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REF 9515-183-50-ENG RevD1

# S12/S19

SURVEYOR PATIENT MONITORS  
**USER MANUAL**

Manufactured by Mortara Instrument, Inc., Milwaukee, Wisconsin U.S.A.



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# 1. GENERAL STATEMENTS

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## Technical Support and Service

### Headquarters

#### **Mortara Instrument, Inc.**

7865 North 86th Street  
Milwaukee, WI 53224  
U.S.A.

Tel: 414.354.1600  
Tel: 800.231.7437  
Fax: 414.354.4760  
Internet: <http://www.mortara.com>

### European Union Representative

#### **Mortara Instrument Europe s.r.l.**

(European Headquarters)  
Via Cimarosa 103/105  
40033 Casalecchio di Reno (BO)  
Italy  
Tel: +39.051.298.7811  
Fax: +39.051.613.3582

### Service/Technical Support Group

#### **Mortara Instrument, Inc.**

7865 North 86th Street  
Milwaukee, WI 53224  
U.S.A.

Tel: 414.354.1600  
Service: 888.MORTARA  
(888.667.8272)  
Fax: 414.354.4760  
E-mail: [techsupport@mortara.com](mailto:techsupport@mortara.com)

### Sales Support/ Supplies & Accessories

#### **Mortara Instrument, Inc.**

7865 North 86th Street  
Milwaukee, WI 53224  
U.S.A.

Tel: 414.354.1600  
Fax: 414.354.4760

Hospital Customers: [orders.us@mortara.com](mailto:orders.us@mortara.com)  
Physician Practice: [orderspc.us@mortara.com](mailto:orderspc.us@mortara.com)  
U.S. Distribution: [orderspc.us@mortara.com](mailto:orderspc.us@mortara.com)

#### **Mortara Instrument Germany**

Bonifaciusring 15  
45309 Essen  
Germany  
Tel: +49.201.18 55 69 70  
Fax: +49.201.18 55 69 77

#### **Mortara Instrument Netherlands**

Postbus 324  
5680 AH Best  
Industrieweg 160b  
5683 CG Best  
Netherlands  
Tel: +31.499.377310  
Fax: +31.499.377908

#### **Mortara Instrument Australia**

PO Box 7568  
Baulkham Hills NSW 2153  
Unit 28, 9 Hoyle Avenue  
Castle Hill NSW 2154  
Australia  
Tel: +61 2 8070 9303  
Fax: +61 2 9899 9478

#### **Mortara Dolby UK Ltd.**

Units 11 & 12, Scion House  
Stirling University Innovation Park  
Stirling FK9 4NF  
Scotland  
Tel: +44.1786.444980  
Fax: +44.1786.446630

## 2. NOTICES

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### Manufacturer's Responsibility

Mortara Instrument, Inc. is responsible for the effects on safety and performance of the patient monitor, as indicated by the  label, only if article 2 of 93/42/EEC directive is applied, in particular:

-  **WARNING:** System installation and assembly operations, extensions, readjustments, modifications or repairs are carried out by personnel authorized by Mortara Instrument, Inc. only.
- The patient monitor is used in accordance with the instructions for use.
- The patient monitor is correctly maintained according to the standards authorized by Mortara Instrument, Inc. using original spare parts.
- The patient monitor is used with original accessories and supplies that are in compliance with the standard specifications described in this manual.
- The electrical installation of the relevant room complies with the requirements of appropriate regulations.

### Responsibility of the Customer

The user of this patient monitor is responsible for ensuring the implementation of a satisfactory maintenance schedule. Failure to do so may cause undue failure and possible health hazards. This manual must be kept in a safe place to prevent its deterioration and/or alteration. The user and Mortara Instrument, Inc. authorized personnel must have access to this manual at any time.

The user of this patient monitor must periodically check the accessories, their functionality and integrity.

### Equipment Identification

Mortara Instrument, Inc. equipment is identified by a serial and reference number on the back of the patient monitor. Care should be taken so that these numbers are not defaced.

### Copyright and Trademark Notices

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### Other Important Information

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## 3. WARRANTY INFORMATION

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### Your Mortara Warranty

MORTARA INSTRUMENT, INC. (hereafter referred to as “Mortara”) warrants that components within Mortara products (hereafter referred to as “Product/s”) will be free from defects in workmanship and materials for the number of years specified on documentation accompanying the product, or previously agreed to by the purchaser and Mortara, or if not otherwise noted, for a period of twelve (12) months from the date of shipment.

Consumable, disposable or single use products such as, but not limited to, PAPER or ELECTRODES are warranted to be free from defects in workmanship and materials for a period of 90 days from the date of shipment or the date of first use, whichever is sooner.

Reusable product such as, but not limited to, BATTERIES, BLOOD PRESSURE CUFFS, BLOOD PRESSURE HOSES, TRANSDUCER CABLES, Y-CABLES, PATIENT CABLES, LEAD WIRES, MAGNETIC STORAGE MEDIUMS, CARRY CASES or MOUNTS, are warranted to be free from defects in workmanship and materials for a period of 90 days. This warranty does not apply to damage to the Product/s caused by any or all of the following circumstances or conditions:

- a) Freight damage;
- b) Supplies, accessories and internal parts NOT approved by Mortara;
- c) Misapplication, misuse, abuse, and/or failure to follow the Product/s instruction sheets and/or information guides;
- d) Accident;
- e) A disaster affecting the Product/s;
- f) Alterations and/or modifications to the Product/s not authorized by Mortara;
- g) Other events outside of Mortara’s reasonable control or not arising under normal operating conditions.

THE REMEDY UNDER THIS WARRANTY IS LIMITED TO THE REPAIR OR REPLACEMENT WITHOUT CHARGE FOR LABOR OR MATERIALS, OR ANY PRODUCT/S FOUND UPON EXAMINATION BY MORTARA TO HAVE BEEN DEFECTIVE. This remedy shall be conditioned upon receipt of notice by Mortara of any alleged defects promptly after discovery thereof within the warranty period. Mortara’s obligations under the foregoing warranty will further be conditioned upon the assumption by the purchaser of the Product/s (i) of all carrier charges with respect to any Product/s returned to Mortara’s principal place or any other place as specifically designated by Mortara or an authorized distributor or representative of Mortara, and (ii) all risk of loss in transit. It is expressly agreed that the liability of Mortara is limited and that Mortara does not function as an insurer. A purchaser of a Product/s, by its acceptance and purchase thereof, acknowledges and agrees that Mortara is not liable for loss, harm, or damage due directly or indirectly to an occurrence or consequence there from relating to the Product/s. If Mortara should be found liable to anyone under any theory (except the expressed warranty set forth herein) for loss, harm, or damage, the liability of Mortara shall be limited to the lesser of the actual loss, harm, or damage, or the original purchase price of the Product/s when sold.

EXCEPT AS SET FORTH HEREIN WITH RESPECT TO REIMBURSEMENT OF LABOR CHARGES, A PURCHASER'S SOLE EXCLUSIVE REMEDY AGAINST MORTARA FOR CLAIMS RELATING TO THE PRODUCT/S FOR ANY AND ALL LOSSES AND DAMAGES RESULTING FROM ANY CAUSE SHALL BE THE REPAIR OR REPLACEMENT OF DEFECTIVE PRODUCT/S TO THE EXTENT THAT THE DEFECT IS NOTICED AND MORTARA IS NOTIFIED WITHIN THE WARRANTY PERIOD. IN NO EVENT, INCLUDING THE CLAIM FOR NEGLIGENCE, SHALL MORTARA BE LIABLE FOR INCIDENTAL, SPECIAL, OR CONSEQUENTIAL DAMAGES, OR FOR ANY OTHER LOSS, DAMAGE, OR EXPENSE OF ANY KIND, INCLUDING LOSS OF PROFITS, WHETHER UNDER TORT, NEGLIGENCE OR STRICT LIABILITY THEORIES OF LAW, OR OTHERWISE. THIS WARRANTY IS EXPRESSLY IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, BUT NOT LIMITED TO THE IMPLIED WARRANTY OF MERCHANTABILITY AND THE WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE.

## 4. USER SAFETY INFORMATION

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**Warning:** Means there is the possibility of personal injury to you or others.



**Caution:** Means there is the possibility of damage to the patient monitor.

**Note:** Provides information to further assist in the use of the patient monitor.

***NOTE:** This manual may contain screen shots and pictures. Any screen shots and pictures are provided for reference only and are not intended to convey actual operating techniques. Consult the actual screen in the host language for specific wording.*

### Safety Regulations

- Surveyor is a medical patient monitor.
- Surveyor and its accessories are **CE** labeled, according to European directive 93/42/EEC (MDD), as a class IIb patient monitor, and class I medical patient monitors respectively.
- Surveyor with all accessories that have a physical or logical connection with it, forms part of a Medical Electrical System. Surveyor complies with various safety and performance regulations as mentioned in this manual (Applied Standards).



### Warnings

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- This manual gives important information about the use and safety of this patient monitor. Deviating from operating procedures, misuse or misapplication of the patient monitor, or ignoring specifications and recommendations could result in increased risk of harm to users, patients and bystanders, or damage to the patient monitor.
- Users are expected to be licensed clinical professionals knowledgeable about medical procedures and patient care, and adequately trained in the use of this patient monitor. Patient monitor captures and presents data reflecting a patient's physiological condition that when reviewed by a trained physician or clinician can be useful in determining a diagnosis; however, the data should not be used as a sole means for determining a patient's diagnosis.
- Before attempting to use this device for clinical applications, the operator must read and understand the contents of the user manual and other accompanying documents. Inadequate knowledge or training could result in increased risk of harm to users, patients and bystanders, or damage to the patient monitor. Contact Mortara Technical Service for additional training options.
- The patient monitor provides the possibility to monitor multiple functions, but is not intended to be connected to more than one patient.
- Operation of the equipment beyond its specified ranges, or beyond normal physiological conditions of human subjects, may cause inaccurate results.
- A possible explosion hazard exists. Do not use the device in the presence of a flammable anesthetic mixture. Do not mount any part of the device closer than 25 cm from outlets of flammable gases, including oxygen.

- For proper operation and the safety of users or patients and bystanders, equipment and accessories must be connected only as described in this manual.
- Repairs and modification must be made by authorized and trained technical personnel. Unauthorized modifications and repairs will void the Surveyor warranty and may pose a danger to patients and users.
- The Surveyor, as all medical equipment or systems, needs special precautions regarding EMC and needs to be installed and put into service according to the EMC information provided in the installation procedure in order to obtain a sufficient degree of immunity as well as not to create disturbance to other equipment. Refer to the specific EMC instructions in this manual.
- The quality of the signal produced by the device may be adversely affected by the use of other medical equipment, including but not limited to electrosurgery and ultrasound machines. Do not use the system in the presence of imaging equipment such as magnetic resonance imaging (MRI) and tomography systems. Simultaneous operation may damage the device or lead to erroneous results.
- Portable and mobile RF communications equipment may affect medical electrical equipment or systems as well as the Surveyor and its accessories. Do not operate the Surveyor near high frequency emissions (e.g. microwaves).
- Various alarm conditions require operator to adjust alarm configurations individualized according to patient condition and demographics. Surveyor supports the selection of appropriate alarm profiles when a patient is admitted. The operator should check these settings with each patient admission to ensure the alarm settings are appropriate for the individual patient. Inappropriate alarm configuration settings may render the alarm system useless.
- Surveyor alarms can only be silenced and not reset. This means that visual representation of an alarm condition remains present after an operator-silenced action until the alarm condition disappears (unless obscured by another, higher level, alarm). The auditory alarm signal does not re-activate after a silence action if the alarm condition remains the same. As soon as the alarm condition of a silenced alarm goes away, the alarm can be reactivated. Always respond promptly to alarms.
- A patient monitor is an addition to monitoring patient status and is not intended to replace clinical assessments and clinical judgments. It is important that a qualified individual regularly supervise the patient.
- In an environment where multiple systems, whether Surveyor and/or other systems, are utilized for monitoring patients, use of different alarm presets on each system may pose a safety risk. Be careful in using different alarm conditions on different systems.

### Power Warnings

- Only use the Mortara-provided external power adapter with the Surveyor. Ensure that the power adapter is connected to a properly grounded power terminal and the electrical installation complies with local safety requirements for the environment where it is used.
- To ensure that electrical safety is maintained during operation from AC power, the Surveyor external power adapter must be plugged into a hospital-grade outlet.
- Where the integrity of external protective earth conductor arrangement is in doubt, the device shall be operated from its internal battery power source.

- Do not use the Surveyor power supply to power other devices, because of the risk of additional leakage currents and of transformer overload.
- The device is not operative if no image appears on the screen. If the device becomes inoperative during monitoring, a medium level type alarm sounds and the system resets automatically.
- Regularly check all mains power cables for damage and proper connection. Do not use equipment with a damaged power cord.
- The Surveyor contains a lithium ion battery. The following precautions should be taken regarding the battery:
  - Do not immerse the device in water.
  - Do not heat or throw the device in fire.
  - Do not leave the in conditions over 60 °C or in a heated car.
  - Do not attempt to crush or drop the device.
  - Only use the approved Mortara battery pack with the Surveyor monitor.
  - Follow the instructions in the disposal section of this manual when the Surveyor monitor is taken out of service.
- The Surveyor battery must be initially fully charged prior to use. Ideally, the battery must be fully charged and fully discharged several times to allow for optimal performance.
- The Surveyor produces audible startup tones when powered on (two tones followed by two higher beeps). If a patient monitor does not sound the startup tones when it is powered on, remove the patient monitor from service and contact Mortara Technical Support.
- If the AC power supply is interrupted or disconnected during monitoring, the Surveyor switches to battery backup if the battery is properly installed and has sufficient charge. If power is completely interrupted, including exhausting the battery supply, monitoring will cease until AC power supply has been restored or a fresh battery is installed, and the monitor's power switch is recycled.
- For continued operation, always connect the Surveyor to a wall outlet when a Low Battery alarm indication occurs. Failure to do this can lead to an interruption of monitoring.
- Ensure the battery has sufficient charge prior to disconnecting the external power supply. To disconnect from the AC power, disconnect the external power adapter from AC power first, then disconnect the power connection from the back of the monitor.
- Always reconnect the power cord to AC power after operating the patient monitor using battery power. This ensures that the batteries are recharged for the next time the patient monitor is operated on battery power. A light next to the on/off switch will illuminate indicating that the patient monitor is connected to mains power and charging. The battery icon on the main display indicates when the battery is fully charged.

### Accessories, Cables, and External Connections Warnings

- The patient monitor is designed to meet applicable specifications when using Mortara-approved patient cables and accessories. Use of non-approved cables and accessories may result in reduced performance and may pose possible patient and user safety concerns.

- It is the user's responsibility to use only approved supplies, accessories and internal parts available through Mortara Instrument, Inc. Product performance and patient safety require the use of supplies, accessories and internal parts that comply with applicable standards. To maintain designed operator and patient safety, peripheral equipment and accessories used that can come in direct patient contact must be in compliance with applicable standards including IEC 60601-1, or other IEC standards (e.g., IEC 60950) as appropriate to the patient monitor. Additionally, cables and accessories must comply with all EMC regulations. In Europe, cables and accessories should bear the CE Mark. Only use parts and accessories supplied with the patient monitor and available through Mortara Instrument, Inc.
- Medical devices have been designed to have a higher degree of protection against electric shock than, for instance, information technology equipment because patients often are connected to multiple devices and also may be more prone to the adverse effect of electric currents than healthy persons. All equipment that is connected to the patient, can be touched by the patient, or can be touched by another person while that person touches the patient at the same time, should have the same level of protection against electric shock as medical equipment. The Surveyor patient monitor is a medical device that has been designed to be connected to other devices for the purpose of receiving and transmitting data. Certain measures must be taken to prevent the risk of excessive electric current flow through the operator or patient when connected:
  - All electrical equipment that is **not medical electrical equipment** must be placed outside of the "patient environment," defined by applicable safety standards to be at least 1.5 meters (5 feet) from the patient. Alternatively, non-medical equipment may be provided with additional protection such as an additional protective earth connection.
  - All **medical electrical equipment** that has a physical connection to the Surveyor or the patient, or is in the patient environment must comply with applicable safety standards for medical electrical devices.
  - All electrical equipment that is **not medical electrical equipment** and has a physical connection to the Surveyor must comply with applicable safety standards, such as IEC 60950 for information technology equipment. This includes information network equipment connected through the LAN connector.
  - Conductive (metal) parts that can be touched by the operator in normal use and that are connected to **non-medical equipment** should not be brought into the patient environment. Examples are connectors for shielded Ethernet or USB cables.
  - If **multiple devices** are connected to each other or to the patient, device chassis and patient leakage currents may be increased, and should be measured for compliance with applicable standards for medical electrical systems.
  - Avoid the use of **portable multiple socket outlets**. If used and not compliant with medical electrical device standards, an additional protective earth connection is required.
  - To prevent electric shock due to unequal ground potentials that may exist between points of a distributed network system or fault conditions in external network connected equipment, network cable shielding (where used) must be connected to protective earth ground appropriate to the area where the device is used.
- Do not use excessive force on any of the connection cables and handle all accessories with care.
- Proper clinical procedure must be employed to prep the electrode and sensor sites and to monitor the patient for excessive skin irritation, inflammation, or other adverse reactions. Electrodes and other sensors are intended for short-term use and should be removed from the patient promptly following testing.

- Conductive parts of the ECG patient cables, electrodes, and associated connections of type CF applied parts, including the neutral conductor of the patient cable and electrode should not come into contact with other conductive parts including earth ground.
- To avoid the possibility of serious injury or death during patient defibrillation, do not come into contact with patient monitor or patient cables. Additionally, proper placement of defibrillator paddles in relation to the ECG electrodes is required to minimize harm to the patient.
- To avoid potential for spread of disease or infection, single-use disposable components (e.g., electrodes, IBP catheters, disposable SpO<sub>2</sub> sensors, disposable temperature sensors, single-use blood pressure cuffs, etc.) must not be reused.
- Mortara-approved manufacturers of accessories provide separate user manuals (e.g., patient cables, electrodes, etc.). Read these manuals thoroughly and refer to them for specific functions. It is recommended to keep all manuals together.
- To maintain safety and effectiveness, reusable sensors and cables - such as ECG electrodes and SpO<sub>2</sub> sensors - must not be used beyond their expiration date or useful life.
- All accessories including hoses, cables, connectors, hoses and other patient-applied parts supplied with the Surveyor do NOT contain any Latex. If the patient develops an allergic reaction or rashes, immediately remove the accessory and inform Mortara Technical Support.
- Check the date and integrity of the packing of all accessories that need to be sterilized before use.
- Do not attach unauthorized devices such as a mouse or keyboard to the USB port.

### Use with Electro Surgery Devices Warnings

- The Surveyor is approved for use in the presence of electrosurgical (ESU) equipment providing the following precautions are taken:
  - To minimize the risk of patient burns, only use ESU equipment that monitors the impedance of the ESU return wires.
  - Users should be properly trained in the operation of the ESU equipment.
  - The AM12 12-Lead ECG Acquisition Module should NOT be used when operating ESU equipment.
  - Keep patient-applied cables (e.g., ECG lead wires) off of earth ground and away from the ESU knife and return wires to prevent burns to measurement sites.
  - To prevent burns to the patient in the event of a defective neutral ECG electrode of the device, it is necessary to place ECG electrodes far from the neutral electrode, and as equidistant as possible from the blade-neutral axis of the surgical patient monitor.
  - When activating the ESU device, the ECG signals may be distorted or may disappear, and Lead Fail or Noise alarms might be present. The signal should return once the ESU activation stops.
  - When activating the ESU device, using the SpO<sub>2</sub> parameter as the heart rate source rather than the ECG parameter to determine heart rate may be clinically preferred.

## Installation and Mounting Warnings

- Place the Surveyor on a flat and leveled surface or mount it according to the manufacturer's instructions. Place the Surveyor in a well-ventilated place. Keep the Surveyor away from overly hot, cold or humid places, places directly under sunlight, or dusty surroundings.
- Ensure that the Surveyor is securely placed or mounted such that it does not tip or drop which may damage the monitor and potentially create a hazard to patients and hospital personnel.
- Only approved rolling stands and wall-mount fixtures should be used with the Surveyor.
- A VESA-standard adapter is available on the back of the Surveyor system for wall, swivel-arm or rolling-stand mounting. The user is responsible for correct installation of the system.
- Do not mount the S12 on a rolling stand at a height exceeding 110 cm (43").
- The S19 should NOT be mounted on a rolling stand.

## ECG Warnings

- Excessive patient movement could interfere with the operation of the system.
- Proper patient preparation is important to proper application of ECG electrodes and operation of the patient monitor.
- If the ECG amplifier input is out of normal operating range, the display will indicate a lead fail for the lead(s) where this condition is present and if the signal is being displayed or printed, the respective lead(s) will print out as blank. A lead fail alarm is generated on the Surveyor Central monitoring station
- The AM12 acquisition module automatically calibrates when it is connected to the monitor or when the monitor powers up. If there is a very high amount of electrical interference present at that time (usually because electrodes make spurious contact with earth ground), the calibration may fail. The monitor is aware of the failure and will not display the ECG waveforms. If this happens, the user should attempt to recalibrate by reconnecting the AM12 to the monitor, making sure that there are no spurious contacts between electrodes and earth ground.
- Patient cables intended for use with the patient monitor include series resistance (9 Kilo Ohm minimum) in each lead for defibrillation protection. Patient cables should be checked for cracks or breakage prior to use
- ECG electrodes could cause skin irritation; patients should be examined for signs of irritation or inflammation.
- Defibrillation protection is guaranteed when the original Mortara ECG patient cables are used.
- The system captures and presents data reflecting a patient's physiological condition that when reviewed by a trained physician or clinician can be useful in determining a diagnosis. However, the data should not be used as a sole means for determining a patient's diagnosis. The system is equipped with Mortara's VERITAS™ 12-lead resting ECG interpretation algorithm. The VERITAS ECG algorithm can provide an over-reading physician with a silent second opinion through diagnostic statements output on the ECG report.

- 12-lead ECGs acquired through Surveyor will normally use a modified lead system with the limb electrodes positioned on the torso. Although this is a generally accepted practice (e.g., in stress testing), the different electrode positions can cause morphology changes on the ECG, thus influencing their interpretation. Most frequently seen differences are a vertical and rightward axis shift, minor changes of evidence of old inferior infarction and changes in the T-wave in the limb leads. All 12-lead ECGs printed with Surveyor have a warning message that alerts the physician that the ECG might have been acquired with torso positioned limb leads. It is recommended that you place the electrodes as close as possible to the normal limb positions avoiding the possibility of causing artifact. The right arm and left arm electrodes should be placed on the clavicles as close as possible to the arms. The left leg electrode should be placed as close as possible to the left leg without subjecting it to the possibility of motion artifact.
- The ST algorithm has been tested for accuracy of the ST segment data. The significance of the ST segment changes need to be determined by a clinician.
- During periods of lead fail and when a reduced lead set is used for patient monitoring, 12-lead resting ECG interpretation cannot be reliably used in determining a diagnosis.
- For full diagnostic quality, the resting ECG should be printed on the Surveyor Central Station printer and not on the S12 or S19 strip chart recorder.

### ECG Calculated Heart Rate Warnings

- Heart rate indication is usually not affected by pacemakers with direct cardiac application, ventricular or supraventricular arrhythmias or irregular heart rates; however, in some conditions a pacemaker pulse can give rise to double QRS detections. Also, not activating the “Analyze Pacers” field in the signals menu in the presence of a pacemaker might lead to beat detections without a QRS complex due to the detection of the pacemaker spike.
- Heart rate is calculated over 16 beats at rates over 40 bpm and 4 beats at lower heart rates. This results in a response time of 9 seconds or less when the heart rate changes suddenly from 80 bpm to 40 or 120 bpm, as measured according to ANSI/AAMI EC13 and IEC 60601-2-27.
- Tall and peaked T-waves may affect QRS detection resulting in doubled heart rates. Surveyor rejects tall T-Waves less than or equal to 240% of a 1mV QRS in diagnostic mode, and 70% of a 1mV QRS in monitoring mode, as well as a Q-T interval of 350 ms measured for both diagnostic and monitoring modes according to ANSI/AAMI EC13 and IEC 60601-2-27.
- The heart rate meter correctly detects all beats of the alternating beat type waveforms considered in ANSI/AAMI EC 13 and IEC 60601-2-27 Figure 201.101 patterns A1-A4 if the QRS amplitudes exceed the minimum detection threshold set by the user.
- Time to tachycardia, as measured according to ANSI/AAMI EC13 and IEC 60601-2-27 Figure 201.101 patterns B1-B2 is less than 8 seconds.
- Heart rate indication is not reliable during episodes of ventricular fibrillation.

