| 612.3125 | 9345 |
| 612.3250 | 9346 |
| 612.3375 | 9347 |
| 612.3500 | 9348 |
| 612.3625 | 9349 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 612.3750 | 9350 |
| 612.3875 | 9351 |
| 612.4000 | 9352 |
| 612.4125 | 9353 |
| 612.4250 | 9354 |
| 612.4375 | 9355 |
| 612.4500 | 9356 |
| 612.4625 | 9357 |
| 612.4750 | 9358 |
| 612.4875 | 9359 |
| 612.5000 | 9360 |
| 612.5125 | 9361 |
| 612.5250 | 9362 |
| 612.5375 | 9363 |
| 612.5500 | 9364 |
| 612.5625 | 9365 |
| 612.5750 | 9366 |
| 612.5875 | 9367 |
| 612.6000 | 9368 |
| 612.6125 | 9369 |
| 612.6250 | 9370 |
| 612.6375 | 9371 |
| 612.6500 | 9372 |
| 612.6625 | 9373 |
| 612.6750 | 9374 |
| 612.6875 | 9375 |
| 612.7000 | 9376 |
| 612.7125 | 9377 |
| 612.7250 | 9378 |
| 612.7375 | 9379 |
| 612.7500 | 9380 |
| 612.7625 | 9381 |
| 612.7750 | 9382 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 612.7875 | 9383 |
| 612.8000 | 9384 |
| 612.8125 | 9385 |
| 612.8250 | 9386 |
| 612.8375 | 9387 |
| 612.8500 | 9388 |
| 612.8625 | 9389 |
| 612.8750 | 9390 |
| 612.8875 | 9391 |
| 612.9000 | 9392 |
| 612.9125 | 9393 |
| 612.9250 | 9394 |
| 612.9375 | 9395 |
| 612.9500 | 9396 |
| 612.9625 | 9397 |
| 612.9750 | 9398 |
| 612.9875 | 9399 |
| 613.0000 | 9400 |
| 613.0125 | 9401 |
| 613.0250 | 9402 |
| 613.0375 | 9403 |
| 613.0500 | 9404 |
| 613.0625 | 9405 |
| 613.0750 | 9406 |
| 613.0875 | 9407 |
| 613.1000 | 9408 |
| 613.1125 | 9409 |
| 613.1250 | 9410 |
| 613.1375 | 9411 |
| 613.1500 | 9412 |
| 613.1625 | 9413 |
| 613.1750 | 9414 |
| 613.1875 | 9415 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 613.2000 | 9416 |
| 613.2125 | 9417 |
| 613.2250 | 9418 |
| 613.2375 | 9419 |
| 613.2500 | 9420 |
| 613.2625 | 9421 |
| 613.2750 | 9422 |
| 613.2875 | 9423 |
| 613.3000 | 9424 |
| 613.3125 | 9425 |
| 613.3250 | 9426 |
| 613.3375 | 9427 |
| 613.3500 | 9428 |
| 613.3625 | 9429 |
| 613.3750 | 9430 |
| 613.3875 | 9431 |
| 613.4000 | 9432 |
| 613.4125 | 9433 |
| 613.4250 | 9434 |
| 613.4375 | 9435 |
| 613.4500 | 9436 |
| 613.4625 | 9437 |
| 613.4750 | 9438 |
| 613.4875 | 9439 |
| 613.5000 | 9440 |
| 613.5125 | 9441 |
| 613.5250 | 9442 |
| 613.5375 | 9443 |
| 613.5500 | 9444 |
| 613.5625 | 9445 |
| 613.5750 | 9446 |
| 613.5875 | 9447 |
| 613.6000 | 9448 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 613.6125 | 9449 |
| 613.6250 | 9450 |
| 613.6375 | 9451 |
| 613.6500 | 9452 |
| 613.6625 | 9453 |
| 613.6750 | 9454 |
| 613.6875 | 9455 |
| 613.7000 | 9456 |
| 613.7125 | 9457 |
| 613.7250 | 9458 |
| 613.7375 | 9459 |
| 613.7500 | 9460 |
| 613.7625 | 9461 |
| 613.7750 | 9462 |
| 613.7875 | 9463 |
| 613.8000 | 9464 |
| 613.8125 | 9465 |
| 613.8250 | 9466 |
| 613.8375 | 9467 |
| 613.8500 | 9468 |
| 613.8625 | 9469 |
| 613.8750 | 9470 |
| 613.8875 | 9471 |
| 613.9000 | 9472 |
| 613.9125 | 9473 |
| 613.9250 | 9474 |
| 613.9375 | 9475 |
| 613.9500 | 9476 |
| 613.9625 | 9477 |
| 613.9750 | 9478 |

Channel: E002 to E398

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1395.0250 | E002 |
| 1395.0375 | E003 |
| 1395.0500 | E004 |
| 1395.0625 | E005 |
| 1395.0750 | E006 |
| 1395.0875 | E007 |
| 1395.1000 | E008 |
| 1395.1125 | E009 |
| 1395.1250 | E010 |
| 1395.1375 | E011 |
| 1395.1500 | E012 |
| 1395.1625 | E013 |
| 1395.1750 | E014 |
| 1395.1875 | E015 |
| 1395.2000 | E016 |
| 1395.2125 | E017 |
| 1395.2250 | E018 |
| 1395.2375 | E019 |
| 1395.2500 | E020 |
| 1395.2625 | E021 |
| 1395.2750 | E022 |
| 1395.2875 | E023 |
| 1395.3000 | E024 |
| 1395.3125 | E025 |
| 1395.3250 | E026 |
| 1395.3375 | E027 |
| 1395.3500 | E028 |
| 1395.3625 | E029 |
| 1395.3750 | E030 |
| 1395.3875 | E031 |
| 1395.4000 | E032 |
| 1395.4125 | E033 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1395.4250 | E034 |
| 1395.4375 | E035 |
| 1395.4500 | E036 |
| 1395.4625 | E037 |
| 1395.4750 | E038 |
| 1395.4875 | E039 |
| 1395.5000 | E040 |
| 1395.5125 | E041 |
| 1395.5250 | E042 |
| 1395.5375 | E043 |
| 1395.5500 | E044 |
| 1395.5625 | E045 |
| 1395.5750 | E046 |
| 1395.5875 | E047 |
| 1395.6000 | E048 |
| 1395.6125 | E049 |
| 1395.6250 | E050 |
| 1395.6375 | E051 |
| 1395.6500 | E052 |
| 1395.6625 | E053 |
| 1395.6750 | E054 |
| 1395.6875 | E055 |
| 1395.7000 | E056 |
| 1395.7125 | E057 |
| 1395.7250 | E058 |
| 1395.7375 | E059 |
| 1395.7500 | E060 |
| 1395.7625 | E061 |
| 1395.7750 | E062 |
| 1395.7875 | E063 |
| 1395.8000 | E064 |
| 1395.8125 | E065 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1395.8250 | E066 |
| 1395.8375 | E067 |
| 1395.8500 | E068 |
| 1395.8625 | E069 |
| 1395.8750 | E070 |
| 1395.8875 | E071 |
| 1395.9000 | E072 |
| 1395.9125 | E073 |
| 1395.9250 | E074 |
| 1395.9375 | E075 |
| 1395.9500 | E076 |
| 1395.9625 | E077 |
| 1395.9750 | E078 |
| 1395.9875 | E079 |
| 1396.0000 | E080 |
| 1396.0125 | E081 |
| 1396.0250 | E082 |
| 1396.0375 | E083 |
| 1396.0500 | E084 |
| 1396.0625 | E085 |
| 1396.0750 | E086 |
| 1396.0875 | E087 |
| 1396.1000 | E088 |
| 1396.1125 | E089 |
| 1396.1250 | E090 |
| 1396.1375 | E091 |
| 1396.1500 | E092 |
| 1396.1625 | E093 |
| 1396.1750 | E094 |
| 1396.1875 | E095 |
| 1396.2000 | E096 |
| 1396.2125 | E097 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1396.2250 | E098 |
| 1396.2375 | E099 |
| 1396.2500 | E100 |
| 1396.2625 | E101 |
| 1396.2750 | E102 |
| 1396.2875 | E103 |
| 1396.3000 | E104 |
| 1396.3125 | E105 |
| 1396.3250 | E106 |
| 1396.3375 | E107 |
| 1396.3500 | E108 |
| 1396.3625 | E109 |
| 1396.3750 | E110 |
| 1396.3875 | E111 |
| 1396.4000 | E112 |
| 1396.4125 | E113 |