- The summarized performance of the QRS recognition and classification algorithm on standard databases, as defined by ANSI/AAMI EC 57, is as follows:

MIT Database	
Performance Measures	Mortara
QRS Detection Sensitivity %	99.94
QRS Detection Positive Predictivity %	99.87
PVC Detection Sensitivity %	95.49
PVC Detection Positive Predictivity %	97.05
PVC Detection False Positive Rate %	0.220
AHA Database	
Performance Measures	Mortara
QRS Detection Sensitivity %	99.86
QRS Detection Positive Predictivity %	99.90
PVC Detection Sensitivity %	93.49
PVC Detection Positive Predictivity %	98.32
PVC Detection False Positive Rate %	0.162

- Because of noise, artifact and the many different physiological manifestations of the ECG signal, it is inevitable that some beats are not detected or correctly classified by the system. The user is advised not to rely completely on automatic alarm systems for the monitoring of critical patients.

### Warnings for Patients with Pacemakers

- Rate meters may continue to count the pacemaker rate during occurrences of cardiac arrest or some arrhythmias. Do not rely entirely upon rate meter alarms. Keep pacemaker patients under close surveillance.
- When using the 3/5 lead ECG cable, pacemaker spikes are normally recognized and rejected by the software. Signals are recognized as pacemaker spikes when they have a slew rate over 1.4 V/s, as measured according to the ANSI/AAMI EC 13 and IEC 60601-2-27 standards.
- When using the AM12 12-lead ECG Acquisition Module, pacemaker spikes in the range of 0.3 to 1.3 mS, +/-2 to +/-700 mV are recognized and rejected according to the ANSI/AAMI EC13 and IEC 60601-2-27:2011 standards.
- The pacemaker rejection software can be deactivated by the user. This should not be done for patients with a pacemaker or suspected to have a pacemaker implanted because this can lead to a heart rate indication and failure to alarm for cardiac arrest.
- Other than the influence on beat detection as stated above, there is no known safety hazard if other equipment, such as pacemakers or other stimulators, is used simultaneously with the system.

### Respiration Warnings

- When using an ECG electrode to calculate respiration rate via the thorax impedance method, movement artifacts may create inaccurate results. Respiration rates derived from CO2 parameter is not subject to such movement artifacts.

## SpO<sub>2</sub> Warnings

- Use only approved pulse oximetry sensors specifically intended for use with the patient monitor. Unapproved components can result in degraded performance and/or device malfunction.
- Use pulse oximetry sensors specified for the correct patient mode and for the correct application position.
- Pulse oximetry sensors must be checked a minimum of every 4 hours and moved to a new site as necessary. Reposition the sensor at least once every 24 hours to allow the patient's skin to breathe.
- Tissue damage or inaccurate measurements may be caused by incorrect SpO<sub>2</sub> sensor application or use, such as wrapping too tightly, applying supplemental tape, failing to inspect periodically, or failing to position appropriately. Read the Instructions for Use provided with the SpO<sub>2</sub> sensor carefully prior to use.
- Do not sterilize or immerse pulse oximetry sensors in liquid. Clean and/or disinfect re-usable sensors between patients.
- Pulse oximetry sensors are susceptible to high ambient light interference including surgical lights, especially xenon light sources, ambient photodynamic therapy (e.g., Bilirubin lamps), fluorescent lights, infrared heating lamps, direct sunlight. Shield the sensor area as necessary.
- SpO<sub>2</sub> measurement may be adversely affected by dyes (e.g., methylene blue, indocyanine green, indigo, carmine, fluorescein) introduced into the bloodstream
- That factors that may cause inaccurate readings and alarms, decreased perfusion, and or low signal strength include:

### Interfering substances:

- Carboxyhemoglobin may erroneously increase SpO<sub>2</sub> reading.
- Methemoglobin (MetHb) usually represents less than 1% of the total Hgb, but in the case of methemoglobinemia that can be congenital or induced by some IV dyes, antibiotics (such as sulphas,) inhaled gases etc. this level increases sharply and thus can confound the SpO<sub>2</sub> reading.
- Intravascular dyes (such as indocyanine green, methylene blue, etc.).

### Physiological conditions:

- Cardiac arrest
- Hypotension
- Shock
- Severe vasoconstriction
- Severe anemia
- Hypothermia
- Venous pulsations
- Ventricular septal defects (VSDs)

### Sensor placement:

- Incorrect sensor placement
- Poor sensor fit
- Any condition that restricts blood flow such as the use of a blood pressure cuff or supplemental tape, or extremes in systemic vascular resistance may cause inability to determine accurate SpO<sub>2</sub> readings.
- Certain conditions such as physical movement (patient and imposed motion); diagnostic testing; low perfusion; electromagnetic interference; electrosurgical patient monitors; dysfunctional hemoglobin; and inappropriate positioning of the pulse oximeter sensor may result in pulse oximetry readings that are unreliable.

- SpO2 signal inadequacy is indicated by error messages or alarms generated at the Surveyor patient monitors.
- If the accuracy of any measurement does not seem reasonable, first check the patient's vital signs, and then check for conditions that may cause inaccurate SpO2 readings. If the problem is still not resolved, check the monitor and the SpO2 module, cable, or sensor for proper functioning.
- A pulse oximeter is not an apnea monitor. A pulse oximeter should be considered an early warning device. As a trend toward patient deoxygenation is indicated, blood samples should be analyzed by a laboratory CO-oximeter to completely understand the patient's condition. Check that the pulse oximetry waveform is physiological in shape.
- To prevent erroneous readings, do not use physically damaged sensors, cables or modules. Discard a damaged sensor or cable immediately.
- The performance of the pulse oximetry may be compromised by excessive motion including tremors or shivering.
- Nail polish and/or artificial fingernails can affect the accuracy of pulse oximetry and should be removed.
- Pulse rate measurement is based on the optical detection of a peripheral flow pulse. While a pulse rate does assist with the detection or absence of a peripheral pulse, the pulse oximeter should not be used as a replacement or substitute for ECG-based arrhythmia analysis.
- In certain situations such as low perfusion or weak signal strength, such as with patients who have pigmented or thick skin, inaccurate SpO2 measurements may be reported. Verification of oxygenation should be made through other means, particularly in preterm infants, and patients with chronic lung disease, prior to instituting any therapy or intervention.
- Always monitor ECG for arrhythmia detection purposes. HR calculated from pulsatile SpO2 waveform may differ significantly from ECG HR measured values.

### NIBP Warnings

- Use only approved blood pressure (BP) cuffs specifically intended for use with the Surveyor patient monitors.
- Use the correct size cuff for the intended limb (see indication of cuff size in cm printed on cuff) of the patient. The terminology printed on some BP cuffs like "child," "adult," "thigh," etc., is only an indication of the size of the cuff and should not be used to determine if the cuff is suitable for the limb. Use the range markers on the BP cuff's to determine whether a particular cuff fits the patient's arm or not.
- The Surveyor patient monitor is not intended for use with neonates.
- Do not fold, clamp, cut, or alter the pressure hose of the cuff or the monitor.
- Periodically check the limb connected to the cuff for adequate perfusion, circulation, and function. Repeated NIBP measurements can lead to hematomas, limb ischemia, and other limb injuries. Kinked or blocked hoses can lead to prolonged impairment of blood circulation and lead to injury.
- Educate the patient to relax, rest, and lie still during inflation and pressure measurements. Patient movement can lead to artifacts or errors.

- The pressure measurement might be influenced by patient position, physical conditions, and other factors.
- Avoid placing the blood pressure cuff on the arm next to where a patient has had a mastectomy.
- Avoid applying the cuff to a wounded limb as this can cause further injury. Use with caution in patients with dermatological disease, subcutaneous laceration, or other integumentary compromise as there may exist a skin damage hazard during electronic NIBP measurements. Follow prudent evidence-based clinical practice to determine if an electronic blood pressure is safe for these patients.
- There may be an increased risk of hematomas in patients with serious coagulation problems.
- Avoid applying the cuff to a limb with a catheter, arterio-venous shunt or infusion pump applied. The cuff pressure could produce damage to the tissues surrounding the catheter, shunt or the infusion needle, or compromise the infusion flow.
- To avoid the potential for spread of disease or infection, reusable blood pressure cuffs should be cleaned after each patient use. Disposable blood pressure cuffs should not be used with multiple patients.
- Inflation of the NIBP cuff can cause a temporary degradation of monitoring of other parameters derived from the same limb, including invasive pressure and SpO2 measurements. If applicable, place the SpO2 sensor and the NIBP cuff on different limbs.
- NIBP measurements may be inaccurate in the presence of arrhythmias, motion artifacts, shivering, or trembling patients.
- NIBP cuffs and hoses supplied with the Surveyor do NOT contain any Latex. If the patient develops an allergic reaction or rashes, immediately remove the cuff.

### Invasive Pressure Warnings

- All invasive procedures involve risks to the patient. Use aseptic technique. Follow catheter manufacturer's instructions and established hospital guidelines.
- Ensure that no part of the patient connections touches any electrically conductive material including earth.
- Only use invasive pressures transducers that can withstand defibrillation as required by ANSI/AAMI BP22 standard.
- Mechanical shock to the invasive blood pressure transducer may cause severe shifts in zero balance and calibration, and cause erroneous readings.

### CO2 Warnings

- Always inspect the airway adapter for a tight connection and proper operation before attaching it to the patient.
- Remove the airway sampling line from the patient's airway while nebulized medications are being delivered.
- Route all tubing away from the patient's throat to avoid strangulation.
- Do not apply pressurized air to any outlet or tubing connected to the monitor. Pressure may destroy sensitive elements.

- When monitoring an anesthetized patient in an operating room environment, it is recommended to connect the CO<sub>2</sub> exhaust port of the Surveyor to the hospital's waste gas scavenging system so as to prevent exposure for other patients and hospital personnel to the patient's respiratory sample. Ensure that sampled gases are not returned from the exhaust port to a breathing system such as a ventilator. Use standard clinical guidelines and/or hospital procedures. Scavenge vacuum greater than 1mmHg may result in damage to the Surveyor.
- When using a sampling line for intubated patients with a closed suction system, do not place the airway adapter between the suction catheter and endotracheal tube. This is to ensure that the airway adapter does not interfere with the functioning of the suction catheter.
- Loose or damaged connections may compromise ventilation or cause an inaccurate measurement of respiratory gases. Securely connect all components and check connections for leaks according to standard clinical procedures.
- Do not cut or remove any part of the sample line. Cutting the sample line could lead to erroneous readings.
- If too much moisture enters the sampling line (i.e., from ambient humidity or breathing of unusually humid air), the message Clearing FilterLine will appear in the message area. If the sampling line cannot be cleared, the message FilterLine Blockage will appear in the message area. Replace the sampling line once the FilterLine Blockage message appears.

### Cardiac Output Warnings

- Refer to the catheter package insert provided with each PA catheter for the appropriate computation constant, specific instructions on catheter placement and use, warnings, cautions, and specifications.
- Inaccurate Cardiac Output measurements may be caused by:
  - Incorrect placement or position of the catheter.
  - Excessive variation in pulmonary artery blood temperature, perhaps caused by bolus drug administration.
  - Clot formation on the thermistor port.
  - Anatomical abnormalities, (for example, cardiac shunts).
  - Excessive patient movement.
  - Repeated intermittent flushes of cold fluid through the fluid lumens of the catheter.
  - Electrocautery or electrosurgical device interference.
  - Rapid changes in cardiac output.
  - Using an incorrect computation constant.



## Cautions

- Cleaning must be performed with the system turned off. Let all parts dry well before turning the power back on.
- Prevent liquids from penetrating the system, components, and transmitters. Do not spray the system with liquid cleaning agents. If liquids have penetrated the system, open by authorized personnel for inspection and let dry completely.
- Do not attempt to clean the patient monitor or patient cables by submersing into a liquid, autoclaving, or steam cleaning as this may damage equipment or reduce its usable life. Wipe the exterior surfaces with a warm water and mild detergent solution and then dry with a clean cloth. Use of unspecified cleaning/disinfecting agents, failure to follow recommended procedures, or contact with unspecified materials could result in increased risk of harm to users, patients and bystanders, or damage to the patient monitor.
- No user-serviceable parts inside. Screw removal by authorized service personnel only. Damaged or suspected inoperative equipment must be immediately removed from use and must be checked/repared by authorized service personnel prior to continued use.
- The rechargeable internal battery is a sealed lithium ion type. If the battery appears to become defective, refer to Mortara Technical Support.
- Do not pull or stretch patient cables as this could result in mechanical and/or electrical failures. When not in use, patient cables can be stored. Keep patient cables should be stored off of the floor away from bedrails and wheels to avoid cable damage. Roll the patient cables into a loose loop prior to hanging for storage.
- When necessary, dispose of the patient monitor, its components and accessories (e.g., batteries, cables, electrodes), and/or packing materials in accordance with local regulations.
- Do not connect the patient monitor to any unauthorized patient monitors or use any third-party accessories. This may cause inaccurate measurements or harm the patient. Installation and connection to data networks must be performed by properly trained personnel, authorized by Mortara.
- Check that all operating and environment conditions such as ambient temperature meet the specifications of the Surveyor.
- Do not exert excessive pressure on the touch panel LCD. Excessive pressure may permanently damage the display.
- During MRI scanning, the module must be placed outside the MRI suite. When the module is used outside the MRI suite, EtCO<sub>2</sub> monitoring can be implemented using the FilterLine XL.
- Use of a CO<sub>2</sub> sampling line with H in its name (indicating that it is for use in humidified environments) during MRI scanning may cause interference. The use of non H sampling lines is advised.

- Microstream® etCO<sub>2</sub> sampling lines are designed for single patient use, and are not to be reprocessed. Do not attempt to clean, disinfect, sterilize or flush any part of the sampling line as this can cause damage to the monitor.
- Dispose of sampling lines according to standard operating procedures or local regulations for the disposal of contaminated medical waste.
- Before use, carefully read the Microstream® etCO<sub>2</sub> sampling lines Directions for Use.
- Only use Microstream® etCO<sub>2</sub> sampling lines to ensure the monitor functions properly.

## Notes

- The Surveyor's NIBP parameter is indicated for use with pregnant patients, including those with pre-eclamptic or eclamptic conditions.
- Patient movements may generate excessive noise that may affect the quality of signals and derived parameters and waveforms.
- Proper patient preparation is important to proper application of sensors and electrodes to ensure the correct operation of the patient monitor.
- There is no known safety hazard if other equipment, such as pacemakers or other stimulators, is used simultaneously with the patient monitor; however, disturbance to the signal may occur.
- If an ECG electrode is not connected properly to the patient, or one or more of the patient cable lead wires are damaged, the display will indicate a lead fault for the lead(s) where the condition is present and if the signal is being printed, the respective lead(s) will print out as blank.
- This patient monitor is intended to be used in a hospital or doctor's office setting, and should be used and stored according to the environmental conditions specified.
- During nebulization or suction for intubated patients, in order to avoid moisture buildup and sampling line occlusion, remove the sampling line luer connector from the monitor.
- Replace the sampling line according to hospital protocol or when a blockage is indicated by the device. Excessive patient secretions or a build-up of liquids in the airway tubing may occlude the sampling line, requiring more frequent replacement.
- When the caution message "Blockage" appears on the screen, indicating that the FilterLine which is attached to the monitor is blocked, the monitor's CO<sub>2</sub> pump will stop pumping the patient's breath into the monitor for testing. Follow the instructions that appear in the Troubleshooting section of this manual: First disconnect and reconnect the FilterLine. If the message still appears, disconnect and replace the FilterLine. Once a working FilterLine is attached to the monitor, the pump will automatically resume operation.
- Following connection of the CO<sub>2</sub> sampling line to the monitor and patient, check that CO<sub>2</sub> values appear on the monitor display.

- The device is ETL listed:



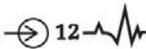
ETL-Listed device in the USA and Canada.

- Upon request, Mortara can supply a Service Manual that includes additional calibration and test instructions as well as list of spare parts and accessories that must be used with the Surveyor patient monitors.
- The S12/S19 recorder may not properly print all characters in all languages. In particular, special characters in certain languages such as accented characters in Polish, Hungarian and Croatian, may not be printed correctly on the recorder and instead be displayed with a “?”.



## 5. EQUIPMENT SYMBOLS AND MARKINGS

### Symbol Delineation

 <p>Indicates compliance to applicable European Union directives</p>	 <p>Do not dispose as unsorted municipal waste. Per European Union Directive 2002/96, requires separate handling for waste disposal according to national requirements</p>
<p><b>IPX1</b></p> <p>Indicates device has been tested for safety from vertically dripping water; specifically, it indicates DRIP PROOF, a higher than ordinary level of protection from drips, leaks, and spills</p>	 <p>Defibrillator-proof type CF applied part</p>
 <p>Tested for safety by the Intertek according to applicable U.S. and Canadian standards and requirements</p>	<p>REF 4101-012</p>  <p>External power AC/DC power supply; use only Mortara Power Supply; REF 4101-012</p>
 <p>Power On/Off switch</p>	 <p>Consult accompanying documents</p>
 <p>Caution</p>	 <p>Recorder interface (S19 only)</p>
 <p>Local Area Network interface</p>	 <p>External alarm interface</p>
<p><b>IOIOI</b></p> <p>Interface to external devices—Reserved for future use</p>	 <p>Connector for 3/5 lead ECG parameter</p>
 <p>Connector for 12-lead ECG parameter using Mortara AM12</p>	<p><b>NIBP</b></p> <p>Connector for non-invasive blood pressure parameter</p>
<p><b>SpO<sub>2</sub></b></p> <p>Connector for oxygen saturation parameter</p>	<p><b>CO</b></p> <p>Connector for cardiac output parameter</p>
<p><b>P 1 &amp; 2</b></p> <p>Connector for invasive pressure 1 &amp; 2 parameters</p>	<p><b>P 3 &amp; 4</b></p> <p>Connector for invasive pressure 3 &amp; 4 parameters</p>
<p><b>T1</b></p> <p>Connector for temperature 1 parameter</p>	<p><b>T2</b></p> <p>Connector for temperature 2 parameter</p>
<p><b>CO<sub>2</sub></b></p>  <p>Connector for CO<sub>2</sub> parameter</p>	<p><b>CO<sub>2</sub></b></p>  <p>Connector for CO<sub>2</sub> parameter exhaust port</p>
 <p>Catalog number for relevant Mortara part</p>	 <p>Serial number</p>

EQUIPMENT SYMBOLS AND MARKINGS

 <p>This end up</p>	 <p>Keep away from sunlight</p>
 <p>Fragile, handle with care</p>	 <p>Keep dry</p>
 <p>Storage temperature range</p>	<p>10  10 rolls of recorder paper per case</p>

## 6. GENERAL CARE

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### Precautions

- Power off the patient monitor before inspecting or cleaning.
- Protect the patient monitor from liquids.
- Never immerse the patient monitor in water.
- Do not drop the patient monitor or subject to shock and/or vibration.
- Do not use organic solvents, ammonia-based solutions, or abrasive cleaning agents that may damage equipment surfaces.

### Inspection

Inspect your equipment daily prior to clinical operation. Do not use the equipment and contact an authorized service representative for servicing if there are concerns about integrity of the system.

- Verify that all cords and connectors are securely seated.
- Check the case and chassis for any visible damage.
- Inspect cables, cords, and connectors for any visible damage.
- Inspect keys and controls for proper function and appearance.
- Check for neat and well balanced screen images.
- Inspect patient accessories such as cuffs, sensors, and wires for any visual damage.
- Ensure that auditory and visual alarms are available and working appropriately.

### Cleaning

The following section provides information on proper cleaning directions for the Surveyor patient monitor and patient accessories. Accessories should be cleaned before they are applied to a new patient. The patient monitor should be cleaned as per facility standard of care. Before cleaning, please refer to the cautions listed below.



**CAUTION:** Always disconnect the Surveyor patient monitor from AC (wall) mains power before cleaning.



**CAUTION:** Do not use harsh chemicals for cleaning. Do not use disinfectants that contain phenol as they can spot plastics. Do not steam autoclave, gas sterilize, irradiate, subject to intense vacuum, or immerse in water or cleaning solution. Be careful to avoid getting cleaning liquids into connectors or the patient monitor. If this occurs, allow the patient monitor to dry in warm air for 2 hours, then check to make sure all monitoring functions are working properly.



**CAUTION:** Take particular care when cleaning the NIBP cuff, NIBP hose, and NIBP connector on the Surveyor patient monitor to prevent fluid from entering the connectors or cuff. Fluid in the NIBP system may affect blood pressure determination accuracy and damage the monitor.



**CAUTION:** Keep the patient accessories off of the floor. Accessories that fall on the floor should be inspected for defects, contamination, proper functionality, and cleaned or discarded according to the approved recommendations.



**CAUTION:** The user has the responsibility to validate any deviations from the recommended method of cleaning and disinfection.

GENERAL CARE	
Touch screen Display	<p><b>Approved Cleaning Agents</b></p> <ul style="list-style-type: none"> <li>Clean the touch screen with a soft cloth moistened with either a solution of 70% isopropyl alcohol in distilled water or soapy water.</li> </ul> <p>Do not spray cleaner directly onto the touch screen. Spray the cleaner onto a lint-free cloth and then wipe the monitor.</p> <p>To clean the touch screen display,</p> <ol style="list-style-type: none"> <li>Select the Settings sidebar button.</li> <li>Select the Administrative menu.</li> <li>Select the Screen Cleaning mode. This action disables the monitor’s touch screen for 15 seconds for cleaning purposes. After the 15 seconds expires, the touch screen controls are reactivated.</li> </ol>
ECG Cables  TEMP Cable  SpO2 Cable  NIBP Hose  External Power Supply  Power Cord	<p><b>Approved Cleaning Agents</b></p> <ul style="list-style-type: none"> <li>Enzymatic detergent such as ENZOL (US) or CIDEZYME (outside the US)</li> <li>Distilled water</li> <li>Disinfectant solution (such as CIDEX OPA, or a 10% solution of household bleach (5.25% sodium hypochlorite) in distilled water)</li> <li>Soft, lint-free cloths and/or soft-bristled brushes</li> <li>Protective gloves and eyewear</li> </ul> <p><b>Procedure</b></p> <ol style="list-style-type: none"> <li>Disconnect the patient monitor from the wall outlet.</li> <li>Put on gloves and protective eyewear.</li> <li>Prepare the enzymatic detergent according to the manufacturer's instructions, and also the disinfectant solution, in separate containers.</li> <li>Apply detergent to product using a soft, lint-free cloth. If material is dried on, allow to sit for 1 minute. Do not immerse cable ends or lead wires in liquid as it can cause corrosion.</li> <li>Wipe smooth surfaces with the cloth.</li> <li>Use a soft-bristle brush on visibly soiled areas and irregular surfaces.</li> <li>Remove detergent from product using cloth dampened in distilled water.</li> <li>Repeat as necessary.</li> <li>Apply disinfectant solution on affected area using a soft cloth. Allow product to sit for 5 minutes.</li> <li>Wipe excess solution and clean product again with cloth dampened in distilled water.</li> <li>Allow 2 hours for drying.</li> </ol>

Reusable NIBP Cuffs	<p><b><u>Approved Cleaning Agents</u></b></p> <ul style="list-style-type: none"> <li>• Mild detergent and water</li> <li>• Non-chlorine bleach</li> </ul> <p><b><u>Procedure</u></b></p> <ol style="list-style-type: none"> <li>1. Prior to washing, remove any internal cuff bladders and engage the Velcro hook and loop fasteners to prevent lint from collecting in the hooks.</li> <li>2. For general cleaning of cuffs, use a soft, lint-free cloth lightly moistened with a mild soap and water solution. Be careful not to get liquid inside the tubes. Allow to air dry.</li> <li>3. For excessive perspiration marks or odor, the exterior of the cuff can be hand-washed under running water with a mild detergent. Do not allow water to enter the cuff. Allow to air dry.</li> <li>4. If required, the use of non-chlorine bleach is acceptable. Using chlorine bleach solutions will shorten the service life of the cuff.</li> <li>5. Sterilize the cuff using commercially available disinfectants. Using dark colored disinfectants may stain the cuff material. Test a single cuff to ensure that no damage or staining occurs. Follow the manufacturer's instructions. Thoroughly rinse each component to remove any residual disinfectants. Once cleaned, wash off all disinfectant material using a cloth dampened with a mild detergent. Failure to remove disinfectants may lead to mild skin irritation on some patients. Allow the components to air dry for a minimum of 2 hours.</li> <li>6. Cuffs may be sterilized with Ethylene Oxide. Do not autoclave or iron the cuff as the hook and loop fasteners will melt at temperatures above 325°F (162°C).</li> <li>7. Use caution with excess liquid.</li> <li>8. Do not use excessive drying techniques such as forced heat.</li> <li>9. Prevent liquid from penetrating the cuff and do not attempt to clean/disinfect the cuff by submerging into liquid, autoclaving, or steam cleaning.</li> </ol>
SpO2 Reusable Sensor	<p><b><u>Approved Cleaning Agents</u></b></p> <ul style="list-style-type: none"> <li>• 70% isopropyl alcohol</li> </ul> <p><b><u>Procedure</u></b></p> <ol style="list-style-type: none"> <li>1. Remove sensor from patient and disconnect from sensor cable. Wipe off with alcohol pad.</li> <li>2. Allow sensor to dry before placing it on a patient.</li> </ol>
Disposable: SpO2 Sensors Temperature Probes CO2 Lines	These items are intended for use with a single-patient and must be properly disposed of after use. Refer to the sensor/probe manufacturer instructions for further details.