| 1396.4250 | E114 |
| 1396.4375 | E115 |
| 1396.4500 | E116 |
| 1396.4625 | E117 |
| 1396.4750 | E118 |
| 1396.4875 | E119 |
| 1396.5000 | E120 |
| 1396.5125 | E121 |
| 1396.5250 | E122 |
| 1396.5375 | E123 |
| 1396.5500 | E124 |
| 1396.5625 | E125 |
| 1396.5750 | E126 |
| 1396.5875 | E127 |
| 1396.6000 | E128 |
| 1396.6125 | E129 |
| 1396.6250 | E130 |
| 1396.6375 | E131 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1396.6500 | E132 |
| 1396.6625 | E133 |
| 1396.6750 | E134 |
| 1396.6875 | E135 |
| 1396.7000 | E136 |
| 1396.7125 | E137 |
| 1396.7250 | E138 |
| 1396.7375 | E139 |
| 1396.7500 | E140 |
| 1396.7625 | E141 |
| 1396.7750 | E142 |
| 1396.7875 | E143 |
| 1396.8000 | E144 |
| 1396.8125 | E145 |
| 1396.8250 | E146 |
| 1396.8375 | E147 |
| 1396.8500 | E148 |
| 1396.8625 | E149 |
| 1396.8750 | E150 |
| 1396.8875 | E151 |
| 1396.9000 | E152 |
| 1396.9125 | E153 |
| 1396.9250 | E154 |
| 1396.9375 | E155 |
| 1396.9500 | E156 |
| 1396.9625 | E157 |
| 1396.9750 | E158 |
| 1396.9875 | E159 |
| 1397.0000 | E160 |
| 1397.0125 | E161 |
| 1397.0250 | E162 |
| 1397.0375 | E163 |
| 1397.0500 | E164 |
| 1397.0625 | E165 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1397.0750 | E166 |
| 1397.0875 | E167 |
| 1397.1000 | E168 |
| 1397.1125 | E169 |
| 1397.1250 | E170 |
| 1397.1375 | E171 |
| 1397.1500 | E172 |
| 1397.1625 | E173 |
| 1397.1750 | E174 |
| 1397.1875 | E175 |
| 1397.2000 | E176 |
| 1397.2125 | E177 |
| 1397.2250 | E178 |
| 1397.2375 | E179 |
| 1397.2500 | E180 |
| 1397.2625 | E181 |
| 1397.2750 | E182 |
| 1397.2875 | E183 |
| 1397.3000 | E184 |
| 1397.3125 | E185 |
| 1397.3250 | E186 |
| 1397.3375 | E187 |
| 1397.3500 | E188 |
| 1397.3625 | E189 |
| 1397.3750 | E190 |
| 1397.3875 | E191 |
| 1397.4000 | E192 |
| 1397.4125 | E193 |
| 1397.4250 | E194 |
| 1397.4375 | E195 |
| 1397.4500 | E196 |
| 1397.4625 | E197 |
| 1397.4750 | E198 |
| 1397.4875 | E199 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1397.5000 | E200 |
| 1397.5125 | E201 |
| 1397.5250 | E202 |
| 1397.5375 | E203 |
| 1397.5500 | E204 |
| 1397.5625 | E205 |
| 1397.5750 | E206 |
| 1397.5875 | E207 |
| 1397.6000 | E208 |
| 1397.6125 | E209 |
| 1397.6250 | E210 |
| 1397.6375 | E211 |
| 1397.6500 | E212 |
| 1397.6625 | E213 |
| 1397.6750 | E214 |
| 1397.6875 | E215 |
| 1397.7000 | E216 |
| 1397.7125 | E217 |
| 1397.7250 | E218 |
| 1397.7375 | E219 |
| 1397.7500 | E220 |
| 1397.7625 | E221 |
| 1397.7750 | E222 |
| 1397.7875 | E223 |
| 1397.8000 | E224 |
| 1397.8125 | E225 |
| 1397.8250 | E226 |
| 1397.8375 | E227 |
| 1397.8500 | E228 |
| 1397.8625 | E229 |
| 1397.8750 | E230 |
| 1397.8875 | E231 |
| 1397.9000 | E232 |
| 1397.9125 | E233 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1397.9250 | E234 |
| 1397.9375 | E235 |
| 1397.9500 | E236 |
| 1397.9625 | E237 |
| 1397.9750 | E238 |
| 1397.9875 | E239 |
| 1398.0000 | E240 |
| 1398.0125 | E241 |
| 1398.0250 | E242 |
| 1398.0375 | E243 |
| 1398.0500 | E244 |
| 1398.0625 | E245 |
| 1398.0750 | E246 |
| 1398.0875 | E247 |
| 1398.1000 | E248 |
| 1398.1125 | E249 |
| 1398.1250 | E250 |
| 1398.1375 | E251 |
| 1398.1500 | E252 |
| 1398.1625 | E253 |
| 1398.1750 | E254 |
| 1398.1875 | E255 |
| 1398.2000 | E256 |
| 1398.2125 | E257 |
| 1398.2250 | E258 |
| 1398.2375 | E259 |
| 1398.2500 | E260 |
| 1398.2625 | E261 |
| 1398.2750 | E262 |
| 1398.2875 | E263 |
| 1398.3000 | E264 |
| 1398.3125 | E265 |
| 1398.3250 | E266 |
| 1398.3375 | E267 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1398.3500 | E268 |
| 1398.3625 | E269 |
| 1398.3750 | E270 |
| 1398.3875 | E271 |
| 1398.4000 | E272 |
| 1398.4125 | E273 |
| 1398.4250 | E274 |
| 1398.4375 | E275 |
| 1398.4500 | E276 |
| 1398.4625 | E277 |
| 1398.4750 | E278 |
| 1398.4875 | E279 |
| 1398.5000 | E280 |
| 1398.5125 | E281 |
| 1398.5250 | E282 |
| 1398.5375 | E283 |
| 1398.5500 | E284 |
| 1398.5625 | E285 |
| 1398.5750 | E286 |
| 1398.5875 | E287 |
| 1398.6000 | E288 |
| 1398.6125 | E289 |
| 1398.6250 | E290 |
| 1398.6375 | E291 |
| 1398.6500 | E292 |
| 1398.6625 | E293 |
| 1398.6750 | E294 |
| 1398.6875 | E295 |
| 1398.7000 | E296 |
| 1398.7125 | E297 |
| 1398.7250 | E298 |
| 1398.7375 | E299 |
| 1398.7500 | E300 |
| 1398.7625 | E301 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1398.7750 | E302 |
| 1398.7875 | E303 |
| 1398.8000 | E304 |
| 1398.8125 | E305 |
| 1398.8250 | E306 |
| 1398.8375 | E307 |
| 1398.8500 | E308 |
| 1398.8625 | E309 |
| 1398.8750 | E310 |
| 1398.8875 | E311 |
| 1398.9000 | E312 |
| 1398.9125 | E313 |
| 1398.9250 | E314 |
| 1398.9375 | E315 |
| 1398.9500 | E316 |
| 1398.9625 | E317 |
| 1398.9750 | E318 |
| 1398.9875 | E319 |
| 1399.0000 | E320 |
| 1399.0125 | E321 |
| 1399.0250 | E322 |
| 1399.0375 | E323 |
| 1399.0500 | E324 |
| 1399.0625 | E325 |
| 1399.0750 | E326 |
| 1399.0875 | E327 |
| 1399.1000 | E328 |
| 1399.1125 | E329 |
| 1399.1250 | E330 |
| 1399.1375 | E331 |
| 1399.1500 | E332 |
| 1399.1625 | E333 |
| 1399.1750 | E334 |
| 1399.1875 | E335 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1399.2000 | E336 |
| 1399.2125 | E337 |
| 1399.2250 | E338 |
| 1399.2375 | E339 |
| 1399.2500 | E340 |
| 1399.2625 | E341 |
| 1399.2750 | E342 |
| 1399.2875 | E343 |
| 1399.3000 | E344 |
| 1399.3125 | E345 |
| 1399.3250 | E346 |
| 1399.3375 | E347 |
| 1399.3500 | E348 |
| 1399.3625 | E349 |
| 1399.3750 | E350 |
| 1399.3875 | E351 |
| 1399.4000 | E352 |
| 1399.4125 | E353 |
| 1399.4250 | E354 |
| 1399.4375 | E355 |
| 1399.4500 | E356 |