## Maintenance

The following table shows the recommended maintenance procedures for the Surveyor patient monitor and its accessories. The Surveyor S12 and S19 patient monitors should be serviced and calibrated once a year by a Mortara authorized service technician. However, it is good practice to periodically ensure the patient monitor is in proper working order. Perform these checks at least every 12 months by a qualified biomedical engineer or other trained service personnel. To accomplish these steps in their entirety and verify the correct operation of the system, appropriate patient simulators or other equipment may be required.

Refer to the service manual for further details.

Functionality	Procedure
Mechanical Integrity	Check for cracks, abrasive edges and other signs of damage.
Power LED	Verify that the green power LED is illuminated when the patient monitor is ON or charging.
Speaker	Power-cycle the Surveyor patient monitor and verify that the power-up speaker test tones are generated.
Second Speaker	Power-cycle the Surveyor patient monitor and verify that the power-up second speaker test tones are generated.
ECG / Respiration	<ul style="list-style-type: none"> <li>• Connect ECG leads to Patient Simulator.</li> <li>• Verify proper heart rate at 30 and 300 bpm (+/- 2 bpm or +/- 1%).</li> <li>• Verify 1 mV test pulse (Lead II).</li> <li>• Verify proper respiration rate at 15 and 120 bpm (+/- 3 bpm).</li> </ul>
SpO <sub>2</sub>	<ul style="list-style-type: none"> <li>• Connect to Patient Simulator (select appropriate sensor type).</li> <li>• Verify proper SpO<sub>2</sub> value at 84% and 96% (+/- 2%).</li> <li>• Verify proper PR value at 30 and 240 bpm (+/- 5%).</li> </ul>
CO <sub>2</sub>	<p><b>NOTE:</b> Use only certified calibration gas apparatus [See “CO<sub>2</sub> Calibration” section below] that has not reached its expiration date. This cal gas can be applied to the Surveyor patient monitor in pulses that simulate patient breaths.</p> <ol style="list-style-type: none"> <li>1. Connect an Oridion Microstream FilterLine single-use capnography sample line to the Surveyor monitor’s gas inlet port.</li> <li>2. Connect with a tight fit, the other end of the Oridion sample line to one of the two open ports on the Cal Gas tubing apparatus.</li> <li>3. Pulse the calibration gas actuator, holding it depressed for 10 seconds and released for 10 seconds (6 BPM). This will allow enough time for the ET CO<sub>2</sub> to stabilize in both inhaled and exhaled states.</li> <li>4. Verify that the EtCO<sub>2</sub> value reads the CO<sub>2</sub> concentration stated on the canister ± the accuracy tolerance stated in the product specifications.</li> <li>5. Verify the FiCO<sub>2</sub> value reads 0 ±2 mmHg.</li> </ol> <p><b>NOTE:</b> Factor a ±0.05 correction for every 100mmHg of ambient barometric pressure above or below sea level respectively.</p> <p><b>NOTE:</b> The monitor should be returned to the manufacturer for periodic servicing of the CO<sub>2</sub> system after 30,000 hours of CO<sub>2</sub> use.</p>

Functionality	Procedure
NIBP	<p><b>NOTE:</b> Do not allow system to remain pressurized and stable below 20 mmHg. The monitor will remove this pressure as a zero offset and this will affect the validity of the calibration check.</p> <p><b>NOTE:</b> The following are required to perform this test: NIBP simulator or sphygmomanometer along with a Y-cable and a hand inflation bulb.</p> <p><b>Pressure Accuracy Test:</b> Via the Service settings, put the NIBP in to calibration mode. Set the pressure to 25 mmHg and 225 mmHg respectively and verify that the pressure values reported by the Surveyor patient monitor matches (<math>\pm 2</math> mmHg) of that reported on the simulator or sphygmomanometer. Release pressure.</p> <p><b>Overpressure Test:</b> Inflate cuff to 300 mmHg. Verify that the pressure is automatically dumped at 300 <math>\pm</math> 30 mmHg.</p> <p><b>Leak Test:</b> Inflate a cuff to 150 mmHg. Allow cuff pressure to settle (thermal effect). Verify that the pressure drops less than 4 mmHg in 1 minute. Verify that the pressure is automatically dumped after 150 seconds of being above 15 mmHg.</p> <p>Set the NIBP back to normal mode. Power cycle the monitor.</p> <p><b>Measurement Accuracy Test:</b> Connect to Patient Simulator and take a NIBP measurement. Verify proper NIBP value at 120/80 (<math>\pm</math> 5 bpm).</p>
Invasive Pressures (P1-P4)	<ul style="list-style-type: none"> <li>• Connect static pressure sources at 20 and later at 100 mmHg to IBP sensors P1-P4. Verify correct pressure is displayed for each (<math>\pm</math> 2 mmHg).</li> <li>• Connect a patient simulator with dynamic IBP waveform for radial artery of 120/80.</li> <li>• Verify correct pressure waveform and values are displayed (<math>\pm</math> 2 mmHg).</li> </ul>
Temperature	None (self-checking).
Leakage Currents	<p>Connect to Safety Analyzer.</p> <p> <b>WARNING:</b> FOLLOW SAFETY INSTRUCTIONS AS INDICATED IN THE MANUAL FOR THE ANALYZER.</p> <ul style="list-style-type: none"> <li>• Verify Patient Lead Leakage (to ground): &lt; 10 uA.</li> <li>• Verify Patient Lead Leakage (inter-lead): &lt; 10 uA.</li> <li>• Verify Patient Lead Leakage (mains applied to leads): &lt; 50 uA.</li> <li>• Verify Leakage to ground (normal): &lt; 500 uA.</li> <li>• Verify Leakage to ground (reversed polarity): &lt; 1000 uA.</li> <li>• Verify Leakage to ground (neutral opened): &lt; 1000 uA.</li> </ul>

## Battery Replacement



**CAUTION:** The battery should be removed from the monitor if the monitor is to be stored for an extended period of time.

The battery may need to be replaced if it is no longer holding a charge. Under optimum conditions, the battery lifetime is approximately two years. Replacing the battery should only be done by qualified service personnel.

 **WARNING:** Use only APPROVED BATTERIES as listed in the Accessories section. Use of unapproved batteries may cause a hazard and will void the warranty.

 **CAUTION:** Batteries should only be replaced by trained service personnel.

To replace the battery:

1. Obtain a replacement battery from Mortara (see Accessories section for part number).
2. Power-off the Surveyor patient monitor.
3. On the back of the Surveyor patient monitor, disconnect the external power supply from the monitor.
4. Remove the battery cover with the VESA mounting plate by removing the four screws holding the cover as shown in the picture below.
5. Remove the battery by pulling on the top side of the battery as shown in Figure 1.
6. Insert new battery ensuring that the connector is properly engaged.
7. Carefully reinstall back cover and screws.
8. Properly dispose of the old battery (see Disposal section).

**Figure 1 Battery Replacement**



### Battery Life and Charge Time

Estimated Battery Life	S12: 3 hours*
	S19: 2 hours*

\*Fully charged new batteries at 25 °C for the following conditions: continuous ECG and SpO<sub>2</sub>, as well as NIBP measurements at every 15 minute interval.

Estimated Battery Charge Time	When OFF, 5 hours
	When ON, S12: 7 hours
	When ON, S19: 20 hours

### Battery Conditions

When the Surveyor S12 and S19 monitor's battery has less than 5 minutes of power remaining, the battery icon flashes, a battery alert message displays, and an audio technical tone is sounded.

When the battery power is too low to continue normal operation, the Surveyor S12 and S19 monitor's screen clears, a Battery Nearly Depleted message displays in the center of the screen, and monitoring is discontinued. When AC power is restored, the battery begins the recharge process and monitoring can resume once the clinician has powered on the monitor.

## Decommissioning and Disposal

Dispose of the patient monitor, its components and accessories (e.g., batteries, cables, electrodes), and/or packing materials in accordance with local regulations. Do NOT incinerate or throw the battery in garbage.

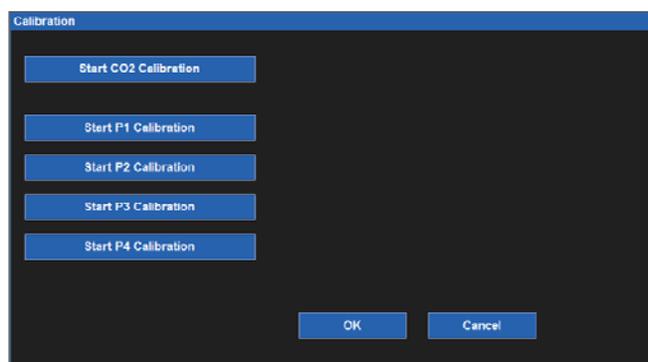
## Calibration

The Surveyor S12 and S19 patient monitors should be serviced and calibrated once a year by a Mortara authorized service technician.

Refer to the service manual for further details.

Trained service technicians can perform the following test and calibration procedures via the Setup > Administrator > Service (password required) > Calibration dialogue as shown below.

**Figure 2 Calibration Dialogue**



### CO2 Calibration

The CO2 module within the patient monitor does not require calibration during normal clinical operation. The Surveyor patient monitor displays a “CO2 Calibration Due” message when the manufacturer’s suggested number of operating hours has been reached. Calibrate the CO2 module when this message is displayed. It is recommended to calibrate the CO2 module on an annual basis or after 4000 hours of use, whichever comes first. In the first year, the CO2 module should be calibrated after 1200 hours of use. The number of hours until calibration is due may be found in the Surveyor patient monitor’s event log, which is accessed via the “Administration – System – Show Event Log” menu.

**NOTE:** Calibration should be performed by a trained technician.

**NOTE:** Ensure that the calibration gas and regulator are functioning properly before calibration.

**NOTE:** Calibration of the CO2 module will require a calibrated gas mixture of 5% CO2, 21% O2, with the balance N2. The calibration kit available from Air Liquide (Scott Medical); Part Number T4653ORF-CD contains a canister of the above gas mixture, a T-piece connector and a Calibration Filterline.

To calibrate the CO2 module:

1. Select “Start CO2 Calibration” via the “Administration - Service – Calibration” screen.
2. Prior to calibration initiation, connect the CO2 sampling line to the monitor.
3. Attach the calibrated CO2 gas mixture to the CO2 sampling line.
4. Select “Start CO2 Calibration” on the screen. The Surveyor patient monitor displays “CO2 Calibrating” for up to 1 minute.
5. Once completed, the Surveyor patient monitor displays “CO2 Calibration Complete” or “CO2 Calibration Failed”.
6. If the calibration fails, determine the cause of failure appropriate to the displayed error message given then repeat the CO2 calibration procedure.
7. Upon successful completion, remove the calibration gas from the monitor.

***NOTE:** Between calibrations, the calibration gas can be applied to the Surveyor patient monitor in pulses that simulate patient breaths. The EtCO2 value should read  $38 \pm 2$  mmHg. The FiCO2 value should read  $0 \pm 2$  mmHg and a  $\pm 0.05$  correction factor for every 100 mmHg ambient pressure above or below sea level respectively.*

### Invasive Pressure Calibration

The Invasive Pressure interfaces do not require calibration during normal clinical operation. In order to calibrate the Invasive Pressure interfaces, perform the following:

1. Connect a static pressure source, such as ambient air, to pressure transducer that is connected to the P1 invasive pressure interface.
2. Select “Start P1 Calibration” via the “Administration - Service – Calibration” screen (password required to access this screen).
3. Await “P1 Calibration OK” message, or similar if the interface is labeled something other than P1.
4. Repeat for interfaces P2 through P4.

### NIBP Calibration

The NIBP interface does not require calibration during normal clinical operation. The accuracy of the NIBP pressure sensor and overall functionality of the NIBP interface can be verified as detailed in the Maintenance section in this manual. If further calibration is required, contact Mortara Technical Support or your authorized service personnel.

## **7. ELECTROMAGNETIC COMPATABILITY (EMC)**

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When using the patient monitor, assess the electromagnetic compatibility with surrounding devices.

An electronic device may either generate or receive electromagnetic interference. Testing for electromagnetic compatibility (EMC) has been performed on the bedside monitor according to the international standard for EMC for medical bedside monitors (IEC 60601-1-2). This IEC standard has been adopted in Europe as the European Norm (EN 60601-1-2).

The patient monitor should not be used adjacent to or stacked with other equipment. If the patient monitor is used in this manner, verify the patient monitor operates in an acceptable manner in the configuration in which it will be used.

Fixed, portable, and mobile radio frequency communications equipment may affect the performance of medical equipment. See Table X-4 for recommended separation distances between the radio equipment and the patient monitor.

The use of accessories, transducers, and cables other than those specified by Mortara Instrument may result in increased emissions or decreased immunity of the equipment.

**Table X-1 Guidance and Manufacturer's Declaration: Electromagnetic Emissions**

The equipment is intended for use in the electromagnetic environment specified in the table below. The customer or the user of the equipment should ensure that it is used in such an environment.

Emissions Test	Compliance	Electromagnetic Environment: Guidance
RF Emissions CISPR 11	Group 1	The Surveyor patient monitor uses RF energy only for its internal function. Therefore, its RF emissions are very low and not likely to cause any interference in nearby electronic equipment.
RF Emissions CISPR 11	Class A	The Surveyor patient monitor is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic Emissions IEC 61000-3-2	Not Applicable	
Voltage Fluctuations/ Flicker Emissions IEC 61000-3-3	Not Applicable	

**Table X-2 Guidance and Manufacturer's Declaration: Electromagnetic Immunity**

The equipment is intended for use in the electromagnetic environment specified in the table below. The customer or the user of the equipment should ensure that it is used in such an environment.

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment: Guidance
Electrostatic discharge (ESD) EN 61000-4-2	+/- 6 kV contact +/- 8 kV air	+/- 6 kV contact +/- 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 EN 61000-4-4	+/- 2 kV for power supply lines +/- 1 kV for input/output lines	+/- 2 kV for power supply lines +/- 1 kV for input/output lines	Mains power quality should be that of a typical commercial or hospital environment.
Surge IEC 61000-4-5	+/- 1 kV differential mode +/- 2 kV common mode	+/- 1 kV differential mode +/- 2 kV common mode	Mains power quality should be that of a typical commercial or hospital environment.
Voltage fluctuations and interruptions	<5% UT for 0.5 cycles 40% UT for 5 cycles 70% UT for 25 cycles <5% UT for 5s	<5% UT for 0.5 cycles 40% UT for 5 cycles 70% UT for 25 cycles <5% UT for 5s	Note that monitoring is interrupted at the level "< 5% UT for 5s", but equipment remains safe (as specified in EN 60601-1-2).
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:** *UT is the AC Mains voltage prior to application of the test level.*

**Table X-3 Guidance and Manufacturer's Declaration: Electromagnetic Immunity**

The equipment is intended for use in the electromagnetic environment specified in the table below. The customer or the user of the equipment should ensure that it is used in such an environment.

Immunity Test	IEC 60601 Test Level	Compliance Level	Electromagnetic Environment: Guidance
Conducted RF EN 61000-4-6	3 Vrms 150 kHz to 80 MHz	3 Vrms 150 kHz to 80 MHz	<p>Portable and mobile RF communications equipment should be used no closer to any part of the equipment, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.</p> <p><b>Recommended separation distance</b></p> $d = 1.2 \sqrt{P}$ $d = 1.2 \sqrt{P} \quad 80 \text{ MHz to } 800 \text{ MHz}$ $d = \sqrt{P} \quad 800 \text{ MHz to } 2.5 \text{ GHz}$ <p>Where <math>P</math> is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and <math>d</math> is the recommended separation distance in meters (m).</p> <p>Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey<sup>a</sup>, should be less than the compliance level in each frequency range<sup>b</sup>.</p> <p>Interference may occur in the vicinity of equipment marked with the following symbol:</p> 
Radiated RF IEC 61000-4-3	3 V/m 80 MHz to 2.5 GHz	3 V/m 80 MHz to 2.5 GHz	

- a. Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radios, AM and FM radio broadcast, and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the equipment is used exceeds the applicable RF compliance level above, the equipment should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as reorienting or relocating the equipment.
- b. Over the frequency range 150 kHz to 80 MHz, field strengths should be less than [3] V/m.

**Table X-4 Recommended Separation Distances Between Portable and Mobile RF Communications Equipment and the Equipment**

The equipment is intended for use in the electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the equipment can help to prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the equipment as recommended in the table 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	80 MHz to 800 MHz	800 MHz to 2.5 GHz
	$d = 1.2 \sqrt{P}$	$d = 1.2 \sqrt{P}$	$d = 2.3 \sqrt{P}$
0.01	0.12 m	0.12 m	0.23 m
0.1	0.38 m	0.38 m	0.73 m
1	1.2 m	1.2 m	2.3 m
10	3.8 m	3.8 m	7.3 m
100	12.0 m	12.0 m	23.0 m

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.

**NOTE:** At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

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

## 8. INTRODUCTION

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### General Information

This User's Guide provides information for users of the Mortara Surveyor S12 and S19 patient monitors. The Surveyor S12 and S19 patient monitors are small, lightweight patient monitors designed to acquire physiological waveforms and parameters, and to transmit this data to the Surveyor Central monitoring station. The terms Surveyor patient monitor, system, patient monitor, monitor, S12, S19, and patient monitor may be used interchangeably in this document to refer to the Mortara Surveyor S12 and S19 patient monitors.

Prior to operating the Surveyor patient monitors, read all sections of this User's Guide. Failure to read and understand the instructions may lead to misuse of the Surveyor patient monitor resulting in harm to the clinician and patient.

### Indications For Use

The Mortara Surveyor S12 and S19 patient monitors are indicated for use in adult & pediatric patient populations. The Mortara Surveyor S12 and S19 patient monitors facilitate the monitoring of:

- Non-invasive blood pressure (NIBP)
- Impedance respiration
- Invasive blood pressures (P1-P4)
- Temperature
- Functional arterial oxygen saturation (SpO<sub>2</sub>)
- End-tidal & inspired CO<sub>2</sub>
- ECG monitoring with arrhythmia and ST-segment analysis
- 12-Lead resting ECG
- Cardiac output (CO)

The Mortara Surveyor S12 and S19 patient monitors are prescription devices intended to be used by knowledgeable healthcare professionals within a healthcare facility.

### Contraindications

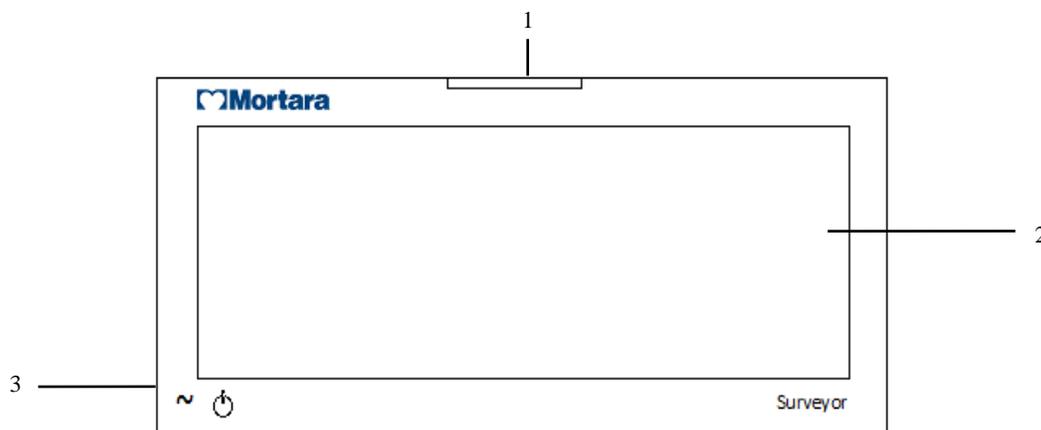
The Surveyor S12 and S19 patient monitors are NOT intended to be used in neonate patient population or for apnea monitoring. The Surveyor patient monitor is not intended for transport applications such as ambulances or aircraft.

### System Overview

The Surveyor S12 patient monitor is designed for continuous monitoring in either stationary or portable applications. The Surveyor S19 is intended for continuous monitoring in a stationary application. The S12 has an 11.6 inch display, and the S19 has an 18.5 inch display.

## Front View

Figure 3 Surveyor Patient Monitor: Front View Example

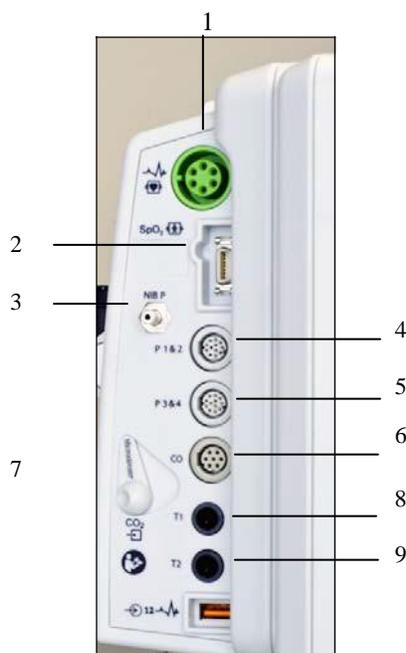


1. Alarm Light
2. Main Screen Display Area
3. Power On/Off Button and LED

The S12/S19 front bezel provides a LED indicator to indicate when the monitor is connected to AC (wall) power.

## Left Side View

Figure 4 Surveyor Patient Monitor: Left Side Patient Cable Connector Ports



10

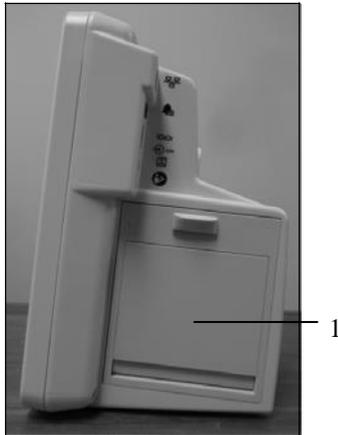
The left side of the S12 and S19 contains the patient cable connections for ECG monitoring, SpO2 NIBP, P1-P4, cardiac output, CO2 temperature, and 12-lead resting ECG.