| 1399.4625 | E357 |
| 1399.4750 | E358 |
| 1399.4875 | E359 |
| 1399.5000 | E360 |
| 1399.5125 | E361 |
| 1399.5250 | E362 |
| 1399.5375 | E363 |
| 1399.5500 | E364 |
| 1399.5625 | E365 |
| 1399.5750 | E366 |
| 1399.5875 | E367 |
| 1399.6000 | E368 |
| 1399.6125 | E369 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1399.6250 | E370 |
| 1399.6375 | E371 |
| 1399.6500 | E372 |
| 1399.6625 | E373 |
| 1399.6750 | E374 |
| 1399.6875 | E375 |
| 1399.7000 | E376 |
| 1399.7125 | E377 |
| 1399.7250 | E378 |
| 1399.7375 | E379 |
| 1399.7500 | E380 |
| 1399.7625 | E381 |
| 1399.7750 | E382 |
| 1399.7875 | E383 |
| 1399.8000 | E384 |
| 1399.8125 | E385 |
| 1399.8250 | E386 |
| 1399.8375 | E387 |
| 1399.8500 | E388 |
| 1399.8625 | E389 |
| 1399.8750 | E390 |
| 1399.8875 | E391 |
| 1399.9000 | E392 |
| 1399.9125 | E393 |
| 1399.9250 | E394 |
| 1399.9375 | E395 |
| 1399.9500 | E396 |
| 1399.9625 | E397 |
| 1399.9750 | E398 |

Channel: E502 to E898

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1427.0250 | E502 |
| 1427.0375 | E503 |
| 1427.0500 | E504 |
| 1427.0625 | E505 |
| 1427.0750 | E506 |
| 1427.0875 | E507 |
| 1427.1000 | E508 |
| 1427.1125 | E509 |
| 1427.1250 | E510 |
| 1427.1375 | E511 |
| 1427.1500 | E512 |
| 1427.1625 | E513 |
| 1427.1750 | E514 |
| 1427.1875 | E515 |
| 1427.2000 | E516 |
| 1427.2125 | E517 |
| 1427.2250 | E518 |
| 1427.2375 | E519 |
| 1427.2500 | E520 |
| 1427.2625 | E521 |
| 1427.2750 | E522 |
| 1427.2875 | E523 |
| 1427.3000 | E524 |
| 1427.3125 | E525 |
| 1427.3250 | E526 |
| 1427.3375 | E527 |
| 1427.3500 | E528 |
| 1427.3625 | E529 |
| 1427.3750 | E530 |
| 1427.3875 | E531 |
| 1427.4000 | E532 |
| 1427.4125 | E533 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1427.4250 | E534 |
| 1427.4375 | E535 |
| 1427.4500 | E536 |
| 1427.4625 | E537 |
| 1427.4750 | E538 |
| 1427.4875 | E539 |
| 1427.5000 | E540 |
| 1427.5125 | E541 |
| 1427.5250 | E542 |
| 1427.5375 | E543 |
| 1427.5500 | E544 |
| 1427.5625 | E545 |
| 1427.5750 | E546 |
| 1427.5875 | E547 |
| 1427.6000 | E548 |
| 1427.6125 | E549 |
| 1427.6250 | E550 |
| 1427.6375 | E551 |
| 1427.6500 | E552 |
| 1427.6625 | E553 |
| 1427.6750 | E554 |
| 1427.6875 | E555 |
| 1427.7000 | E556 |
| 1427.7125 | E557 |
| 1427.7250 | E558 |
| 1427.7375 | E559 |
| 1427.7500 | E560 |
| 1427.7625 | E561 |
| 1427.7750 | E562 |
| 1427.7875 | E563 |
| 1427.8000 | E564 |
| 1427.8125 | E565 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1427.8250 | E566 |
| 1427.8375 | E567 |
| 1427.8500 | E568 |
| 1427.8625 | E569 |
| 1427.8750 | E570 |
| 1427.8875 | E571 |
| 1427.9000 | E572 |
| 1427.9125 | E573 |
| 1427.9250 | E574 |
| 1427.9375 | E575 |
| 1427.9500 | E576 |
| 1427.9625 | E577 |
| 1427.9750 | E578 |
| 1427.9875 | E579 |
| 1428.0000 | E580 |
| 1428.0125 | E581 |
| 1428.0250 | E582 |
| 1428.0375 | E583 |
| 1428.0500 | E584 |
| 1428.0625 | E585 |
| 1428.0750 | E586 |
| 1428.0875 | E587 |
| 1428.1000 | E588 |
| 1428.1125 | E589 |
| 1428.1250 | E590 |
| 1428.1375 | E591 |
| 1428.1500 | E592 |
| 1428.1625 | E593 |
| 1428.1750 | E594 |
| 1428.1875 | E595 |
| 1428.2000 | E596 |
| 1428.2125 | E597 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1428.2250 | E598 |
| 1428.2375 | E599 |
| 1428.2500 | E600 |
| 1428.2625 | E601 |
| 1428.2750 | E602 |
| 1428.2875 | E603 |
| 1428.3000 | E604 |
| 1428.3125 | E605 |
| 1428.3250 | E606 |
| 1428.3375 | E607 |
| 1428.3500 | E608 |
| 1428.3625 | E609 |
| 1428.3750 | E610 |
| 1428.3875 | E611 |
| 1428.4000 | E612 |
| 1428.4125 | E613 |
| 1428.4250 | E614 |
| 1428.4375 | E615 |
| 1428.4500 | E616 |
| 1428.4625 | E617 |
| 1428.4750 | E618 |
| 1428.4875 | E619 |
| 1428.5000 | E620 |
| 1428.5125 | E621 |
| 1428.5250 | E622 |
| 1428.5375 | E623 |
| 1428.5500 | E624 |
| 1428.5625 | E625 |
| 1428.5750 | E626 |
| 1428.5875 | E627 |
| 1428.6000 | E628 |
| 1428.6125 | E629 |
| 1428.6250 | E630 |
| 1428.6375 | E631 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1428.6500 | E632 |
| 1428.6625 | E633 |
| 1428.6750 | E634 |
| 1428.6875 | E635 |
| 1428.7000 | E636 |
| 1428.7125 | E637 |
| 1428.7250 | E638 |
| 1428.7375 | E639 |
| 1428.7500 | E640 |
| 1428.7625 | E641 |
| 1428.7750 | E642 |
| 1428.7875 | E643 |
| 1428.8000 | E644 |
| 1428.8125 | E645 |
| 1428.8250 | E646 |
| 1428.8375 | E647 |
| 1428.8500 | E648 |
| 1428.8625 | E649 |
| 1428.8750 | E650 |
| 1428.8875 | E651 |
| 1428.9000 | E652 |
| 1428.9125 | E653 |
| 1428.9250 | E654 |
| 1428.9375 | E655 |
| 1428.9500 | E656 |
| 1428.9625 | E657 |
| 1428.9750 | E658 |
| 1428.9875 | E659 |
| 1429.0000 | E660 |
| 1429.0125 | E661 |
| 1429.0250 | E662 |
| 1429.0375 | E663 |
| 1429.0500 | E664 |
| 1429.0625 | E665 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1429.0750 | E666 |
| 1429.0875 | E667 |
| 1429.1000 | E668 |
| 1429.1125 | E669 |
| 1429.1250 | E670 |
| 1429.1375 | E671 |
| 1429.1500 | E672 |
| 1429.1625 | E673 |
| 1429.1750 | E674 |
| 1429.1875 | E675 |
| 1429.2000 | E676 |
| 1429.2125 | E677 |
| 1429.2250 | E678 |
| 1429.2375 | E679 |
| 1429.2500 | E680 |
| 1429.2625 | E681 |
| 1429.2750 | E682 |
| 1429.2875 | E683 |
| 1429.3000 | E684 |
| 1429.3125 | E685 |
| 1429.3250 | E686 |
| 1429.3375 | E687 |
| 1429.3500 | E688 |
| 1429.3625 | E689 |
| 1429.3750 | E690 |
| 1429.3875 | E691 |
| 1429.4000 | E692 |
| 1429.4125 | E693 |
| 1429.4250 | E694 |
| 1429.4375 | E695 |
| 1429.4500 | E696 |
| 1429.4625 | E697 |
| 1429.4750 | E698 |
| 1429.4875 | E699 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1429.5000 | E700 |