**NOTE:** These cable connection ports are dependent upon the purchased monitor configuration.

1. ECG Connector
2. SpO2
3. NIBP
4. P1 & 2
5. P3 & 4
6. Cardiac Output
7. CO2 Input Port
8. T1
9. T2
10. AM12 12-Lead ECG Acquisition Module/USB Port

## Right Side View

**Figure 5 Surveyor Patient Monitor: Right Side View of S12 with Optional Bedside Recorder**



The right side of the Surveyor S12 may contain the optional integrated dual channel thermal recorder (1).

## Back View

**Figure 6 Surveyor Patient Monitor: Top Back View of S12**



The top corner of the back of the Surveyor S12 and S19 contains the communication ports, an opening for the audio speaker as well as a connection for CO2 exhaust.

This area contains the connections for wired Ethernet, an external alarm indicator, a serial port for other medical device interfaces, and AC power.

The right side of the S19 has a dedicated connection for its optional dual-channel recorder.

Power is provided through an external medical-grade power supply or an internal lithium-ion battery.

Figure 7 Surveyor Patient Monitor: Back View of S12 with Optional Bedside Recorder (1)



Figure 8 Surveyor Patient Monitor: Back View of S19



## 9. INSTALLATION AND SETUP

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### Unpacking and Checking

The first step in using the Surveyor patient monitor is to ensure the appropriate accessories are available for patient monitoring.

Depending on your exact configuration, your system may include the following components:

- Surveyor S12 or S19 monitor
- Surveyor patient monitor power supply with power cable
- ECG cables
- Mortara AM12 12-Lead ECG Acquisition Module
- ECG lead wire sets
- ECG electrodes
- SpO2 sensor(s) / extender cable
- Temperature cable(s)
- Temperature probe(s)
- NIBP hose
- NIBP cuff(s)
- Invasive pressure cables
- Invasive pressure Y cables
- CO2 FilterLines
- Cardiac Output cable
- Cardiac Output thermistor adaptors (in-line, bath probe)

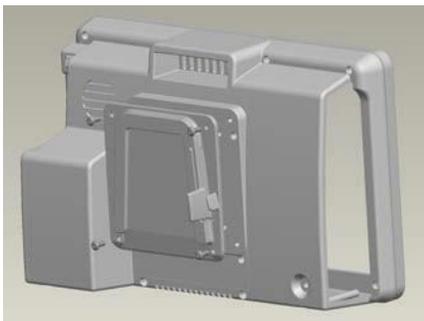
A connector cable from the patient monitor to the “Surveyor Central” Ethernet a wall plate is required if the patient monitor is to communicate to the Surveyor Central monitoring system. Refer to service manual for further details.

### Installation Methods

The Surveyor S12 patient monitor can be mounted on a rolling stand or on the wall using a stationary or articulating arm. The Surveyor S19 patient monitor can only be mounted on the wall using a stationary or articulating mounting arm.

Attach the Socket Mount (8363-021-50 Socket Mount Roll Stand and Wall S12) to the back of the S12 Battery Cover / VESA Mount using 4) M4 x 16mm socket button head cap screws as shown.

**Figure 9 Mounting Plate for S12**



## Rolling Stand

The Surveyor S12 patient monitor can be mounted on a rolling stand using the Surveyor mounting plate. Carefully follow the instructions included with the rolling stand mount for proper installation.

## Wall Mount

The Surveyor S12 and S19 patient monitors can be mounted on a wall using the VESA mount on the back. Carefully follow the instructions of the manufacturer of the wall mount for proper installation.

## Power On/Off

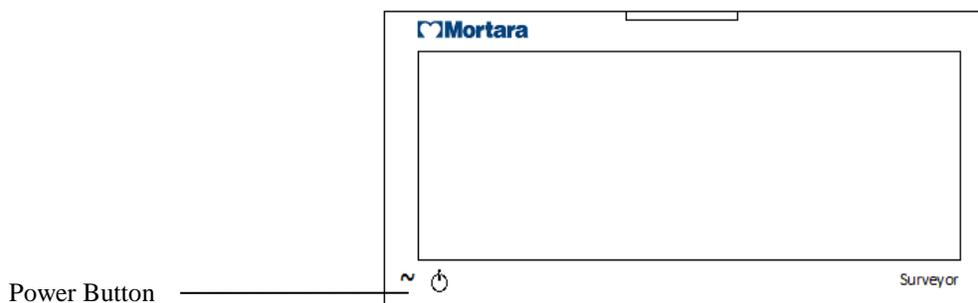
Before making any connections, place the Surveyor patient monitor in relation to the patient where patient cables do not tangle or trip individuals.

The dedicated ON/OFF switch, AC power LED, and the visual alarm indicator are located on the front of the patient monitor.

To connect the Surveyor patient monitor to AC (mains) power:

1. Plug the Power Cable Plug into the power connector port on the back of the Surveyor patient monitor (right hand side).
2. Connect the Surveyor patient monitor power cable into the AC wall outlet.
3. The Battery Charging LED indicator should now be illuminated.

**Figure 10 Power On/Off Button**

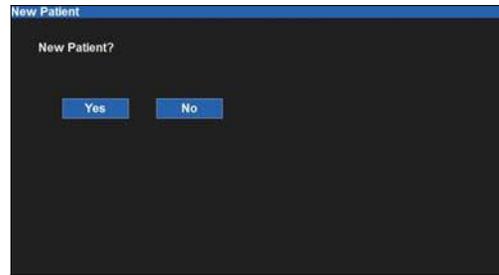


To power on the Surveyor patient monitor:

1. Press and hold the power button on Surveyor patient monitor for 2 seconds (See figure above).
2. The monitor performs a self-test. Any faults or errors should be displayed on the main screen.
3. A proper power up produces audible startup tones (two tones followed by two higher beeps).
4. The monitor's main screen display illuminates and then briefly shows the Mortara logo.

5. When the Surveyor patient monitor is initially powered up, the New Patient confirmation message displays on the main screen.
  - a. Select “Yes” to begin a new monitoring session for a new patient. This activity erases previously stored monitoring data, previously configured patient-specific monitor settings, and previously entered patient demographic information. This activity restores the monitor configuration to the departmental default settings.
  - b. Select “No” to retain previously stored patient data and monitor configurations.

**Figure 11 New Patient Confirmation Dialogue**



To power-down the Surveyor patient monitor:

1. Press the power button briefly.

***NOTE:** The patient mode selected is retained upon a power up/down sequencing. Ensure the monitor configuration is appropriate to patient and patient mode upon powering up.*

**Best Practice Recommendation:** Keep the monitor connected to the AC (wall) outlet to recharge the monitor’s battery even if the monitor is not in use.

The Surveyor patient monitor settings (patient demographics, alarm limits, trend data and other information) are stored via on-board non-volatile Flash memory. These settings are preserved when the monitor is turned off, or in the event of power failure. Once power is reestablished, resumption of monitoring restores these values.

## To Connect for Central Station Communication

To connect the Surveyor patient monitor to the Surveyor Central Station, a dedicated network connection is required. Consult your authorized service representative to connect the Surveyor patient monitor to the Surveyor Central via a dedicated Ethernet cable and wall-jack.

To communicate with the Surveyor central monitoring station,

1. Connect the network cable into the network connector port on the back of the Surveyor patient monitor.
2. Connect the other end of the network cable into the wall plate connector marked "Surveyor Central".

Refer to the service manual for further details on central station networking.

## To Connect for 3<sup>rd</sup> Party EMR Software

To connect the Surveyor patient monitor to 3<sup>rd</sup> Party Electronic Medical Record (EMR) solutions, you will need:

- Connect the S12 or S19 monitor to the EMR workstation via a dedicated serial cable.
- Configure the Communications settings (available from the Setup – Administration – Communications menu) of the S12 or S19 to be of type “Serial”.
- Configure the Connectivity setting (available from the Setup – Administration – Connectivity). The typical setting for most EMR applications is “1”.

Setup Communications

Bed ID  Use DHCP  No  Yes

Unit ID

Central Host Name

Central IP Address

Central Port Number

IP Address

Subnet

Gateway

DNS

Connect Type

OK Cancel

Setup Connectivity

EMR Interface Type

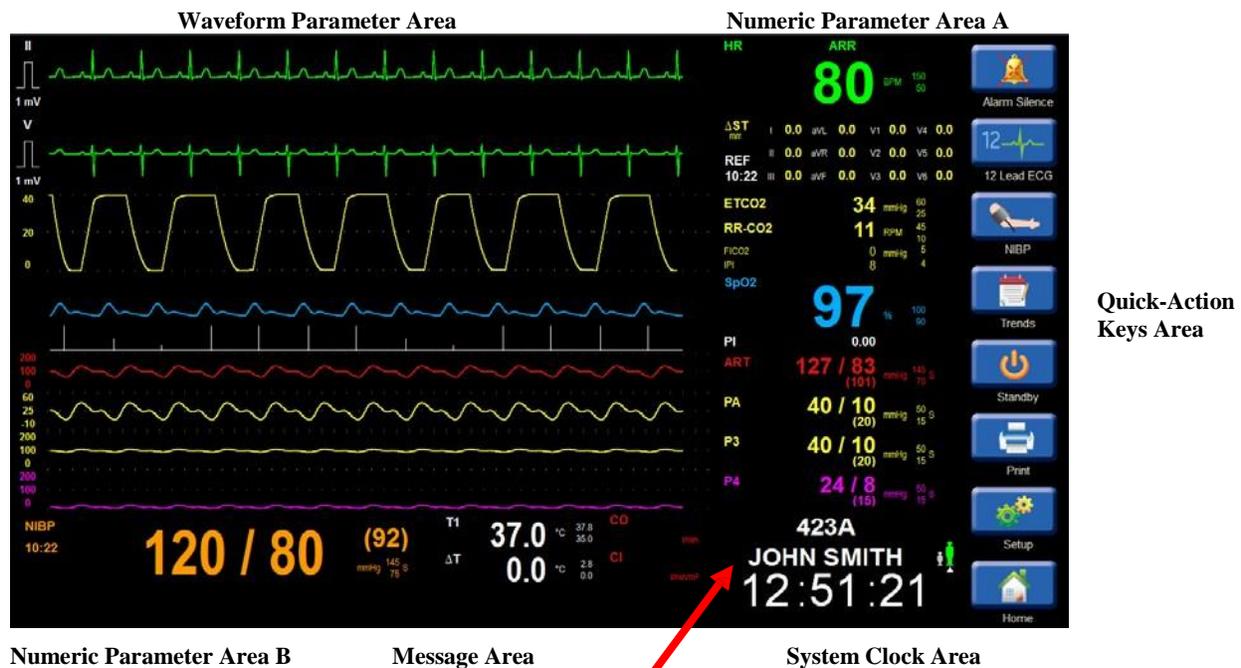
OK Cancel

## 10. MAIN SCREEN DISPLAY

### Overview

The Surveyor S12 and S19 patient monitors feature a wide-screen resistive touchscreen with a display resolution of 1366 x 768 pixels. The high-resolution display presents patient monitoring information in an intuitive fashion allowing clinicians to easily and quickly visualize important data.

Figure 12 Main Screen (example)



Numeric Parameter Area B

Message Area

System Clock Area

Patient Demographic,  
Mode, and Network Status Area

Quick-Action  
Keys Area

### Parameter Areas

The parameter areas of the main display are divided into an area for displaying the waveform parameters and two areas for displaying the numeric parameters. The parameter areas display the available configured parameters.

The waveform and associated numeric parameters are displayed in the same color providing easy visualization of both parameter formats. The colors of the waveform and numeric parameters are not clinician configurable.

#### Waveform Parameter Area

The waveform parameter area displays the available configured parameter waveforms. The waveform parameter tile is always located to the left of the corresponding numeric parameter tile.

The main screen supports up to eight waveform parameters simultaneously. The top waveform parameter tile is always reserved for an ECG tracing. When active, the bottom four waveform parameter tiles display the four invasive pressure waveforms.

The ECG waveform parameter tiles contain the ECG calibration pulse indicator and unit of measure. The CO2 and invasive pressure waveform parameter tiles contain the waveform gain setting.

When using the Mortara AM12 12-Lead ECG Acquisition Module, the waveform parameter area can change to a split-screen format displaying all 12 ECG vectors.

When accessing advanced functions, the opened dialogue menus display in the waveform parameter area. The top waveform tracing of ECG remains visible at all times.

The waveform parameter colors are not clinician configurable and are as follows:

- ECG: Green
- SpO2: Cyan
- CO2: Yellow
- Respirations (from ECG): White
- P1: Red
- P2: Light Blue
- P3: Yellow
- P4: Magenta
- ART: Red
- PA: Yellow
- RA: Light Blue
- LA: Light Blue
- CVP: Light Blue
- ICP: Magenta
- PAWP: Yellow

### Numeric Parameter Area

The numeric parameter area displays the numeric values of the available configured parameters. The numeric parameter area is divided into two areas:

#### **Numeric Parameter Area A**

This area displays the numeric values adjacent to the corresponding waveform parameter tile. The numeric parameter tile is always located to the right of the corresponding waveform parameter.

#### **Numeric Parameter Area B**

Located in the lower portion of the main screen, this area displays numeric values that are not associated with waveform parameters. This area contains the NIBP, CO/CI, and Temperature numeric values if actively being monitored.

In addition to the numeric parameter values, the numeric parameter tile may also contain the configured high and low alarm limit settings and the parameter's units of measure. If alarms are disabled for a given parameter, the Alarm Off icon appears next to the parameter value. For pressure numeric parameters, the alarm icon appears if alarms are turned off for any of the three pressure values of systolic, mean, or diastolic.

Selecting the numeric parameter tile opens the parameter dialogues. Use the parameter dialogues to make adjustments in that parameter. Refer to the specific parameter sections of this manual for further details on parameter dialogues.

The numeric parameter colors are not clinician configurable and are as follows:

- HR: Green (if source is ECG)
- PR: Cyan (if source is SpO2)
- PR: Red (if source is ART invasive pressure)
- ST: Green
- RR (from ECG): White
- EtCO2: Yellow
- FiCO2: Yellow
- RR (from CO2): Yellow
- IPI: Yellow
- SpO2: Cyan
- P1: Red
- P2: Light Blue
- P3: Yellow
- P4: Magenta
- ART: Red
- PA: Yellow
- RA: Light Blue
- LA: Light Blue
- CVP: Light Blue
- ICP: Magenta
- PAWP: Yellow
- CO: Red
- CI: Red
- T1: White
- T2: White
- $\Delta T$ : White
- NIBP: Orange

## Quick-Action Key Area

Figure 13 Main Screen Quick-Action Keys



The quick-action keys provide rapid access to commonly used functions.

### Alarm Silence Quick-Action Key

Select this quick-action key to silence all current and future alarm tones for the configured time period, and to remove displayed alarm messages. Once the latched alarm condition resolves, select the Alarm Silence quick-action key to acknowledge the latched alarm discontinuing the latched alarm behaviors. Refer to the Alarm section of this manual for further details on latched alarms.

### All ECG/12-Lead ECG Quick-Action Key

This quick-action key is a toggle button and is context sensitive specific to the ECG lead set in use. When configured for a 12-lead ECG set and connected as such, the All ECG quick-action key is re-labeled “12 Lead ECG.”

#### All ECG

- When the 3 or 5 lead ECG wire set is selected, pressing this soft key shows the ALL ECG view displaying all available ECG vectors simultaneously.
- When in the All ECG view, the quick-action key re-labels to “Normal.”
- Select the Normal quick-action key to return to the main screen display.

#### 12-Lead ECG

- When the AM12 is selected, pressing the 12 Lead ECG quick-action key displays all 12 ECG vectors simultaneously in a split-screen format.
- When in the 12 Lead ECG view, the quick-action key re-labels to “Normal.”
- Select the Normal quick-action key to return to the main screen display.

### NIBP Start/Stop Quick-Action Key

This quick-action key is a toggle button and changes function based on the NIBP status.

- Selecting this quick-action key during an NIBP idle or deflated status initiates a non-invasive blood pressure (NIBP) measurement.
- Selecting this quick-action key during an NIBP acquire mode (currently inflating status) stops the NIBP measurement and deflates the NIBP cuff.

### Trends Quick-Action Key

Select this quick-action key to display the patient’s trends or vital sign numeric values. Refer to the Trends section of this manual for further details.

### Standby Quick-Action Key

Select this quick-action key to place the monitor into the Standby Mode or sleep mode. The Standby quick-action key is also used to discharge the monitor.

While in the Standby Mode, the main screen display is black and reads “Standby Mode.”

**NOTE:** *During the Standby mode the patient monitor does not show or capture any patient monitoring data, does not perform alarm surveillance, and does not perform any arrhythmia surveillance. Patients must be closely observed during a Standby mode.*

Refer to the Standby section of this manual for further details.

### Print Quick-Action Key

Select this quick-action key to print a real-time waveform recording at the bedside thermal recorder. If configured appropriately and actively communicating to the Surveyor Central Station, the Print quick-action key also prints a real-time waveform at the central station. The waveforms printed are based on the configuration settings in the Setup> Setup Recorder dialogue. Refer to the Setup Recorder dialogue in this manual for further details.

The following table lists specific reports and where they may be printed based on system configuration.

Recording type	Prints at
Strip chart (initiated by pressing the Print soft key on monitor)	Print location setting (Bedside, Central, or both)
12 lead report	Print location setting (Bedside, Central, or both)
Alarm report	Print location setting (Bedside, Central, or both)
Trend report	Bedside
ST averages	Bedside

### Setup Quick-Action Key

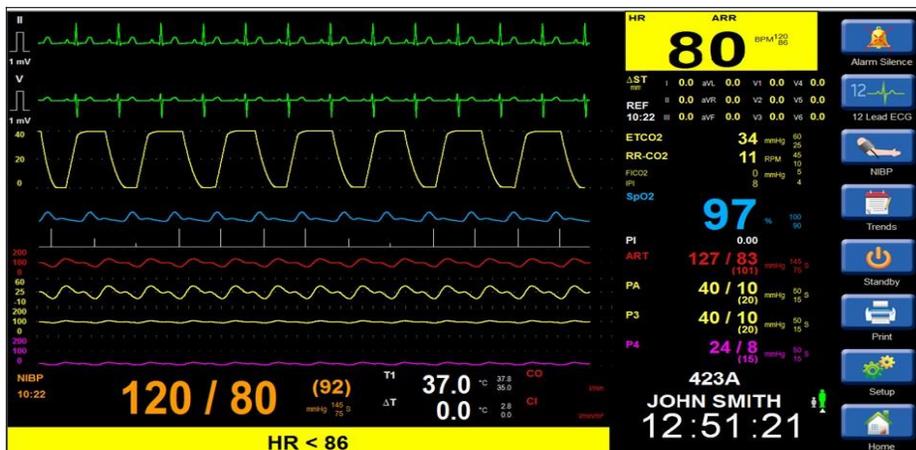
Select this quick-action key to access advanced functions such as arrhythmia settings, alarm settings, and other monitor configuration menus. Refer to the Setup section of this manual for further details.

### Home Quick-Action Key

Select this quick-action key to close open dialogues and return to the main screen display.

## Message Area

Figure 14 Message Area



Message Area

The lower portion of the main screen is where alarm and system messages are displayed. These alarm messages flash and display in the background color of the configured alarm level color for that condition. If multiple alarm conditions occur, the most recent alarm condition having the highest level displays. If there are multiple alarm conditions with the same level, the alarm messages rotate in the message area. Refer to the Alarms section of this manual for further details on alarm messaging.

## System Clock Area

This area displays the system time and date. The system date and time area displays in the format of HH:MM:SS. When communicating to the Surveyor Central Station, the system date and time synchronizes between the patient monitor and the central station.

## Demographic and Status Area

Figure 15 Demographic and Status Area



The Demographic and Status area displays three categories of information: Patient information, patient mode icon, and network status icon.

### Patient Information

This area displays entered patient information such as name, room number, and ID number. Select this area to open the Patient Information dialogue for adjusting the patient information. Refer to the Patient Information section in this manual for further details.

### Patient Mode Icon

This area displays an icon for Adult patient mode and for Pediatric patient mode. The selected patient mode icon displays in green and is noted by an up arrow below the icon. Select this area to open the Patient Information dialogue for adjusting the patient mode. Refer to the Patient Information section in this manual for further details.

### Network Status Icon

This area displays a network status icon when the S12/S19 is configured to communicate to the Surveyor Central Monitoring system. The network status icon displays above the patient mode icon.

Figure 16 Example Network Status Icon: Successfully Communicating with Central Station



Figure 17 Example Network Status Icon: Not Actively Communicating with Central Station



# 11. PATIENT MANAGEMENT

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## Overview

The Surveyor S12 and S19 patient monitors ship with factory default configuration settings allowing the clinician to begin safely monitoring a patient without making any monitor configuration adjustments. However, the department administrator may choose to adjust the monitor configuration for specific departmental default settings for waveforms, parameters, alarm settings, and other functions. These departmental default configuration settings may present upon monitor discharge for new patient monitoring sessions. The factory and departmental configurable default settings may be adjusted based on the specific monitoring needs of patients.

## Patient Information Dialogue

The Patient Information dialogue provides controls for entering patient demographic information. There are two ways to access the Patient Information dialogue:

1. Select the Settings quick-action key -
  - a. Select the blue Patient Information button.
  - b. This opens the Patient Information dialogue.
2. Select the black patient information area located above the system date and time -
  - a. This opens the Patient Information dialogue.

**Figure 18 Patient Information Dialogue**

The screenshot shows a 'Patient Information' dialog box with the following fields and values:

Last	SMITH	M.I.		First	JOHN
ID	MG642BW	Room	423A		
Mode	Adult				
Gender	Male	Ethnicity	Other		
Date of Birth:					
Year		Height		in	
Month		Weight		lb	
Day					
OK Cancel					

To enter patient information,

1. Select the blue demographic indicator button.
2. Based on the demographic label selected, the onscreen keyboard, keypad, or dropdown list box open.
3. Enter the information.
4. Selecting OK enters the information and displays the Setup dialogue.
5. Selecting CANCEL cancels the function and displays the Setup dialogue.
6. When in the Setup dialogue, select CLOSE to close the Setup dialogue.
7. Select the HOME quick-action key to close all dialogues and return to the main screen.

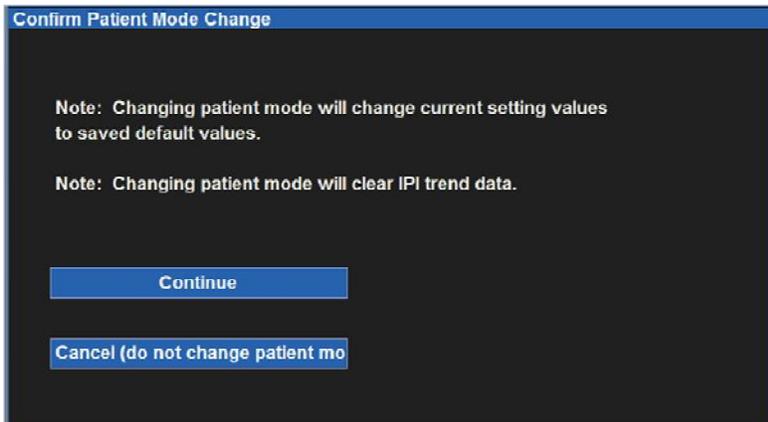
Information that can be entered includes Last Name, Middle Initial, First Name, ID, Room number, Mode, Gender, Ethnicity, Date of Birth, Height and Weight.