| 1429.5125 | E701 |
| 1429.5250 | E702 |
| 1429.5375 | E703 |
| 1429.5500 | E704 |
| 1429.5625 | E705 |
| 1429.5750 | E706 |
| 1429.5875 | E707 |
| 1429.6000 | E708 |
| 1429.6125 | E709 |
| 1429.6250 | E710 |
| 1429.6375 | E711 |
| 1429.6500 | E712 |
| 1429.6625 | E713 |
| 1429.6750 | E714 |
| 1429.6875 | E715 |
| 1429.7000 | E716 |
| 1429.7125 | E717 |
| 1429.7250 | E718 |
| 1429.7375 | E719 |
| 1429.7500 | E720 |
| 1429.7625 | E721 |
| 1429.7750 | E722 |
| 1429.7875 | E723 |
| 1429.8000 | E724 |
| 1429.8125 | E725 |
| 1429.8250 | E726 |
| 1429.8375 | E727 |
| 1429.8500 | E728 |
| 1429.8625 | E729 |
| 1429.8750 | E730 |
| 1429.8875 | E731 |
| 1429.9000 | E732 |
| 1429.9125 | E733 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1429.9250 | E734 |
| 1429.9375 | E735 |
| 1429.9500 | E736 |
| 1429.9625 | E737 |
| 1429.9750 | E738 |
| 1429.9875 | E739 |
| 1430.0000 | E740 |
| 1430.0125 | E741 |
| 1430.0250 | E742 |
| 1430.0375 | E743 |
| 1430.0500 | E744 |
| 1430.0625 | E745 |
| 1430.0750 | E746 |
| 1430.0875 | E747 |
| 1430.1000 | E748 |
| 1430.1125 | E749 |
| 1430.1250 | E750 |
| 1430.1375 | E751 |
| 1430.1500 | E752 |
| 1430.1625 | E753 |
| 1430.1750 | E754 |
| 1430.1875 | E755 |
| 1430.2000 | E756 |
| 1430.2125 | E757 |
| 1430.2250 | E758 |
| 1430.2375 | E759 |
| 1430.2500 | E760 |
| 1430.2625 | E761 |
| 1430.2750 | E762 |
| 1430.2875 | E763 |
| 1430.3000 | E764 |
| 1430.3125 | E765 |
| 1430.3250 | E766 |
| 1430.3375 | E767 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1430.3500 | E768 |
| 1430.3625 | E769 |
| 1430.3750 | E770 |
| 1430.3875 | E771 |
| 1430.4000 | E772 |
| 1430.4125 | E773 |
| 1430.4250 | E774 |
| 1430.4375 | E775 |
| 1430.4500 | E776 |
| 1430.4625 | E777 |
| 1430.4750 | E778 |
| 1430.4875 | E779 |
| 1430.5000 | E780 |
| 1430.5125 | E781 |
| 1430.5250 | E782 |
| 1430.5375 | E783 |
| 1430.5500 | E784 |
| 1430.5625 | E785 |
| 1430.5750 | E786 |
| 1430.5875 | E787 |
| 1430.6000 | E788 |
| 1430.6125 | E789 |
| 1430.6250 | E790 |
| 1430.6375 | E791 |
| 1430.6500 | E792 |
| 1430.6625 | E793 |
| 1430.6750 | E794 |
| 1430.6875 | E795 |
| 1430.7000 | E796 |
| 1430.7125 | E797 |
| 1430.7250 | E798 |
| 1430.7375 | E799 |
| 1430.7500 | E800 |
| 1430.7625 | E801 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1430.7750 | E802 |
| 1430.7875 | E803 |
| 1430.8000 | E804 |
| 1430.8125 | E805 |
| 1430.8250 | E806 |
| 1430.8375 | E807 |
| 1430.8500 | E808 |
| 1430.8625 | E809 |
| 1430.8750 | E810 |
| 1430.8875 | E811 |
| 1430.9000 | E812 |
| 1430.9125 | E813 |
| 1430.9250 | E814 |
| 1430.9375 | E815 |
| 1430.9500 | E816 |
| 1430.9625 | E817 |
| 1430.9750 | E818 |
| 1430.9875 | E819 |
| 1431.0000 | E820 |
| 1431.0125 | E821 |
| 1431.0250 | E822 |
| 1431.0375 | E823 |
| 1431.0500 | E824 |
| 1431.0625 | E825 |
| 1431.0750 | E826 |
| 1431.0875 | E827 |
| 1431.1000 | E828 |
| 1431.1125 | E829 |
| 1431.1250 | E830 |
| 1431.1375 | E831 |
| 1431.1500 | E832 |
| 1431.1625 | E833 |
| 1431.1750 | E834 |
| 1431.1875 | E835 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1431.2000 | E836 |
| 1431.2125 | E837 |
| 1431.2250 | E838 |
| 1431.2375 | E839 |
| 1431.2500 | E840 |
| 1431.2625 | E841 |
| 1431.2750 | E842 |
| 1431.2875 | E843 |
| 1431.3000 | E844 |
| 1431.3125 | E845 |
| 1431.3250 | E846 |
| 1431.3375 | E847 |
| 1431.3500 | E848 |
| 1431.3625 | E849 |
| 1431.3750 | E850 |
| 1431.3875 | E851 |
| 1431.4000 | E852 |
| 1431.4125 | E853 |
| 1431.4250 | E854 |
| 1431.4375 | E855 |
| 1431.4500 | E856 |
| 1431.4625 | E857 |
| 1431.4750 | E858 |
| 1431.4875 | E859 |
| 1431.5000 | E860 |
| 1431.5125 | E861 |
| 1431.5250 | E862 |
| 1431.5375 | E863 |
| 1431.5500 | E864 |
| 1431.5625 | E865 |
| 1431.5750 | E866 |
| 1431.5875 | E867 |
| 1431.6000 | E868 |
| 1431.6125 | E869 |

| Transmission Frequency (MHz) | Channel No. |
|---|---|
| 1431.6250 | E870 |
| 1431.6375 | E871 |
| 1431.6500 | E872 |
| 1431.6625 | E873 |
| 1431.6750 | E874 |
| 1431.6875 | E875 |
| 1431.7000 | E876 |
| 1431.7125 | E877 |
| 1431.7250 | E878 |
| 1431.7375 | E879 |
| 1431.7500 | E880 |
| 1431.7625 | E881 |
| 1431.7750 | E882 |
| 1431.7875 | E883 |
| 1431.8000 | E884 |
| 1431.8125 | E885 |
| 1431.8250 | E886 |
| 1431.8375 | E887 |
| 1431.8500 | E888 |
| 1431.8625 | E889 |
| 1431.8750 | E890 |
| 1431.8875 | E891 |
| 1431.9000 | E892 |
| 1431.9125 | E893 |
| 1431.9250 | E894 |
| 1431.9375 | E895 |
| 1431.9500 | E896 |
| 1431.9625 | E897 |
| 1431.9750 | E898 |

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Contact information is accurate as of Sep 2022. Visit https://www.nihonkohden.com/ for the latest information.

The model and serial number of your device are identified on the rear or bottom of the unit.
Write the model and serial number in the spaces provided below. Whenever you call your representative concerning this device, mention these two pieces of information for quick and accurate service.

Model _____ Serial Number _____

Your Representative

Note for users in the territory of the EEA and Switzerland:
Any serious incident that has occurred in relation to the device should be reported to the European Representative designated by the manufacturer and the Competent Authority of the Member State of the EEA and Switzerland in which the user and/or patient is established.

ZM-520PA, ZM-521PA, ZM-530PA, ZM-531PA_0614-904743G

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1st Edition: 27 Apr 2011
8th Edition: 15 Feb 2023