### Patient Mode Specifics

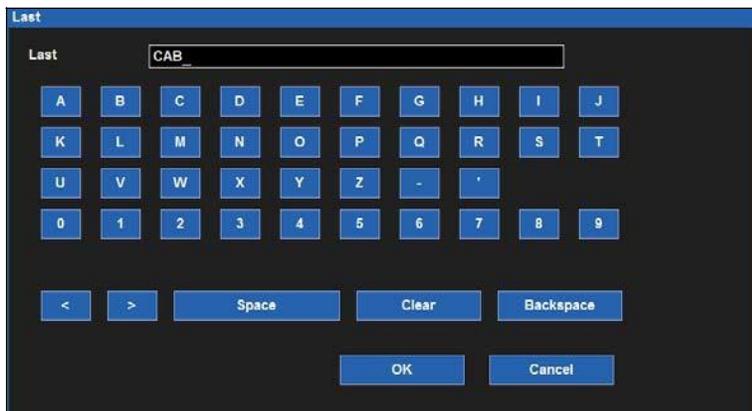
The patient mode choices include Adult and Pediatric. The patient mode is not based on the entered date of birth and must be adjusted manually.

If the patient mode is changed during an active monitoring session a Confirm Patient Mode Change message shall be displayed on the main screen. This confirmation message consists of continuing and changing configuration settings back to departmental defaults, or canceling the change in patient mode.

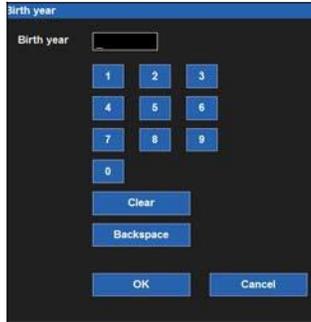
**Figure 19 Confirm Patient Mode Change Dialogue**



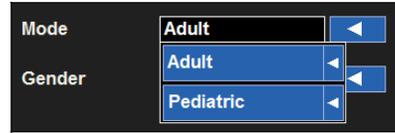
**Figure 20 Example Onscreen Keyboard (Last Name)**



**Figure 21**  
**Example Onscreen Keypad (Birth Year)**



**Figure 22**  
**Example Drop Down List Box (Patient Mode)**



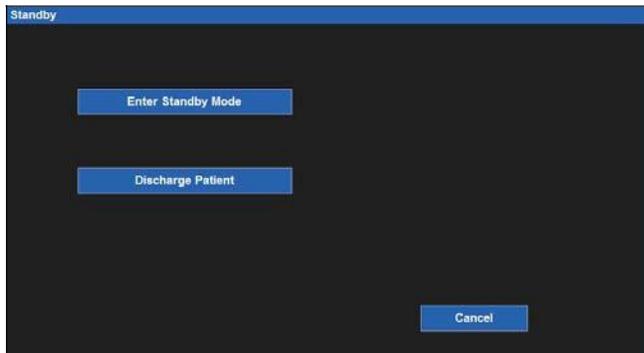
## Admit

To admit a patient, simply connect the appropriate parameter cables and sensors to the patient. The patient demographic information may be entered as per hospital standard of care at any time during the active monitoring session. Refer to the Patient Information section in this manual for details on entering patient information.

## Standby Mode

The Standby mode can be used to temporarily suspend patient monitoring (patient returning to same monitor) or to permanently discharge the patient monitor (patient not returning to monitor). Selecting the Standby quick-action key displays the Standby Mode Choice dialogue.

**Figure 23 Standby Mode Choice Dialogue**



## Standby: Hibernation Mode

The Standby hibernation mode discontinues active patient monitoring but maintains the patient data and monitor configuration settings. This use of the Standby mode may be used when the patient is disconnected from the patient monitor for ambulation purposes, for example. Use the Standby mode based on the hospitals' approved standard of care.

**NOTE:** *During the Standby mode the patient monitor does not show or capture any patient monitoring data, does not perform alarm surveillance, and does not perform any arrhythmia surveillance. Patients must be closely observed during a Standby mode.*

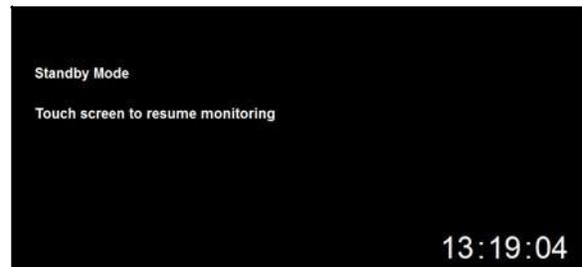
Entering the Standby hibernation mode:

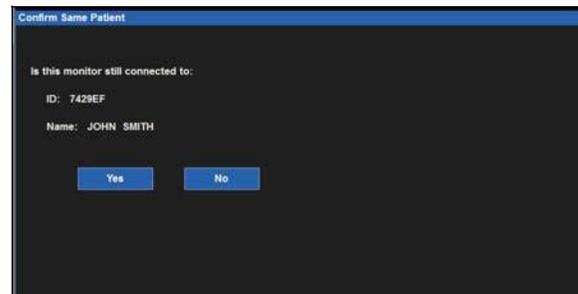
- Places the main screen into the Standby mode.
- Suspends monitoring of all patient data.
- Suspends the capturing of any patient monitoring data.
- Suspends alarm surveillance for all arrhythmias and physiological patient parameters.
- Suspends any active NIBP intervals.
- Suspends the CO2 pump.
- Displays the system clock and a Standby Mode message on the main screen at the patient.
- Places the Surveyor Central Station into the standby mode for this patient monitor. Refer to the central station operator's manual for details of the Standby mode at the central station.

To enter the Standby hibernation mode:

1. Select the Standby quick-action key on the right side of the main screen.
2. The Standby Mode Choice dialogue displays.
3. Select the Enter Standby Mode choice.
4. The monitor enters the Standby hibernation mode.
5. The Standby Mode screen displays.

**Figure 24 Standby Mode Display**



**Figure 25 Confirm Same Patient Prompt**

To exit the Standby hibernation mode:

1. Touch the main screen to resume monitoring.
2. The “Confirm Same Patient” prompt appears.
  - a. Exiting the Standby hibernation mode by selecting the YES button (is the same patient)-
    - Resumes monitoring of patient parameter monitoring as previously configured.
    - Resumes capturing of any patient monitoring data.
    - Resumes alarm surveillance for all arrhythmias and physiological patient parameters as previously configured.
    - Re-enables the CO2 pump for use as configured.
    - Initiates a relearn of the Arrhythmia and ST algorithms.
    - Resumes monitoring for this patient monitor at the Surveyor Central Station. Refer to the central station operator’s manual for details of the Standby mode at the central station.
    - Select the START/STOP NIBP quick-action key to resume the previously configured NIBP interval and to start the cuff inflation.
  - b. Exiting the Standby Mode by selecting the NO button (not the same patient)-
    - Erases the previous patient monitoring data at the patient monitor (and central station as applicable).
    - Erases the entered demographic information at the patient monitor (and central station as applicable).
    - Erases any previously set alarm configuration settings at the patient monitor (and central station as applicable).
    - Returns the monitor to the departmental default configuration settings at the patient monitor (and central station as applicable).
    - Begins a new monitoring session at the patient monitor (and central station as applicable).

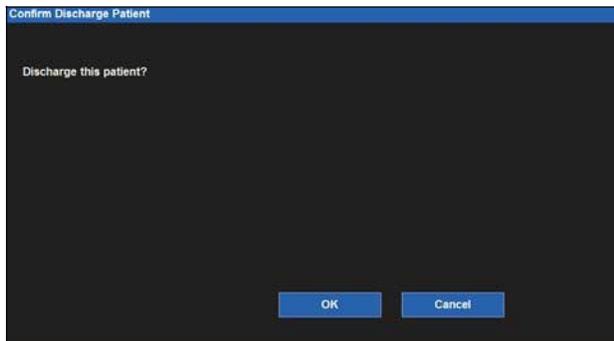
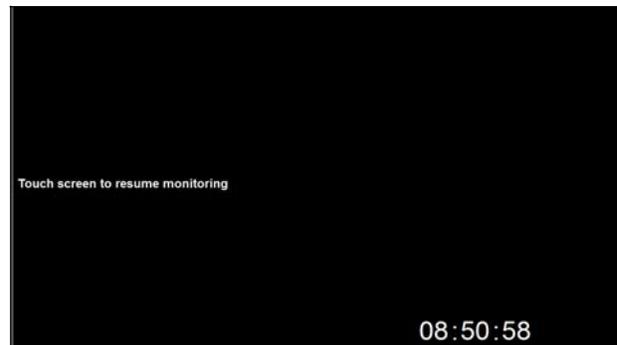
**Best Practice Recommendation:** Upon resumption of monitoring, ensure the alarm settings and monitor configuration is appropriate for the patient based on the hospital standards of care.

### Standby: Discharge Mode

To Discharge a patient:

1. Select the Standby quick-action key on the right side of the main screen.
2. The Standby Mode Choice dialogue displays
3. Select the Discharge Patient choice
4. The Confirm Discharge Patient confirmation message displays.
  - a. Select the OK button to discharge all previous patient data. This action-
    - Erases the previous patient monitoring data at the patient monitor (and central station as applicable).
    - Erases the entered demographic information at the patient monitor (and central station as applicable).
    - Erases any previously set alarm configuration settings at the patient monitor (and central station as applicable).

- Returns the monitor to the departmental default configuration settings at the patient monitor (and central station as applicable).
  - Displays the Discharged monitor screen.
  - Touch the screen to begin a new monitoring session at the patient monitor (and central station as applicable).
- b. Select the Cancel button to return to previous monitoring session.

**Figure 26 Confirm Discharge Patient Message****Figure 27 Discharged Monitor screen**

**NOTE:** When connected to the Surveyor Central Station, ensure that patient demographics have been defined for each monitoring session. Discharging a patient, placing the monitor in standby mode or switching the monitor off when a monitoring session where no patient demographics have been defined, results in the permanent loss of monitoring data on the Surveyor Central related to that monitoring session.

**NOTE:** When moving a monitor from one Surveyor Central to another Surveyor Central, in order to avoid mixing up patient and monitoring session data, ensure that the patient is discharged on the monitor before establishing a new monitoring session. Changing the communications setup for the monitor will automatically force a discharge of the current patient.

## 12. ALARM BEHAVIORS AND MANAGEMENT

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### General Alarm Behavior

The Surveyor S12 and S19 patient monitors may provide alarm notifications when a patient's physiological status changes, there is a specific technical issue, or there is a system monitoring issue. The alarms are categorized into different priorities or levels to aid in clinician recognition of urgent situations.

### Physiological Alarms

Physiological alarms occur when the patient's monitored data violates the configured alarm threshold for that parameter. Physiological numeric alarm limit violations occur when the current parameter exceeds the configured high alarm limit for that parameter or when the current parameter is less than the configured low alarm limit for that parameter.

Arrhythmia and ST segment alarms are also considered physiological alarms. Arrhythmia alarms present as configured when the defined criteria for the arrhythmia exists. ST segment alarms present as configured when the defined criteria for the ST alarm exists.

### Alarm Levels

Physiological alarms may be considered high level, medium level, or low level based on monitor configuration. Some physiological alarm responses may be configurable by the clinician while some physiological alarm responses are set by the Surveyor patient monitor and are not configurable by the clinician.

**Red Alarm** A red alarm is a high level alarm. A red high level alarm is a potentially life-threatening critical alarm requiring immediate clinician interaction with the patient. Lethal Arrhythmias (Ventricular Fibrillation, Ventricular Tachycardia, and Asystole) are examples of red alarms. Tachycardia and Bradycardia can also be configured to be red high level alarms.

**Yellow Alarm** A yellow alarm is a medium level alarm. A yellow medium level alarm is considered an urgent alarm requiring clinician interaction with the patient. A high Non-Invasive Blood Pressure (NIBP) alarm may be configured as a Medium level alarm.

**Cyan Alarm** A cyan alarm is a low level alarm. A cyan low level alarm is considered a non-urgent alarm notification. The clinician should check the patient status when a low level alarm occurs. An example of a low level alarm may be a ECG Leads Off situation.

### Technical Alarms

Technical alarms occur when there is a patient-specific issue with the cables or parameter sensors of the Surveyor patient monitor. Technical alarms indicate a non-physiological condition exists and the patient monitor cannot measure or detect certain alarm conditions reliably. An example of a technical alarm is an ECG Leads Off situation. Technical alarms are considered to be of low level importance. Parameter values that are out of measurable range are considered technical alarms displayed in cyan. Technical alarm responses are determined by the monitor's software and cannot be adjusted by the clinician.

## Informational Alert Messages

Informational alert messages appear on the patient monitor providing helpful prompts for proper operation. These alerts on the lower portion of the main screen appear in white letters on black background and are not considered alarm notifications. An example of an informational alert is “CO2 Warming Up.”

## Alarm Configuration Defaults

Physiological alarms limits for each parameter have factory and configuration departmental default minimum and maximum values. These alarm limits are based on the chosen patient mode whether adult or pediatric.

### Factory Default Settings

The Surveyor S12 and S19 patient monitors are shipped with certain factory default alarm settings. Factory default settings may differ for the adult patient mode and the pediatric patient mode. These factory default settings allow the clinician to quickly use the patient monitors in a safe manner without spending time configuring the device.

### Departmental Default Settings

The factory default settings can be adjusted by the facility’s system administrator and saved as Departmental Defaults. These departmental defaults are configured specific to the needs of the typical population cared for in that particular department.

The Surveyor S12 and S19 patient monitors can be restored to the original factory default settings via the Setup Administrator menu (password required)

## Alarm Notifications

Alarm notifications consist of three categories:

- Visual alarm notifications
- Alarm light notifications
- Audio alarm notifications

The visual and audio alarm notifications vary according to the alarm level or importance of the condition. All alarm visual and audio notifications meet IEC 60601-1-8 standards.

### Visual Alarm Notifications

Visual alarm notifications may consist of alarm light activation, alarm messaging along the bottom portion of the patient monitor’s main screen, a flashing parameter background color, or a combination of the previous behaviors. The physiological visual alarm behavior varies based on the parameter and the alarm level configured for the parameter.

Physiological visual alarm notifications are divided into three colors based on alarm level:

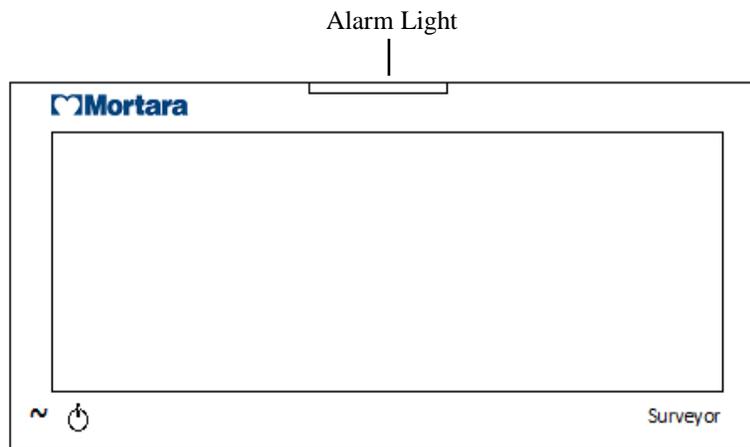
**Red Alarm**      A red alarm is a high level alarm. In a high level alarm condition, the Surveyor S12 and S19 patient monitor’s alarm light flashes red, the alarm messaging area on the main screen flashes red, and the involved parameter such as Heart Rate for Ventricular Tachycardia flashes with a red background.

**Yellow Alarm** A yellow alarm is a medium level alarm. In a medium level alarm condition, the Surveyor S12 and S19 patient monitor's alarm light flashes yellow, the alarm messaging area on the main screen flashes yellow, and the associated numeric parameter tile flashes yellow.

**Cyan Alarm** A cyan alarm is a low level, non-urgent alarm notification. In a low level alarm condition, the Surveyor S12 and S19 patient monitor's alarm light flashes cyan, the alarm messaging area on the main screen flashes cyan, and the associated numeric parameter tile flashes cyan.

### Alarm Light Notifications

The system's front bezel has an alarm light that annunciates the highest grade active alarm in concert with the visual alarm annunciation on the display, using the same color palette (red, yellow or cyan).



### Audio Alarm Notifications

Alarm conditions produce specific audio tones based on their alarm level.

**Red Alarm** A red alarm produces a high alarm level tone of three chime tones separated by one-second intervals.

**Yellow Alarm** A yellow alarm produces a medium alarm level tone of a set of two chime tones separated by two-second intervals.

**Cyan Alarm** A cyan alarm produces a low alarm level tone of a single chime tone separated by three-second intervals.

### Audio Annunciation Type

Each alarm condition has an associated annunciation type. The annunciation type may be one of the following:

- **Persistent** - A persistent alarm annunciation continues as long as the alarming condition continues. An example of persistent alarm annunciations is the visual and audio alarm notifications associated with an Asystole alarm.

- **One-Time** - A One-Time alarm annunciation is performed only once with the annunciation ending once the clinician silences the condition even if the alarm condition is still current. An example of a one-time alarm annunciation is a Low Battery technical alarm.

### Audio Silence

Selecting the Alarm Silence quick-action key on the main screen silences the audio notifications for the current alarm condition for the configured time period. During the alarm audio silenced period, the visual alarm notifications continue to display on the main screen for the duration of the alarm condition. If the alarm audio silenced period expires and the alarm condition continues, the audio alarm notifications resume.

When the Surveyor S12 or S19 patient monitor is actively communicating to a Surveyor Central Station, silencing an alarm is communicated bidirectionally between the patient monitor and the Surveyor central station.

- Silencing an alarm at the central station silences that alarm at the patient monitor.
- Silencing an alarm at the patient monitor silences that alarm at the central station.

During an alarm audio silenced period, the audio for the active alarm condition is the only alarm that is silenced. If a different alarm condition occurs during this time, the new alarm condition produces audio and visual alarm notifications as configured.

### Alarm Paused/Suspend

The ability to suspend all alarms is a configurable feature determined by the system administration and is protected behind a password. Contact the system administrator for further details.



**WARNING:** *IF this feature is enabled, suspending all alarms suspends ALL alarm conditions **including** the lethal arrhythmias (VFib, VTach, and Asystole). Use this feature with extreme caution as alarm checking is suspended for **all** alarm conditions **including** the lethal arrhythmias (VFib, VTach, and Asystole). Patients must be closely observed if all alarms are suspended.*

**NOTE:** *Follow hospital standard of care for the use of this feature. This feature is only intended to be used during end of life situations and only based on the hospital standard of care.*

**NOTE:** *This feature can be enabled/disable by the system administrator.*

When this feature is enabled, during an Alarm Suspend mode, an Alarm Suspend message appears in the messaging area of the main screen. Once the Alarm Suspend period ends the audio and visual alarm notifications automatically resume.

When the Surveyor S12 or S19 patient monitor is actively communicating to a Surveyor Central Station and this feature is enabled at the patient monitor, alarm suspension is communicated bidirectionally between the patient monitor and the Surveyor central station.

- Suspending an alarm at the central station suspends that alarm at the patient monitor.
- Suspending an alarm at the patient monitor suspends that alarm at the central station.

When this feature is enabled, to enter the All Alarms Suspended Mode and suspend **all** alarm notifications (including VFib, Vtach, and Asystole):

1. Select the Setup quick-action key on the main screen.
2. Select the Alarm Suspend button in the Setup menu.
  - This displays the “Alarms Suspended” message in the message area on the main screen.
  - **ALL** alarms are now suspended including the lethal arrhythmias (VFib, Vtach, and Asystole).
3. Select the Close button to close the Setup menu.

When this feature is enabled, to exit the All Alarms Suspended Mode and resume alarm notifications:

1. Select the Setup quick-action key on the main screen.
2. Select the Alarm Resume button in the Setup menu.
  - This removes the “Alarms Suspended” message in the message area on the main screen.
  - All configured alarms are now active.
3. Select the Close button to close the Setup menu.

### Alarm Off Icon

The Alarm Off icon indicates that one or more subsets of that parameter’s alarm settings are disabled. For example, if the Respiration low limit is set to Off and the Respiration high limit is set to a valid limit, the Alarm Off icon displays in the Respiration digital parameter tile.

The Alarm Off icon  displays in the digital parameter tile as per definition.

### Alarm Latching

For certain alarms the visual and audio alarm notifications continue even after the condition that caused the alarm has resolved. This is called Alarm Latching. Once the alarm condition resolves, a latched alarm continues with the audio and visual alarm notifications. Alarm Latching is intended to notify the clinician that an important episode occurred that requires patient interaction. After assessing the patient and resolving the alarm condition, the alarm must be acknowledged by the clinician.

The lethal arrhythmias (VFib, VTach, and Asystole) are always latched alarms.

Once the patient is assessed and the alarm condition is resolved, the clinician can acknowledge a latched alarm by doing either of the following:

- Select the Alarm Silence quick-action key on the main screen.
- Acknowledging the alarm from the Surveyor Central monitoring station.

When the Surveyor S12 or S19 patient monitor is actively communicating to a Surveyor Central, acknowledging the latched alarm is communicated bidirectionally between the patient monitor and the Surveyor central station.

- Acknowledging a latched alarm at the central station acknowledges that latched alarm at the patient monitor.
- Acknowledging a latched alarm at the patient monitor acknowledges that latched alarm at the central station.

### Alarm Delay

If Alarm Delay is enabled by the facility’s system administrator alarms are indicated after a specific delay time. This alarm delay is designed to lessen erroneous false alarm calls sometimes associated with brief, transient fluctuations in parameter data. The alarm delay values are based on the specific parameter and as follows:

Parameter	Lower limit violation delay	Upper limit violation delay
HR, PR (from SpO2), PR (from IBP)	3 seconds	3 seconds
RR	5 seconds	5 seconds
Mortara SpO2, Nellcor SpO2 (SatSeconds disabled)	10 seconds	10 seconds
IPI	10 seconds	0 seconds
Nellcor SpO2 (SatSeconds enabled), all other parameters	0	0

## Multiple Active Alarms: Hierarchy of Display

### Different Alarm Priorities

If multiple alarm conditions having **different** alarm priorities occur, the monitor produces alarm visual and audio notifications for the alarm condition having the highest alarm level. For example, if VTach (red high level alarm) occurs and a low SpO2 alarm (configured to be a yellow, medium level) also occurs, the higher level VTach alarm produces the visual and audio alarm notifications.

### Same Alarm Priorities

If multiple alarm conditions having the **same** alarm level occur, the monitor produces alarm visual and audio notifications based on the highest alarm level and scrolls the alarm messages for each of those highest alarm level conditions in the alarm messaging area. For example, if a high HR alarm (configured to be a yellow, medium level) occurs and a low SpO2 alarm (configured to be a yellow, medium level alarm) is also occurring, the medium level audio tone is produced, the HR and SpO2 tiles flash in yellow, and the alarm messaging area scrolls the High HR alarm and Low SpO2 alarm in the yellow background.

## Automatic Print on Alarm

Alarm conditions can be configured to automatically print a real-time waveform report when the alarm occurs. If a parameter is configured to automatically print on an alarm condition, a real-time waveform report may be printed at the bedside thermal recorder and the Surveyor Central Station based on the system configuration settings.

On the patient monitor's printout, the alarm condition message and corresponding numeric parameter (as applicable) is located at the beginning of the printed waveform report. The waveforms printed at the bedside recorder are based on the configuration settings in the Setup> Setup Recorder dialogue. Refer to the Setup Recorder dialogue in this manual for further details.

There are two ways to enable/disable an automatic print on alarm for a numeric parameter-

1. Select the numeric parameter tile to open the numeric parameter dialogue.
  - a. Locate the Print on Alarm button.
    - Selecting Yes produces the automatic printout for that numeric parameter.
    - Selecting No disables the automatic printout for that numeric parameter.
  - b. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

2. Select the Settings quick-action key.
  - a. Select the Alarms button in the Setup menu.
  - b. Locate the parameter and the Print On Alarm column.
    - Selecting Yes produces the automatic printout for that numeric parameter.
    - Selecting No disables the automatic printout for that numeric parameter.
  - c. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

To enable/disable an automatic print on alarm for an arrhythmia alarm condition:

1. Select the Setup quick-function button on the main screen.
2. Select the Arrhythmia button in the Setup menu.
3. Locate the arrhythmia and the Print On Alarm column.
  - a. Selecting Yes produces the automatic printout for that arrhythmia condition.
  - b. Selecting No disables the automatic printout for that arrhythmia condition.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Adjusting Alarm Limits

Numeric parameters are associated with adjustable alarm limit settings. Ensure that numeric parameter alarm limit settings are appropriate for the patient. Use patient-specific customization to maximize the provision of safe patient care and to minimize false alarm calls.

When the Surveyor S12 or S19 patient monitor is actively communicating to a Surveyor Central Station, alarm limit changes are communicated bidirectionally between the patient monitor and the Surveyor central station.

- Adjusting an alarm limit at the central station adjusts that alarm limit at the patient monitor.
- Adjusting an alarm limit at the patient monitor adjusts that alarm limit at the central station.

## Adjusting Non-ST Numeric Parameter Alarm Limits

There are two ways to adjust the numeric parameter's alarm limits at the patient monitor:

1. Select the numeric parameter tile.
  - a. Adjust the Upper alarm limit by selecting the up/down arrows to move the upper alarm limit box until the desired value is reached.
  - b. Adjust the Lower alarm limit, select the up/down arrows to move the lower alarm limit box until the desired value is reached.
  - c. Select the OK button to enter that change OR select the Cancel button to cancel the changes.
2. Select the Settings quick-action key.
  - a. Select the Alarms button in the Setup menu.
  - b. Locate the numeric parameter.
    - Adjust the Upper alarm limit by selecting the up/down arrows to move the upper alarm limit box until the desired value is reached.
    - Adjust the Lower alarm limit, select the up/down arrows to move the lower alarm limit box until the desired value is reached.
  - c. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

Refer to the specific parameter's section in this manual for further details.

## Adjusting ST Alarm Limits

1. Select the ST parameter tile:
  - a. Locate the ST Change Alarm Limit.
  - b. Select the up/down arrows to move the ST alarm limit box until the desired value is reached.
  - c. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

Refer to the ST section in this manual for further details.

## Adjusting Alarm Levels

Patient physiological alarm conditions are associated with an alarm level. Some of these parameter's alarm levels can be adjusted by the clinician while other parameter's alarm levels cannot be changed.

When the Surveyor S12 or S19 patient monitor is actively communicating to a Surveyor Central Station, alarm level changes are communicated bidirectionally between the patient monitor and the Surveyor central station.

- Adjusting an alarm level at the central station adjusts that alarm level at the patient monitor.
- Adjusting an alarm level at the patient monitor adjusts that alarm level at the central station.

### Lethal Arrhythmia Alarm Levels

The three lethal arrhythmias (VFib, VTach, and Asystole) are always considered red high alarm levels. The lethal arrhythmia alarm levels cannot be adjusted by the clinician.

### Non-Lethal Arrhythmia Alarm Levels

Figure 28 Setup Arrhythmia Dialogue

Arrhythmia	Limit	Alarm Level	Print on Alarm
VFib		LETHAL	No Yes
Asystole		LETHAL	No Yes
VTach Rate	125	LETHAL	No Yes
VTach Count	6		
VRun		OFF	No Yes
VRhythm		OFF	No Yes
Couplet		LOW	No Yes
PVC/min	30	MED	No Yes
Bigeminy		MED	No Yes
Tachycardia	170	OFF	No Yes
Bradycardia	30	OFF	No Yes
Pause		OFF	No Yes
Irregular		OFF	No Yes
NonCapture		OFF	No Yes

To adjust an alarm level for a non-lethal arrhythmia:

1. Select the Setup quick-action key on the main screen.
2. Select the Arrhythmia button in the Setup menu.
3. Locate the non-lethal arrhythmia.
4. Locate the Alarm Level column.
5. Select the arrow to display the list box of available alarm level choices (MED, LOW, or OFF).
  - a. Select MED to make that non-lethal arrhythmia a yellow medium level alarm level.
  - b. Select LOW to make that non-lethal arrhythmia a cyan low level alarm level.
  - c. Select OFF to disable that non-lethal arrhythmia. If the alarm level is set to OFF, the patient monitor does not product alarm notifications for that non-lethal arrhythmia.
  - d. Tachycardia and Bradycardia have the choices of HIGH or OFF for the alarm level.
6. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### Non-ST Numeric Parameter Alarm Levels

If enabled, non-ST numeric parameters are medium alarm levels and cannot be adjusted by the clinician.

## ST Alarm Levels

The alarm level for the ST parameter is adjusted via the ST numeric parameter tile. To adjust the ST alarm level:

1. Select the ST numeric parameter tile.
2. Locate the ST Increase Alarm Level condition.
3. Select the arrow to display the list box of available alarm level choices (MED, LOW, or OFF).
  - a. Select MED to make the ST Increase alarm a yellow medium level alarm level.
  - b. Select LOW to make the ST Increase alarm a cyan low level alarm level.
  - c. Select OFF to disable the ST Increases alarm . If the alarm level is set to OFF, the patient monitor does not product alarm notifications for the ST Increase alarm condition.
4. Locate the ST Decrease Alarm Level condition.
5. Select the arrow to display the list box of available alarm level choices (MED, LOW, or OFF).
  - a. Select MED to make the ST Decrease alarm a yellow medium level alarm level.
  - b. Select LOW to make the ST Decrease alarm a cyan low level alarm level.
  - c. Select OFF to disable the ST Decrease alarm. If the alarm level is set to OFF, the patient monitor does not product alarm notifications for the ST Increase alarm condition.
6. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Alarm Auto Set

The Auto set feature automatically calculates the high and low alarm limits based on the current value for that numeric parameter. The Auto set feature does not apply to the Arrhythmia, ST, or Cardiac Output parameters.

To Auto set an alarm:

- Select the numeric parameter tile.
- Select the Auto quick button in the parameter setup menu.
- Select the OK button to enter that change OR select the Cancel button to cancel the changes.

Refer to the following table for the auto set percentages of alarm limit adjustment.

Parameter	Lower limit adjustment	Upper limit adjustment
HR, PR, RR	Changes to 80% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Changes to 125% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)
EtCO <sub>2</sub>	Changes to 80% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Changes to 120% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)
FiCO <sub>2</sub>	Not applicable	Changes to 200% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)
IPI	Changes to 80% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Not applicable
SpO <sub>2</sub>	Changes to 95% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Set to 100%
Ps, Pm, Pd, P2s, P2m, P2d, P3s, P3m, P3d, P4s, P4m, P4d, NIBPs, NIBPm, NIBPd	Changes to 80% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Changes to 120% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)
T1, T2, ΔT	Changes to 95% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Changes to 105% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)
NIBPs, NIBPm, NIBPd	Changes to 80% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Changes to 120% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)

## Alarm Interfaces

### Alarm Output/Nurse Call

The Alarm Output/Nurse Call provides an “open collector” relay driver that can be used to remotely annunciate or illuminate an audible or visual alarm as needed. The monitor interface is a 1/8-inch stereo audio jack type connector and the cable can be linked to an audible or visual alarm as needed.

The Alarm Output/Nurse call interface is a single-close-on-alarm interaction.

Signals will not be sent out if the monitor is in the alarm paused or alarm off state.

### Surveyor Central Station

If the Surveyor patient monitor is connected to Surveyor Central monitoring station, alarms may be acknowledged, suspended or otherwise inactivated remotely through Surveyor Central monitoring station.

Refer to the Surveyor Central Monitoring Station User’s Manual for further details.

## 13. ECG MONITORING

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### Overview

The ECG monitoring capabilities of the Surveyor patient monitor includes:

- Simultaneous display of multiple ECG tracings.
- An All ECG mode that displays up to seven tracings of ECG when using a 5-wire lead set.
- An All ECG mode that displays up to twelve tracings of ECG in a split-screen format when using the AM12.
- Display, analysis and interpretation of all 12 leads when using the AM12 12-Lead ECG Acquisition Module and in diagnostic mode.
- Calculating the average heart rate in beats per minute (based on analysis of the top displayed ECG lead, or Lead II if no ECG lead is displayed).
- Detecting Asystole and Ventricular Fibrillation (performed on the same lead as the heart rate calculation).
- Pacer pulse detection (performed on Lead II).
- Generating an audible pulse tone for each detected beat.
- Monitoring of Arrhythmia conditions as configured.
- Monitoring of ST segments as configured.

### Quality ECG Data Acquisition

Obtaining quality ECG data is important in continuous ECG monitoring. A quality ECG signal depends largely on the patient prep and electrode placement. Direct contact between the electrodes and the patient's skin and correct placement of the electrode can help ensure obtaining quality ECG data.

A good quality ECG contains:

- Discernible P waves, QRS complexes, and T waves.
- Good R wave detection.
- Steady, even, crisp baseline.
- Absent of respiratory variability, artifact, noise, and other interference.

A good quality ECG may enhance the performance of the arrhythmia algorithm and may lessen false erroneous alarm notifications.

A poor quality ECG may be caused by many factors:

- Poor site preparation may lead to poor quality ECG data.
- Poor electrode application may lead to poor quality ECG data.
- Patient movement may lead to poor quality ECG data.
- Interference by other equipment in the room may lead to poor quality ECG data.
- Poor quality ECG becomes synonymous with artifact and interference in the ECG waveforms.

A poor quality ECG may manifest in several ways:

- Superfluous baseline artifact.
- Erratic baseline.
- Sharp “spikes.”
- Rolling, wandering waveforms as seen with patient breathing patterns.
- Difficult to discern P waves from atrial fib waves from noise.
- Poor R wave detection.
- Inability to discern P waves, QRS complexes, T waves.

Artifact and interference in the ECG waveforms may be caused by using accessories, lead wires, and ECG cables other than those specified to work with the Surveyor patient monitors. Always use accessories, lead wires, ECG cables, and other accessories specified to work with the Surveyor patient monitors.

## Skin Preparation

In continuous ECG monitoring, the goal of skin preparation is to maximize the surface area of direct contact between the patient's skin and the ECG electrode. Follow the facility's standard of care when preparing the patient's skin for ECG electrode placement and ECG monitoring.

To prepare the patient's skin for electrode placement:

1. Explain the procedure to the patient.
2. Maintain patient privacy during skin prep and electrode placement.
3. Locate the correct anatomical landmarks for electrode placement.
4. Clip or shave excess hair in the areas marked for electrode placement.
5. Remove residual skin oils, creams, and lotions by gently abrading the skin with a small gauze pad.

***NOTE:** With elderly or frail patients take care to not abrade the skin causing discomfort or bruising. Clinical discretion should always be used in patient preparation.*

## Electrode Placement

To apply electrodes:

1. Use pre-gelled, Ag/AgCl disposable electrodes.
  - a. Do not use electrodes after their expiration date, or if the gel has dried out.
    - Store electrodes in an air tight container.
    - Electrodes dry out if not stored properly leading to loss of adhesion and conductivity.
  - b. Always use the same electrodes.
    - Do not mix electrode brands or types.
    - Using different types of electrodes may cause a fluctuation in the impedance and this can lead to baseline artifact and noise in the ECG tracing.
2. Apply the electrodes in the following manner:
  - a. Attach the electrode to the ECG lead wires prior to attaching the electrode to the patient's chest.
  - b. Place the electrode in the properly prepared, correct location by using a circular motion on the electrode adhesive area.
  - c. Gently press the electrode adhesive to the patient's skin until the entire outer surface of the electrode is adhered to the patient's chest.
  - d. Once the electrode adhesive is attached, gently press on the gel area to ensure proper gel to chest contact. Avoid dislodging the gel as the displaced gel can increase baseline artifact and noise in the ECG tracing.
  - e. Test for firm electrode contact by slightly tugging on the electrode to check for adhesion among the entire electrode surface. If the electrode moves freely, change the electrode. If the electrode does not move easily, a good adhesive contact has been obtained.

Refer to the Electrode Location section in this manual for further details on correct anatomical landmarks for electrode placement.

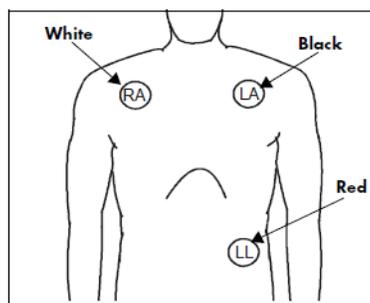
**Best Practice Recommendation:** Change electrodes as per hospital standard of care, or at least every 24 hours to enhance patient skin care and the acquisition of quality ECG data. Clinical discretion should always be used in patient preparation.

## Electrode Locations

The ECG electrodes sense the electrical signals generated by the electrical activity of the heart as it beats. The Surveyor patient monitor amplifies the signals so they can be displayed on the screen. The Surveyor patient monitor uses a 3-lead, 5-lead ECG cable set or the AM12 12-Lead ECG Acquisition Module. The 3-lead ECG cable set provides monitoring of ECG vectors I, II and III. The 5-lead ECG cable set supports the following ECG vectors: I, II, III, V, AVL, AVR, and AVF. The AM12 12-Lead ECG Acquisition Module supports the following ECG vectors: I, II, III, AVL, AVR, AVF, V1, V2, V3, V4, V5, and V6.

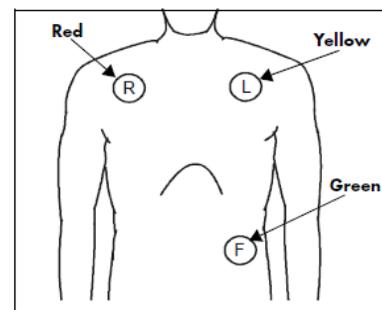
### Using a 3-Wire ECG Lead Set

**Figure 29 Electrode Locations: 3-Wire Lead Set**



**3-Wire Lead Placement (AHA)**

- Place the RA (white) electrode under the patient's right **clavicle**, at the midclavicular line within the rib cage frame.
- Place the LA (black) electrode under the patient's left clavicle, at the midclavicular line within the rib cage frame.
- Place the LL (red) electrode on the patient's lower left abdomen within the rib cage frame.

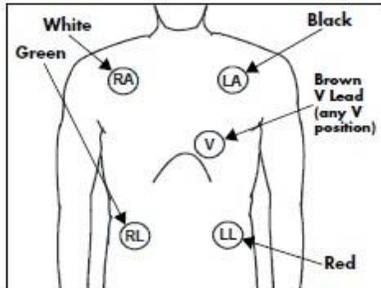


**3-Wire Lead Placement (IEC)**

- Place the R (red) electrode under the patient's right **clavicle**, at the midclavicular line within the rib cage frame.
- Place the L (yellow) electrode under the patient's left clavicle, at the midclavicular line within the rib cage frame.
- Place the F (green) electrode on the patient's lower left abdomen within the rib cage frame.

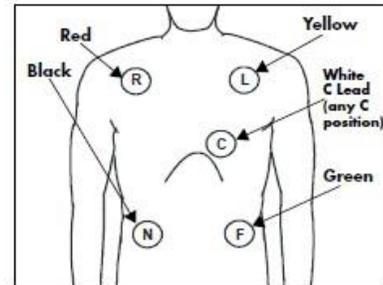
## Using a 5-Wire ECG Lead Set

Figure 30 Electrode Locations: 5-Wire Lead Set



5-Wire Lead Placement (AHA)

- Place the RA (white) electrode under the patient's right clavicle, at the midclavicular line within the rib cage frame.
- Place the LA (black) electrode under the patient's left clavicle, at the midclavicular line within the rib cage frame.
- Place the LL (red) electrode on the patient's lower left abdomen within the rib cage frame.
- Place the RL (green) electrode on the patient's lower right abdomen within the rib cage frame.
- Place the V (brown) electrode in one of the V-lead positions (V1 – V6) depicted in the following section.

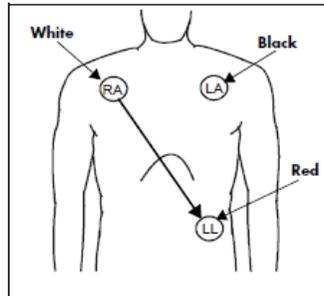


5-Wire Lead Placement (IEC)

- Place the R (red) electrode under the patient's right clavicle, at the midclavicular line within the rib cage frame.
- Place the L (yellow) electrode under the patient's left clavicle, at the midclavicular line within the rib cage frame.
- Place the F (green) electrode on the patient's lower left abdomen within the rib cage frame.
- Place the N (black) electrode on the patient's lower right abdomen within the rib cage frame.
- Place the C (white) electrode in one of the C-lead (C1 – C6) positions depicted in the following section.

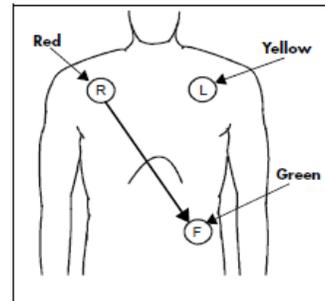
## Lead II Monitoring

**Figure 31 Electrode Locations: Lead II Monitoring**



**Lead II Monitoring (AHA)**

- Place the RA (white) electrode under the patient's right clavicle, at the midclavicular line within the rib cage frame.
- Place the LA (black) electrode under the patient's left clavicle, at the midclavicular line within the rib cage frame.
- Place the LL (red) electrode on the patient's lower left abdomen within the rib cage frame.

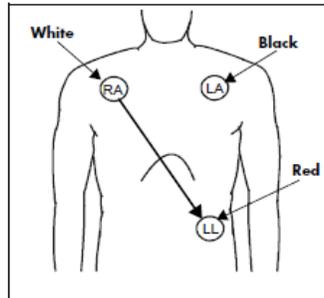


**Lead II Monitoring (IEC)**

- Place the R (red) electrode under the patient's right clavicle, at the midclavicular line within the rib cage frame.
- Place the L (yellow) electrode under the patient's left clavicle, at the midclavicular line within the rib cage frame.
- Place the F (green) electrode on the patient's lower left abdomen within the rib cage frame.

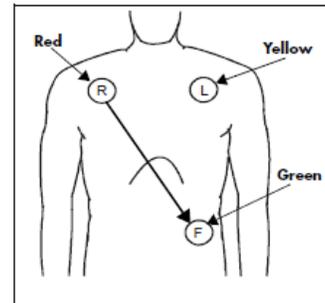
## Modified Chest Lead (MCL) Monitoring

Figure 32 Electrode Locations: MCL Monitoring



### MCL Monitoring with 3-Wire Lead Set (AHA)

- Place the RA (white) electrode under the patient's left clavicle, at the midclavicular line within the rib cage frame.
- Place the LA (black) electrode on the right sternal border, at the fourth intercostal space within the rib cage frame.
- Place the LL (red) electrode on the patient's lower left abdomen within the rib cage frame.
- Select ECG Lead I for MCL<sub>1</sub> monitoring. Lead I is the direct electrical line between the RA (white) electrode and the LA (black) electrode.
- Select ECG Lead II for MCL<sub>6</sub> monitoring. Lead II is the direct electrical line between the RA (white) electrode and the LL (red) electrode.



### MCL Monitoring with 3-Wire Lead Set (IEC)

- Place the R (red) electrode under the patient's left clavicle, at the midclavicular line within the rib cage frame.
- Place the L (yellow) electrode on the right sternal border, at the fourth intercostal space within the rib cage frame.
- Place the F (green) electrode on the patient's lower left abdomen within the rib cage frame.
- Select ECG Lead I for MCL<sub>1</sub> monitoring. Lead I is the direct electrical line between the R (red) electrode and the L (yellow) electrode.
- Select ECG Lead II for MCL<sub>6</sub> monitoring. Lead II is the direct electrical line between the L (red) electrode and the F (green) electrode.

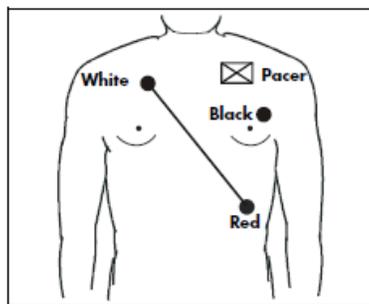
### Pacemaker Patients

Pacemaker patients may require a modified electrode placement based on the physical location of the patient’s pacemaker generator device. Do not place an ECG electrode directly over the pacemaker generator as this may lead to artifact and noise on the ECG tracings.

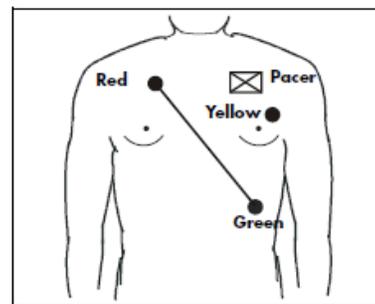
**Best Practice Recommendation:** Place the electrode patches 3 – 5 inches away from the pacemaker generator area. For example, if the pacemaker generator is located in the right subclavian area, relocate the Right Arm electrode closer in towards the center of the chest.

Use the following lead placement for monitoring pacemaker patients:

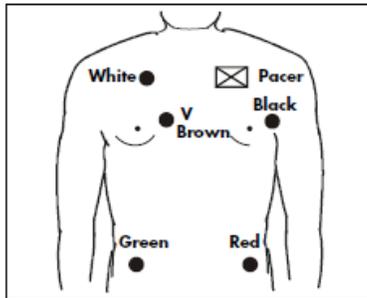
**Figure 33 Electrode Locations: Pacemaker Patients**



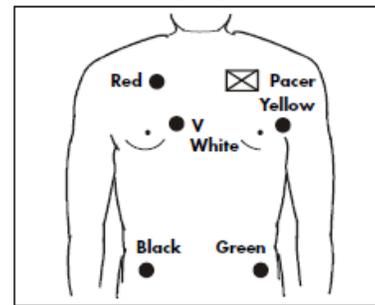
**3-Wire Lead Placement for Pacemaker Patients (AHA)**



**3-Wire Lead Placement for Pacemaker Patients (IEC)**



**5-Wire Lead Placement for Pacemaker Patients (AHA)**



**5-Wire Lead Placement for Pacemaker Patients (IEC)**

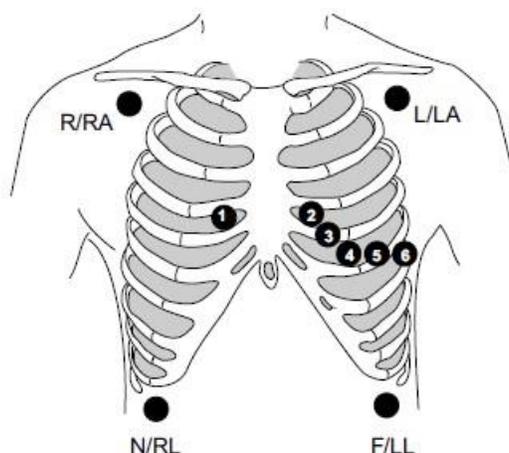
## Using the AM12 for Continuous ECG Monitoring

The Mortara AM12 may be used for continuous simultaneous monitoring of 12 vectors of ECG. Arrhythmia and ST analysis on all 12 ECG leads may be performed by the patient monitor when the AM12 is in use.

Refer to the Arrhythmia and ST sections in this manual for further details.

The following diagram describes the recommended electrode placement for using the AM12 in a continuous monitoring mode.

**Figure 34 Electrode Locations: Continuous 12-Lead Monitoring**



IEC	AHA	Lead Placement
R (red)	RA (white)	<i>Just below the right clavicle.</i>
L (yellow)	LA (black)	<i>Just below the left clavicle.</i>
N (black)	RL (green)	<i>Lower right edge of the rib cage.</i>
F (green)	LL (red)	<i>Lower left edge of the rib cage.</i>
C1 (white)	V1 (brown)	4th intercostal space, right sternal border.
C2 (yellow)	V2 (yellow)	4th intercostal space, left sternal border.
C3 (green)	V3 (green)	Midway between C2/V2 and C4/V4.
C4 (brown)	V4 (blue)	5th intercostal space, mid-clavicular line.
C5 (black)	V5 (orange)	Left anterior axillary line at C4/V4 level.
C6 (purple)	V6 (purple)	Mid-axillary line at C4/V4 and C5/V5 levels.

For accurate V-lead placement and monitoring, it is important to locate the 4<sup>th</sup> intercostal space. The 4<sup>th</sup> intercostal space is determined by first locating the 1<sup>st</sup> intercostal space. Because patients vary with respect to body shape, it may be difficult to palpate the 1<sup>st</sup> intercostal space with accuracy. Thus, locate the 2<sup>nd</sup> intercostal space by first palpating the little bony prominence called the **Angle of Lewis**, where the body of the sternum joins the manubrium. This rise in the sternum identifies where the second rib is attached, and the space just below it is the 2<sup>nd</sup> intercostal space. Palpate and count down the chest until the 4<sup>th</sup> intercostal space is located.

## Using the AM12 for Diagnostic Resting 12-Lead ECG Acquisition

The Mortara AM12 may be used for acquiring true diagnostic resting 12-lead data. The resting 12-Lead ECG function can also provide a diagnostic 12-Lead interpretive report. This feature allows the patient monitor to perform as a diagnostic resting 12-Lead ECG acquisition device and may limit the need for using an independent diagnostic resting 12-Lead acquisition device.

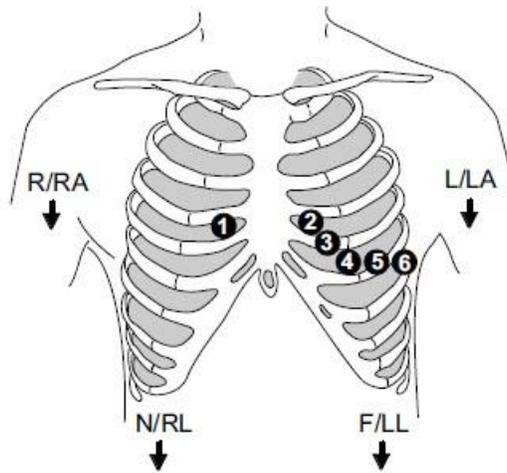
**Best Practice Recommendation:** To be truly diagnostic and comparable to standard resting 12-Lead data acquisition devices, it is recommended that the arm and leg electrodes be placed on the patient's arm and legs as per the following diagram prior to acquiring the resting 12-lead ECG.



**WARNING:** For full diagnostic quality, the 12-lead resting ECG should be printed on the Surveyor Central Station printer and not on the S12 or S19 strip chart recorder.

The following diagram describes the recommended electrode placement for using the AM12 in a diagnostic resting 12-Lead acquisition mode.

**Figure 35 Electrode Locations: Diagnostic Resting 12-Lead Acquisition**



IEC	AHA	Lead Placement
R (red)	RA (white)	<i>Right deltoid or wrist.</i>
L (yellow)	LA (black)	<i>Left deltoid or wrist.</i>
N (black)	RL (green)	<i>Right thigh or ankle.</i>
F (green)	LL (red)	<i>Left thigh or ankle.</i>
C1 (white)	V1 (brown)	4th intercostal space, right sternal border.
C2 (yellow)	V2 (yellow)	4th intercostal space, left sternal border.
C3 (green)	V3 (green)	Midway between C2/V2 and C4/V4.
C4 (brown)	V4 (blue)	5th intercostal space, mid-clavicular line.
C5 (black)	V5 (orange)	Left anterior axillary line at C4/V4 level.
C6 (purple)	V6 (purple)	Mid-axillary line at C4/V4 and C5/V5 levels.

For accurate V-lead placement and monitoring, it is important to locate the 4<sup>th</sup> intercostal space. The 4<sup>th</sup> intercostal space is determined by first locating the 1<sup>st</sup> intercostal space. Because patients vary with respect to body shape, it may be difficult to palpate the 1<sup>st</sup> intercostal space with accuracy. Thus, locate the 2<sup>nd</sup> intercostal space by first palpating the little bony prominence called the **Angle of Lewis**, where the body of the sternum joins the manubrium. This rise in the sternum identifies where the second rib is attached, and the space just below it is the 2<sup>nd</sup> intercostal space. Palpate and count down the chest until the 4<sup>th</sup> intercostal space is located.

## Checking the ECG Signal

Once the patient has been properly prepared, the electrodes attached and in the correct anatomical location, the patient ECG cable is connected to the Surveyor S12/S10, and the monitor is powered on, the main screen display should display the ECG tracing(s).

Check to ensure the ECG tracing is free of artifact and noise with a clean ECG baseline as per patient condition permits. If the ECG contains artifact or noise, review the steps for proper electrode site preparation and placement.

## ECG Waveform Tile

The waveform parameter tile located in the top position of the main screen is always reserved for an ECG waveform. The main screen normal display can display up to two ECG waveforms in waveform position 1 and 2. The ECG vectors displayed in waveform position 1 and 2 are configurable via the Setup HR/PR dialogue. Each ECG waveform tile contains the configured ECG waveform tracing, the lead label, and the cal pulse indicator.

**Figure 36 Example ECG Waveform Tiles**



## All ECG/12-Lead Display Mode

The Surveyor S12 and S19 patient monitors can display multiple ECG waveforms on the main screen. This All ECG view provides a real-time view of the available ECG waveforms. The waveforms available in the All ECG view are based on the ECG lead wire set configured for use in the Setup HR/PR dialogue. The All ECG mode is an additional view of the main screen. The All ECG view remains displayed until the clinician manually chooses to return to the normal main screen view.

When in the All ECG/12-Lead display mode-

- Numeric parameter tiles continue to display in real time.
- Visual and audio alarm notifications continue as configured.

When configured for a 5-wire ECG lead set, the All ECG mode can display up to seven ECG waveform vectors. When configured for a 12-lead ECG set, the All ECG mode displays all 12 ECG waveform vectors in a split screen format. Refer to the Setup HR/PR dialogue section in this manual regarding details on configuring ECG lead sets.

Figure 37 All ECG Mode: 5-Wire ECG Set



To enter the All ECG mode when using a 3-wire or 5-wire ECG lead set:

- Select the All ECG quick-action key on the main screen.
- The All ECG mode is now displayed.
- When in the All ECG view, the quick-action key re-labels to “Normal.”
- Select the Normal quick-action key to return to the main screen display.

When configured for a 12-lead ECG set, the All ECG quick-action key is re-labeled “12 Lead ECG.”

Figure 38 All 12 Lead ECG view



To enter the All ECG mode when using a 12-lead ECG lead set:

- Select the 12 Lead ECG quick-action key on the main screen.
- The all 12 Lead ECG view is now displayed.
- When in the 12 Lead ECG view, the quick-action key re-labels to “Normal.”
- Select the Normal quick-action key to return to the main screen display.

## Resting 12-Lead ECG Interpretation

The Surveyor patient monitor provides Mortara’s 12-lead resting ECG interpretation VERITAS algorithm when the AM12 12-Lead ECG Acquisition Module is utilized. This generates the 12-lead complexes, QRS measurements, and the interpretation statement.

To generate a resting ECG interpretation:

1. Enable the 12-lead via the Setup HR/PR dialogue.
2. Perform electrode site preparation as per hospital standard of care. Refer to Quality ECG section of this manual for future details.
3. Select the 12-Lead ECG quick-action key on the right side of the main screen.
4. Select the Analyze button to have the algorithm analyze the 12-lead data.
5. Select the Interp button to display the 12-lead interpretation on the display.
6. Select the Print button to print the 12-lead interpretive report.



**WARNING:** For full diagnostic quality, the 12-lead resting ECG should be printed on the Surveyor Central Station printer and not on the S12 or S19 strip chart recorder.

7. Select the Close button to close the 12-lead interpretation view and return to the main 12-lead view display.

Figure 39 Resting 12-Lead Interpretation



The resting 12-lead interpretation includes global measurements and a standard advisory statement stating that a 12-lead ECG obtained with torso-located limb electrodes is not equivalent to a conventional diagnostic ECG.

When connected to the Surveyor Central Station, the central station performs the 12-lead interpretation for the S12 and S19 patient monitors. This process may take several seconds to retrieve the analysis statements and display on the patient monitors. Do not attempt to re-analyze, re-interpret or re-print until the initial process has been completed and displays on the patient monitors.

Some resting 12-lead interpretation statements may be lengthy and extend beyond one screen/printed record.



**WARNING:** For full diagnostic quality, the 12-lead resting ECG should be printed on the Surveyor Central Station printer and not on the S12 or S19 strip chart recorder.

## 14. ECG/HEART RATE/PULSE RATE MONITORING

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### Overview

The Surveyor S12 and S19 patient monitors can monitor the patient's heart rate (pulse rate) parameter. Alarm limits can be enabled to detect high heart rate alarm conditions and low heart rate alarm conditions.

The algorithm calculates the heart rate from its available source:

- If the heart rate from the last four R to R intervals is greater than 48 beats per minute, the average heart rate is determined by averaging the last 16 R to R intervals.
- If the heart rate from the last four R to R intervals is less than or equal to 48 beats per minute, then this rate is used.
- Paced beats and PVCs are included in the heart rate calculation.

### Heart Rate/Pulse Rate Tile

Figure 40 Example HR Tile



The Heart Rate/Pulse rate numeric parameter tile may display:

- The parameter label.
- The current heart rate/pulse rate numeric value.
- The “BPM” (beats per minute) HR/PR units of measure label.
- The configured HR alarm limits if the HR alarm limits are enabled.
- The Alarm Off icon if either the high or low HR alarm limit is disabled.
- The “ARR” text to indicate arrhythmia analysis is enabled.
- The “Learning” text when the ARR/ST algorithm is in a learn period.

### HR/PR Alarm Behaviors

The HR tile flashes when in an high or low HR alarm condition. The alarm light, HR numeric parameter tile, and HR alarm message in the alarm message area of the main screen flashes and displays in the color of the configured HR alarm level.

When a lethal red high level arrhythmia occurs, the HR parameter tile, alarm light, and alarm message in the main screen alarm message area flashes and displays in red.

### Heart Rate/Pulse Rate Sourcing

The patient's heart rate (or pulse rate) is displayed in the color of its source. The HR/PR sourcing hierarchy can automatically obtain the parameter from the best available physiological source. The clinician may also manually configure a HR/PR source.

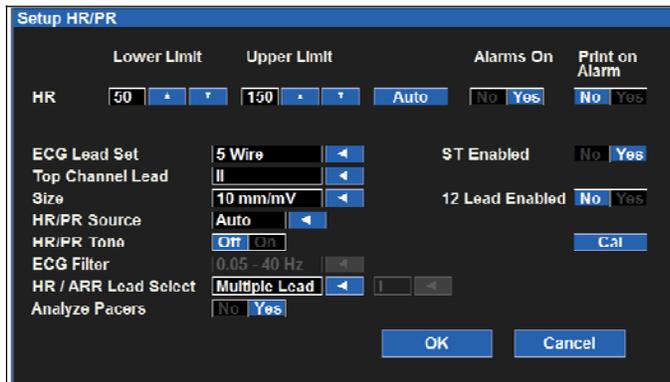
The HR/PR parameter may be sourced based on the following hierarchy:

- Heart Rate (HR): Green when the source is ECG.
- Pulse Rate (PR): Cyan when the source is SpO2.
- Pulse Rate (PR): Red when the source is the P1/ART invasive pressure.

## Setup HR/PR Dialogue

Select the HR/PR tile to open the Setup HR/PR dialogue. This dialogue is used to make adjustments in the ECG, Heart Rate (HR), and Pulse Rate (PR) parameters.

**Figure 41 Example Setup HR/PR Dialogue**



### HR/PR Alarm Limits

To adjust the HR/PR alarm limits:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
  - a. Adjust the Upper alarm limit by selecting the up/down arrows to move the upper alarm limit box until the desired value is reached.
  - b. Adjust the Lower alarm limit, select the up/down arrows to move the lower alarm limit box until the desired value is reached.
2. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The HR/PR alarm limits may also be adjusted via the Settings quick-action key. Refer to the Alarm Limits section in this manual for further details.

### Auto Set HR/PR Alarm Limits

The Auto set feature automatically calculates the high and low HR/PR alarm limits based on the current value.

Parameter	Auto Lower limit adjustment	Auto Upper limit adjustment
HR, PR	Changes to 80% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Changes to 125% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)

To Auto set an alarm:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Select the Auto button. Notice the limit values in the Lower Limit window and the Higher Limit window adjust.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## HR/PR Alarms On

The ability to disable the HR/PR alarms is a configurable feature determined by the system administration and is protected behind a password. Contact the system administrator for further details.



**WARNING:** *Disabling the HR/PR alarm limits means that NO low or high HR/PR alarm conditions will produce alarm notifications. Use this feature with extreme caution. Patients must be closely observed if the HR/PR alarm limits are disabled.*

**NOTE:** *Follow hospital standard of care for the use of this feature. This feature is only intended to be used during end of life situations and only based on the hospital standard of care.*

**NOTE:** *This feature can be enabled/disable by the system administrator.*

If configured by the system administrator to allow the clinician to enable/disable the HR/PR alarm limits:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the Alarms On button.
  - a. Select Yes to enable HR/PR alarms.
  - b. Select No to disable HR/PR alarms.
    - The Alarm Off icon is displayed in the HR/PR numeric parameter tile.

**NOTE:** *The Lower Limit and Higher Limit windows in the HR/PR dialogue may contain limit values but these alarms ARE disabled if the Alarms On button is set to NO.*

3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## HR/PR Print on Alarm

High and Low HR/PR alarm limit conditions can be configured to automatically print a real-time waveform report when the alarm occurs.

To enable/disable the HR/PR alarm limit conditions to automatically print:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the Print On Alarm button.
  - a. Select Yes to enable the Print On Alarm.
  - b. Select No to disable the Print On Alarm.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The Print On Alarm feature for the HR/PR alarm limit conditions may also be adjusted via the Settings quick-action key. Refer to the Print On Alarm section in this manual for further details.

## ECG Lead Set

The clinician must choose the ECG lead set in use on the patient. The ECG lead set chosen determines the number of ECG tracings available for display on the patient monitor's main screen and other settings within the user interface.

The choices for the ECG lead set are 3-wire and 5-wire lead sets. If 12-Lead is enabled and available, these choices are hidden. To re-enable the 3-wire and 5-wire choices, disable the 12 Lead in the Setup HR/PR dialogue or unplug the AM12.

To choose the proper ECG lead set:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the ECG Lead Set button.
  - a. Select the arrow to display the drop down list box with choices (3-wire, 5-wire).
  - b. Select the appropriate lead set.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### ECG 12-Lead Enabled

When using the AM12 12-Lead ECG Acquisition Module, the clinician must enable the patient monitor to recognize the AM12. Ensure the 12-lead is disabled when not in use.

To enable/disable the 12-lead:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the 12 Lead Enabled button.
  - a. Select Yes to enable the 12-lead feature.
  - b. Select No to disable the 12-lead feature.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

If 12-lead is enabled and the AM12 is plugged into the monitor, the ECG lead set choices are hidden. Disable the 12-lead to show the ECG lead set 3-wire and 5-wire choices.

### ECG Top Channel Lead

The Top Channel Lead provides the ability to change the ECG vector displayed in waveform position one on the patient monitor's main screen. The choices for the top channel lead are dependent upon the ECG lead set configured in the ECG Lead Set feature.

To adjust the top channel lead:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the Top Channel Lead label.
  - a. Select the arrow to display the drop down list box with choices (based on configured ECG lead set).
  - b. Select the appropriate lead.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### ECG Size

The Size feature provides the ability to adjust the size of the ECG vectors displayed on the patient monitor's main screen. The Size setting affects all ECG vectors that are displayed on the main screen.

To adjust the size of the ECG waveforms:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the Size label.
  - a. Select the arrow to display the drop down list box with choices (2.5 mm/mV, 5 mm/mV, 10 mm/mV, 20 mm/mV).
  - b. Select the appropriate lead.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## HR/PR Source

The HR/PR Source feature provides the ability to adjust which pulsatile source the monitor uses to provide the HR/PR audible beep tone.

To adjust the HR/PR Source:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the HR/PR Source button.
  - a. Select the arrow to display the drop down list box with choices (AUTO, ECG, SPO2, and P1 /ART).
  - b. Select the appropriate HR/PR source.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

**NOTE:** When no IBP channels are available, there is no P1/ART available as the HR/PR source

## HR/PR Tone

The HR/PR Tone feature provides the ability to configure an audio tone for each detected QRS complex or pulse. If the HR/PR Tone feature is enabled, an audio tone is produced for each systole beat detected.

To enable/disable the HR/PR systole audio tone:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the HR/PR Tone button.
  - a. Select Yes to enable the HR/PR systole audio tone.
  - b. Select No to disable the HR/PR systole audio tone.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

When the HR/PR Source defined as SPO2 or AUTO with HR/PR determined by ECG, the HR/PR tone will decrease in accordance to the patient's SpO2 level. This is intended to provide audible feedback during a procedure, such as surgery, without requiring constant viewing of the oxygen saturation level.

## ECG Filter

The ECG Filter allows for filtering of the ECG signal depending on the type of cable currently in use. Specifically:

- With the 3/5-lead cable, choices for ECG filter are: "0.67 – 40 Hz" or "0.05 – 40 Hz".
- When AM12 is used (connected and enabled), the choices for ECG filter are "0.05 – 40 Hz" or "0.05 – 150 Hz".

## HR/ARR Lead Select

This feature defines the ECG leads used for heart rate calculation and arrhythmia analysis. The choices for this setting are dependent upon the configured ECG lead set.

**3-Wire ECG Lead Set:** Top Channel Lead as defined in the Setup HR/PR dialogue.

**5-Wire ECG Lead Set:**

- When configured to **Auto**, the ECG leads used for HR and ARR processing start with II and V for detection and III for confirmation while allowing the algorithm to switch to other available leads based on signal quality.
- When configured to **Single Lead**, the ECG lead used for HR and ARR processing is the one specified by the user from the set I, II, III, or V.
- When configured to **Multiple Leads**, the ECG leads used for HR and ARR processing are selected internally from the set II and V for detection, and III for confirmation.

When using a 5-wire ECG lead set, to select the HR/ARR Lead Select for analysis:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the HR/ARR Lead Select button.
  - a. Select the arrow to display the drop down list box with choices (Multiple Lead, Single Lead, Auto).
  - b. Select the appropriate choice.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

**AM12 12-Lead ECG Acquisition Module:**

- When configured to **Auto**, the ECG leads used for HR and ARR processing start with II and V5 for detection and V1 for confirmation while allowing the algorithm to switch to other available leads based on signal quality.
- When configured to **Single Lead**, the ECG lead used for HR and ARR processing is the one specified by the user from the set I, II, III, or V (V1).
- When configured to **Multiple Leads**, the ECG leads used for HR and ARR processing are selected internally from the set II and V5 for detection, and V1 for confirmation.

When using the AM12, to select the HR/ARR Lead Select for analysis:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the HR/ARR Lead Select button.
  - a. Select the arrow to display the drop down list box with choices (Multiple Lead, Single Lead, Auto).
  - b. Select the appropriate choice.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

**Analyze Pacers**

The Surveyor patient monitor may be configured to automatically reject pacer pulses rather than calling them as QRS complexes. The Analyze Pacer feature is enabled in the factory default configuration.

**Best Practice Recommendation:** When the patient has an implanted pacemaker generator, enable the Analyze Pacer feature. This should maximize the algorithm's ability to recognize pacemaker pulses and QRS complexes. Proper electrode placement is crucial in continuous ECG monitoring of the patient possessing an implanted pacemaker. Refer to the Electrode Locations section in this manual for further details on proper electrode location in the pacemaker patient.

When the Analyze Pacer function is enabled and the patient possesses an active pacemaker, the patient monitor displays an exaggerated tick mark at the point where a pacer pulse is detected on the ECG waveform. This pacer spike display may assist the clinician identification of pacer-initiated complexes.

***NOTE:** Proper clinical assessment and close surveillance is recommended for patients possessing pacemakers during continuous ECG monitoring. Do not rely entirely on rate meters for these patients.*

To enable/disable the system to automatically detect pacemaker pulses:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the Analyze Pacers button.
  - a. Select Yes to enable the automatic detection of pacemaker pulses.
  - b. Select No to disable the automatic detection of pacemaker pulses.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### ST Enabled

To enable/disable ST analysis:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the ST analysis button.
  - a. Select Yes to enable ST analysis.
  - b. Select No to disable ST analysis.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.



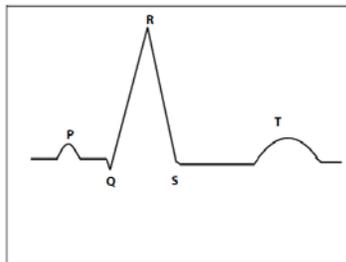
## 15. ECG ARRHYTHMIA MONITORING

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### Overview

The Surveyor S12 and S19 patient monitors use the Mortara arrhythmia algorithm to monitor the patient's ECG waveform data. This algorithm analyzes the patient's ECG waveform, "learns" the patient's ECG baseline, and establishes normal beat templates for that patient. The algorithm uses these beat templates to determine if the subsequent ECG beats are the same or different than the patient's normal ECG rhythm.

**NOTE:** *Arrhythmia monitoring is designed to assist the clinician, not replace the clinician's knowledge. The arrhythmia analysis is an adjunct to the clinician's knowledge and is not designed to replace clinical expertise.*



### Noise and Artifact

The Mortara arrhythmia algorithm uses several techniques to differentiate and filter noise from the ECG data. If too much ECG artifact occurs, the arrhythmia processing is hindered from properly analyzing the ECG data. Should this occur, the monitor will alert the clinician informing of the suspension of arrhythmia processing during this condition. This situation produces the cyan low priority visual and audio alarm notifications.



**WARNING:** *Arrhythmia processing is suspended during periods of high ECG artifact. The clinician should observe the patient directly should a high ECG artifact condition occur. The clinician should correct the cause of the artifact in the patient's ECG waveform to allow the algorithm to process the patient's ECG monitoring data.*

During periods of ECG artifact the Surveyor S12 and S19 patient monitors:

- Invalidates the heart rate numeric.
- Displays an "---" in the numeric value area in the HR/PR numeric parameter tile.
- Displays an Artifact low level technical message in system's message area.
- Produces the low level alarm audio tones.
- Displays the cyan low level alarm color in the alarm light.

The algorithm resumes processing of the patient's ECG monitoring data once the ECG artifact is cleared.

### Aberrant Beats

The Mortara arrhythmia algorithm is ventricular based and does not analyze P waves. Because of this, situations may occur where the monitor is challenged in differentiating aberrant supraventricular beats and true ventricular beats. In this situation, the algorithm may classify the aberrancy as ventricular. Patient experiencing aberrant conduction rhythms should be closely observed by a trained clinician.

## Atrial Rhythms

The Mortara arrhythmia algorithm is a ventricular based algorithm and does **not** analyze P waves. Identification of discrete atrial rhythms is not performed. Variance in the R to R interval such as occurs in Atrial Fibrillation is classified as an Irregular arrhythmia call.

## Arrhythmia/ST Algorithm Learning

The Arrhythmia/ST algorithm analyzes the patient's ECG waveform, "learns" the patient's ECG baseline, and establishes a normal beat template for that patient. This learning phase is how the Arrhythmia/ST algorithm collects ECG information to differentiate between the patient's normal ECG baseline and a change in the patient's ECG or QRS morphology.

A Learn updates the Arrhythmia/ST algorithm with the patient's most current ECG information. During a learning phase any previously stored arrhythmia templates are cleared from the algorithm.



**WARNING:** *Arrhythmia/ST learning should be initiated when the patient's dominant ECG rhythm is free of noise artifact, and is non-ventricular based. Beats may not be properly detected or may be classified erroneously if the learning phase occurs during a noisy ECG signal. If Arrhythmia/ST learning occurs when the patient's dominant ECG is ventricular, the ectopic ventricular beats may be classified as the normal QRS template. This may result in a missed detection of subsequent ventricular events such as PVC/min, Ventricular Run, Ventricular Rhythm, or even Ventricular Tachycardia. For optimal arrhythmia performance, ensure the patient's ECG waveform is noise-free and non-ventricular based during a Learn period.*

## Automatic Learn

The patient monitor automatically initiates an Arrhythmia/ST Learn in the following situations:

- Initial power up.
- Resumption of monitoring post-Standby.
- ST Enabled.
- After a change in the patient mode.

## Manual Relearn

A manual Arrhythmia/ST Learn should be initiated in the following situations:

- The patient's ECG baseline has changed.
- The patient's QRS morphology has changed.
- The patient's ECG rhythm has changed.
- After ECG electrodes have been repositioned.
- The clinician observes erroneous arrhythmia alarm notifications.
- The patient's ST baseline has changed.
- As per hospital standard of care.

Figure 42 ARR/ST Relearn: Setup Arrhythmia Dialogue

Arrhythmia	Limit	Alarm Level	Print on Alarm
VFib		LETHAL	No Yes
Asystole		LETHAL	No Yes
VTach Rate	125	LETHAL	No Yes
VTach Count	6		
VRun		OFF	No Yes
VRhythm		OFF	No Yes
Couplet		OFF	No Yes
PVC/min	30	OFF	No Yes
Bigeminy		OFF	No Yes
Tachycardia	170	OFF	No Yes
Bradycardia	62	OFF	No Yes
Pause		OFF	No Yes
Irregular		OFF	No Yes
NonCapture		OFF	No Yes

Buttons: Arrhythmia OFF, Presets, ARR / ST Relearn, OK, Cancel

To perform an Arrhythmia/ST Relearn using the Settings quick-action key:

- Select the Setup quick-action key on the main screen.
- Select the Setup Arrhythmia button in the Setup menu.
- Select the ARR/ST Relearn button.
- The “Learning” message is displayed in the heart rate numeric parameter tile during the learning period.

To perform an Arrhythmia/ST Relearn via the ST numeric parameter tile:

- Select the ST numeric parameter tile to display the Setup ST dialogue.
- Select the ARR/ST Relearn button.
- The “Learning” message displays in the heart rate numeric parameter tile during the learning period.

## Arrhythmia Analysis Methodology

There are three main components to the arrhythmia analysis algorithm: Beat detection, heart rate calculation, and beat typing.

### First Step: Beat Detection

**NOTE:** The QRS amplitude must be greater than 0.3 mV for the algorithm to detect. Ensure the QRS complexes are > 0.3 mV in amplitude to ensure accurate QRS detection.

The first step in the arrhythmia analysis is for the algorithm to detect the presence of QRS complexes.

- If no QRS complexes are present, a Ventricular Fibrillation (“VFib”) alarm is called.
- If QRS complexes are present, the algorithm then proceeds to the next step.

### Second Step: Heart Rate Calculation

The arrhythmia algorithm next calculates the heart rate from the ECG data.

- If the heart rate from the last four R to R intervals is greater than 48 beats per minute, the average heart rate is determined by averaging the last 16 R to R intervals.
- If the heart rate from the last four R to R intervals is less than or equal to 48 beats per minute, then this rate is used.
- Paced beats and PVCs are included in the heart rate calculation.

### Third Step: Beat Typing and Template Memory

The arrhythmia algorithm next begins matching beats according to their morphology. Templates are formed and retained for beat typing and matching of subsequent QRS complexes.

- The algorithm classifies each QRS complex into its template memory.
- The templates are internal and not viewable to the clinician.
- If the subsequent QRS complexes are not identical to the learned averaged QRS complex, then the arrhythmia algorithm follows a decision tree to determine the differences in the complex.
  - Normal Template: This is the most frequently-occurring, dominant beat. This excludes paced beats.
  - Ventricular Template: This is for detected ventricular beats such as premature ventricular beats.
  - Paced Template: This template is for detected pacemaker-initiated beats.
  - Unknown Template: This template is for non-QRS beat labels and for beats that cannot be determined.
- The arrhythmia algorithm classifies the abnormal beat and produces alarm notifications based on system configuration.

### ECG Leads Used for Analysis

#### 3-Wire ECG Lead Set

When using a 3-wire ECG lead set, the ECG processing and arrhythmia analysis is performed on the ECG vector displaying in top waveform position of the patient monitor's main screen. This vector is used to determine Heart Rate, beat detection, and Ventricular Fibrillation detection. The algorithm initiates a Relearn event if the ECG vector displayed in the top waveform position is changed thereby updating the algorithm inputs.

#### 5-Wire ECG Lead Set

When using a 5-wire ECG set, the leads used for ECG processing and arrhythmia analysis are configurable.

- When configured to **Auto**, the ECG leads used for HR and ARR processing start with II and V for detection and III for confirmation while allowing the algorithm to switch to other available leads based on signal quality.
- When configured to **Single Lead**, the ECG lead used for HR and ARR processing is the one specified by the user from the set I, II, III, or V.
- When configured to **Multiple Leads**, the ECG leads used for HR and ARR processing are selected internally from the set II and V for detection, and III for confirmation.

When using a 5-wire ECG lead set, to select the HR/ARR Lead Select for analysis

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the HR/ARR Lead Select button.
  - a. Select the arrow to display the drop down list box with choices (Multiple Lead, Single Lead, Auto).
  - b. Select the appropriate choice.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes

**12-Lead ECG:**

When using the AM12, the leads used for ECG processing and arrhythmia analysis are configurable.

- When configured to **Auto**, the ECG leads used for HR and ARR processing start with II and V5 for detection and V1 for confirmation while allowing the algorithm to switch to other available leads based on signal quality.
- When configured to **Single Lead**, the ECG lead used for HR and ARR processing is the one specified by the user from the set I, II, III, or V (V1).
- When configured to **Multiple Leads**, the ECG leads used for HR and ARR processing are selected internally from the set II and V5 for detection, and V1 for confirmation.

When using the AM12, to select the HR/ARR Lead Select for analysis:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the HR/ARR Lead Select button.
  - a. Select the arrow to display the drop down list box with choices (Multiple Lead, Single Lead, Auto).
  - b. Select the appropriate choice.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Arrhythmia Definitions

### Lethal Arrhythmias

A lethal arrhythmia is an arrhythmia that if left untreated may lead to patient death. The Surveyor patient monitor classifies Asystole, Ventricular Fibrillation (VFib), and Ventricular Tachycardia (VTach) as the three lethal arrhythmias. These lethal arrhythmias are red high level alarms and cannot be changed.

#### **Asystole**

Asystole is defined as a state of no cardiac electrical or mechanical activity. During Asystole, there is no myocardial contraction, no heart rate, and no cardiac output. The ECG waveform has no recognizable P, QRS, or T waves and is often referred to as cardiac standstill. Asystole is a lethal arrhythmia because there is no blood pumped out of the heart. Asystole requires rapid recognition and clinical intervention.

The algorithm uses a four-second Asystole delay to prevent erroneous false Asystole calls. Asystole is always a red high level alarm and cannot be changed. Asystole is always a latched alarm.

#### **Ventricular Fibrillation (VFib)**

Ventricular Fibrillation or "VFib" is when many ventricular foci are firing in rapid succession. The electrical activity in the ventricles is chaotic and the myocardium is twitching rather than contracting. There is no effective ventricular contraction, no heart rate, and no cardiac output. The ECG waveform is distinctively chaotic with no recognizable P, QRS, or T waves. VFib is a lethal arrhythmia because there is no blood pumped out of the heart. VFib requires rapid recognition and clinical intervention. VFib is called when there are no recognizable P, QRS, or T waves in a 5 second window.

VFib is always a red high level alarm and cannot be changed. VFib is always a latched alarm.

**Ventricular Tachycardia (VTach)**

Ventricular Tachycardia or “VTach” occurs when one or more ventricular foci fires in rapid succession. Because of the rapid ventricular fire, the ventricles may not have adequate time to fill. Therefore the cardiac output may be compromised. During early VTach, there may be small amounts of blood being pumped out of the heart but within seconds, the ventricular rate becomes so fast that there is limited ventricular chamber filling time so no blood gets pumped out of the heart. This arrhythmia is considered a lethal arrhythmia because the blood pumped out of the heart during VTach may be significantly compromised.

To detect VTach, the VTach rate threshold AND the PVC Run length must be exceeded. **Both** conditions must occur for a VTach alarm to be called.

**VTach Rate Threshold:** The VTach rate is calculated on a four beat average of the consecutive ventricular beats. The VTach rate threshold can be configured from 100-200 beats per minute. For a VTach condition to be considered, the rate of the ventricular rate must be greater than the configured VTach rate.

The VTach rate threshold is configured in the Setup Arrhythmia dialogue.

**VTach Count:** The VTach count or PVC run length is the number of consecutive ventricular beats in the waveform. They must be consecutive. A normal beat or an unknown beat will reset the PVC Run length. The VTach length can be configured from 3-20 consecutive ventricular beats. For a VTach condition to be considered, the length of the ventricular waveform must be greater than the configured VTach length.

The VTach count threshold is configured in the Setup Arrhythmia dialogue.

VTach is always a red high level alarm and cannot be changed. VTach is always a latched alarm.

**Non-Lethal Arrhythmia Classifications**

All other arrhythmias are classified as non-lethal arrhythmias. Non-Lethal arrhythmias are never latched alarms.

**Ventricular Run (VRun)**

A Ventricular Run or “VRun” is detected when the number of consecutive ventricular beats is less than or equal to the configured VTach count.

**Ventricular Rhythm (VRhythm)**

Ventricular Rhythm or “VRhythm” is detected when the rate of the ventricular beats is less than the configured VTach rate.

**Couplet**

Couplet is detected when the last 4 beats have the following sequence: N, V, V, N.

**PVC/min**

The PVC/min condition is detected when the number of PVCs over the past rolling minute is  $\geq$  the configured PVC per minute value. The PVC/min value may be configured to between 1-30 PVCs per minute.

**Bigeminy**

Ventricular Bigeminy or “Bigeminy” is detected when the last 9 beats have the following sequence: N, V, N, V, N, V.

**Pause**

A Pause condition is detected when an RR interval is more than 140% of the current 16-beat averaged heart rate, the previous beat is not a PVC, and the rhythm is not in the Irregular state. Compensatory pauses after a PVC are excluded and the call is not made during the "Irregular" rhythm.

**Irregular Rhythm**

An Irregular Rhythm is detected when the variance in the RR interval over the running averaging exceeds the limit established by the algorithm. The irregularity is computed in the following way:

$$\text{Irregularity} = \frac{\text{StandardDev}}{\text{RRMean}} * 100 \quad [10 \text{ ms units}]$$

**Tachycardia**

Tachycardia is detected when the averaged heart rate is 30 beats above the configured High Heart Rate alarm limit. Adjusting the High Heart Rate alarm limit automatically adjusts the tachycardia alarm limit.

**Bradycardia**

Bradycardia is detected when the averaged heart rate is 10 beats below the configured Low Heart Rate alarm limit. Adjusting the Low Heart Rate alarm limit automatically adjusts the bradycardia alarm limit.

**Non Capture**

This non-lethal arrhythmia is applicable to patients possessing a pacemaker device. A Non Capture condition is detected when there are no QRS complexes detected within 300ms after a pacemaker induced impulse. The used time interval is relatively large because atrial stimulation with normal ventricular conduction is included in the factoring.

## Arrhythmia Setup

Figure 43 Setup Arrhythmia Dialogue

Arrhythmia	Limit	Alarm Level	Print on Alarm
VFib		LETHAL	No Yes
Asystole		LETHAL	No Yes
V Tach Rate	125	LETHAL	No Yes
V Tach Count	6		
VRun		OFF	No Yes
VRhythm		OFF	No Yes
Couplet		OFF	No Yes
PVC/min	30	OFF	No Yes
Bigeminy		OFF	No Yes
Tachycardia	150	OFF	No Yes
Bradycardia	30	OFF	No Yes
Pause		OFF	No Yes
Irregular		OFF	No Yes
NonCapture		OFF	No Yes

Arrhythmia OFF

Presets

ARR / ST Relearn

OK

Cancel

To adjust Arrhythmia alarm settings:

1. Select the Setup quick-action key on the main screen.
2. Select the Arrhythmia button in the Setup menu.
3. Adjust the Arrhythmia alarm settings as desired.
  - To adjust the Alarm Level:
    - Locate the Alarm Level button.
    - Select the arrow to display the drop down list box with choices (OFF, LOW, MED).
    - Select the appropriate choice.
  - To adjust the Print on Alarm:
    - Locate the Print On Alarm button.
    - Select Yes to enable the Print On Alarm.
    - Select No to disable the Print On Alarm.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

VFib, Asystole and VTach may not be turned off, are only available as high level alarms, and are labeled as LETHAL.

To disable all the non-lethal arrhythmias with one action:

1. Select the Setup quick-action key on the main screen.
2. Select the Arrhythmia button in the Setup menu.
3. Select the Arrhythmia OFF button.
4. This action disables all the non-lethal arrhythmia alarms. Selecting OFF does NOT affect the alarm notifications for the LETHAL arrhythmias.
5. To re-enable a non-lethal arrhythmia, select the individual non-lethal arrhythmia and configure.

## Arrhythmia Settings

Arrhythmia	Limit Choices	Alarm Level Choices	Print on Alarm Choices
Asystole		<b>Lethal*+</b>	<b>No*</b> , Yes
VFib		<b>Lethal*+</b>	<b>No*</b> , Yes
VTach Rate	100-200 (* <b>125</b> )	<b>Lethal*+</b>	<b>No*</b> , Yes
VTach Count	3-20 (* <b>6</b> )		
VRun		<b>Off*</b> , Low, Med	<b>No*</b> , Yes
VRhythm		<b>Off*</b> , Low, Med	<b>No*</b> , Yes
Couplet		<b>Off*</b> , Low, Med	<b>No*</b> , Yes
PVC/min	1-30 (* <b>30</b> )	<b>Off*</b> , Low, Med	<b>No*</b> , Yes
Bigeminy		<b>Off*</b> , Low, Med	<b>No*</b> , Yes
Tachycardia	ADULT: 80-280 (* <b>150</b> ) PEDS: 80-280 (* <b>180</b> )	<b>Off*</b> , High	<b>No*</b> , Yes
Bradycardia	ADULT: 10-90 (* <b>40</b> )	<b>Off*</b> , High	<b>No*</b> , Yes
Pause		<b>Off*</b> , Low, Med	<b>No*</b> , Yes
Irregular		<b>Off*</b> , Low, Med	<b>No*</b> , Yes
Non Capture		<b>Off*</b> , Low, Med	<b>No*</b> , Yes

\* Factory Default Settings

+ Lethal alarms are the same as High priority alarms but highlighted as such due to their severity

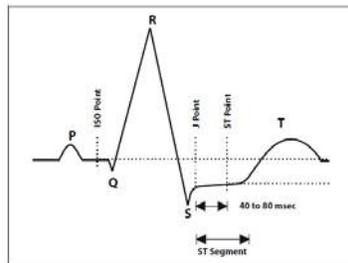
## 16. ECG ST MONITORING

### Overview

ST analysis is done through the ECG tracing. The ST segment is the area of the ECG from the end of the QRS complex to the beginning of the T wave. The computer utilizes an algorithm to identify specific points on the ECG and to detect very minor changes in the ST segment. The clinician can adjust the PR or ISO point, the J point, and the ST point to determine monitoring conditions.

The computer is assessing the ST segment for horizontal changes based on a learned template. The algorithm will “learn” the ST segment, establish that template as the “norm” for that patient, and use that template for pattern recognition on all ST segments thereafter. The ST segment is normally a horizontal isoelectric line. The ST segment may go above or below the isoelectric baseline depending upon the patient’s condition. An elevated ST segment or an ST segment that goes above the isoelectric line may indicate that the patient’s heart is in the process of being injured as in the case of a heart attack. A depressed ST segment or an ST segment that goes below the isoelectric line may indicate that the patient’s heart is in an ischemic state.

The Mortara ST algorithm analyzes the ST on ECG vectors available as configured. For each lead available and configured, the ST algorithm computes the current ST offset, and the delta ST offset (how much the current has changed from a reference value). During a learning period, the algorithm reviews the running 32 beats of ECG complexes and establishes the averaged ST for each available, configured lead.



The ISO point is defined as the area between the end of the P wave and the beginning of the QRS complex. This ISO point provides a baseline for determining the isoelectric line. The ST segment is defined as a fixed distance after the QRS complex (the “J point”) and the ST point. The algorithm compares the ST segment to its learned isoelectric line and reports the ST location value as equal to (the same as) the isoelectric line, elevated, or depressed.

ST measurements are factory defaulted to perform 60 ms after the detected J-point. The clinician can manually adjust the ST location via the Setup ST menu.

### Enable/Disable ST Analysis

Select the HR/PR tile to open the Setup HR/PR dialogue. This dialogue is used to enable/disable the ST analysis.

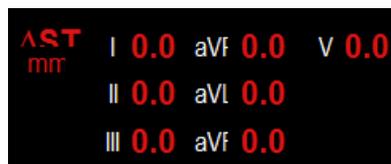
To enable/disable ST analysis:

1. Select the HR/PR numeric parameter tile to display the Setup HR/PR dialogue.
2. Locate the ST analysis button.
  - a. Select Yes to enable ST analysis.
  - b. Select No to disable ST analysis.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

After the ST analysis has been enabled, it is important to set a current reference by pressing “Set Reference” and selecting “Display Averages” to view current ST averages and confirming that averages are established correctly. Repeat this process whenever ECG-related alarms occur or as defined by clinical and hospital guidelines.

## ST Tile

Figure 44 Example ST Tile: Delta ST Values



The ST numeric parameter tile may display:

- The current or delta ST numeric values (configurable).
- The current ST numeric values are displayed in green.
- The delta ST numeric values are displayed in red.
- The current or delta ST label.
- The “REF” label and time stamp indicating the time of the last ST learn event.
- The ECG Lead labels.
- The “mm” ST units of measure label.

## ST Alarm Behaviors

The ST alarms are based on the relative variation between the current ST value and the value of the last reference ST values. Therefore the ST alarms are always based on the Delta ST value. The Surveyor patient monitor generates alarms when the ST variation exceeds the configured ST alarm settings. When the ST alarms are configured properly, the clinician can be notified when the patient’s ST value worsens (moving further away from isoelectric) and when the patient’s ST values improve (moving towards isoelectric).

### Physiological ST Alarms

The Surveyor patient monitor generates alarm conditions based on the ST-increase and ST-decrease values, according to the following rules:

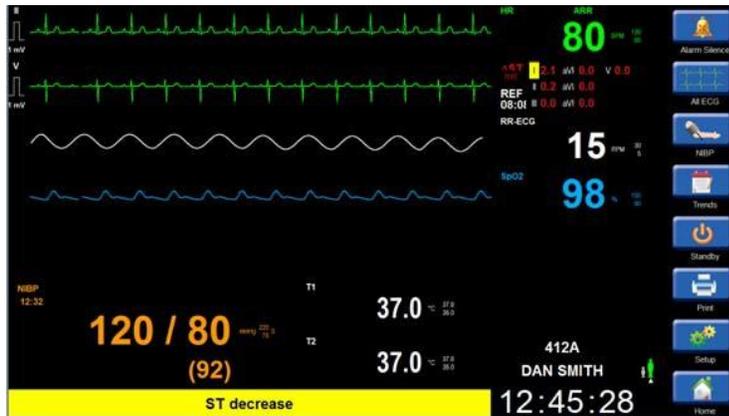
- **ST-Increase:** Delta ST is above configured threshold in a single lead or above 70% of the threshold in 2 leads simultaneously. The alarm sounds if the condition exists continuously for 60 seconds (independent of the lead(s)). This is a worsening condition.
- **ST-Decrease:** Delta ST is above configured threshold in a single lead or above 70% of the threshold in 2 leads simultaneously. The alarm sounds if the condition exists continuously for 60 s (independent of the lead(s)). This is an improving condition.

***NOTE:** The Surveyor S12/S19 will not automatically establish a new reference on ST alarm conditions. Establish a new reference when considered necessary.*

## ST Tile Alarm Behaviors

The ST parameter tile flashes the ECG lead label of the ECG vector that is causing the ST alarm condition. The alarm light, ST numeric parameter in alarm and ST alarm message displays in the color of the configured ST alarm level.

Figure 45 Example ST Decrease Alarm



## ST Alarm Delay

The Surveyor patient monitor supports an ST alarm delay of 60 seconds. This means the ST changes must be sustained for at least 60 seconds prior to any configured alarm notifications. This non-configurable ST alarm delay is implemented to reduce possible false erroneous ST alarms.

*NOTE: ST alarm events are not generated during a Learn phase, an ST Learn phase, Asystole, Ventricular Fibrillation, or Ventricular Tachycardia episodes. ST alarm events are not generated during periods of Low or High Frequency Suspend states.*

## Setup ST Dialogue

Figure 46 Setup ST Dialogue



## Arrhythmia and ST Algorithm Learning

The Arrhythmia/ST algorithm analyzes the patient's ECG waveform, "learns" the patient's ECG baseline, and establishes a normal beat template for that patient. This learning phase is how the Arrhythmia/ST algorithm collects ECG information to differentiate between the patient's normal ECG baseline and a change in the patient's ECG or QRS morphology.

A Learn updates the Arrhythmia/ST algorithm with the patient's most current ECG information. During a learning phase any previously stored arrhythmia templates are cleared from the algorithm.



**WARNING:** *Arrhythmia/ST learning should be initiated when the patient's dominant ECG rhythm is free of noise artifact, and is non-ventricular based. Beats may not be properly detected or may be classified erroneously if the learning phase occurs during a noisy ECG signal. If Arrhythmia/ST learning occurs when the patient's dominant ECG is ventricular, the ectopic ventricular beats may be classified as the normal QRS template. This may result in a missed detection of subsequent ventricular events such as PVC/min, Ventricular Run, Ventricular Rhythm, or even Ventricular Tachycardia. For optimal arrhythmia performance, ensure the patient's ECG waveform is noise-free and non-ventricular based during a Learn period.*

*Before starting ST-monitoring or issuing a "Relearn", make sure all leads are connected properly and ECG quality is adequate. An ST-reference is established during the ST learn period, and leads that are of poor quality or are disconnected during part of the learn period can result in incorrect reference values and false ST-alarms. Always check proper ST average complexes.*

### Automatic Learn

The patient monitor automatically initiates an Arrhythmia/ST Learn in the following situations:

- Initial power up.
- Resumption of monitoring post-Standby.
- After a change in the patient mode.

### Manual Relearn

A manual Arrhythmia/ST Learn should be initiated in the following situations:

- The patient's ECG baseline has changed.
- The patient's QRS morphology has changed.
- After ECG electrodes have been repositioned.
- The clinician observes erroneous arrhythmia alarm notifications.
- As per hospital standard of care.

There are two ways to perform an Arrhythmia/ST relearn.

1. To perform an Arrhythmia/ST Relearn via the ST numeric parameter tile:
  - a. Select the ST numeric parameter tile to display the Setup ST dialogue.
  - b. Select the ARR/ST Relearn button.
  - c. The "Learning" message displays in the heart rate numeric parameter tile during the learning period.
2. To perform an Arrhythmia/ST Relearn using the Settings quick-action key:
  - a. Select the Setup quick-action key on the main screen.
  - b. Select the Setup Arrhythmia button in the Setup menu.
  - c. Select the ARR/ST Relearn button.
  - d. The "Learning" message displays in the heart rate numeric parameter tile during the learning period.

## ST Alarm Levels

The Surveyor S12 and S19 patient monitors provide the ability to configure a different alarm level for an increase in the ST segment and a different alarm level for a decrease in the ST segment. This is beneficial based on the patient's specific cardiac condition.

To adjust the ST Increase/ST Decrease alarm levels:

1. Select the ST numeric parameter tile to display the Setup ST dialogue.
  - a. To adjust the ST Increase/ST Decrease Alarm Level-
    - Locate the ST Increase/ST Decrease Alarm Level buttons.
    - Select the arrow to display the drop down list box choices (OFF, LOW, MED).
    - Select the appropriate choice.
2. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## ST Print on Alarm

The ST Increase and the ST Decrease alarm conditions can be independently configured to automatically print a real-time waveform report when the alarm occurs.

To enable/disable the ST Increase/Decrease alarm limit conditions to automatically print:

1. Select the ST numeric parameter tile to display the Setup ST dialogue.
2. To adjust the ST Increase Alarm to print on alarm:
  - a. Locate the ST Increase Print On Alarm button.
    - Select Yes to enable the Print On Alarm.
    - Select No to disable the Print On Alarm.
3. To adjust the ST Decrease Alarm to print on alarm:
  - a. Locate the ST Decrease Print On Alarm button.
    - Select Yes to enable the Print On Alarm.
    - Select No to disable the Print On Alarm
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## ST Alarm Limits

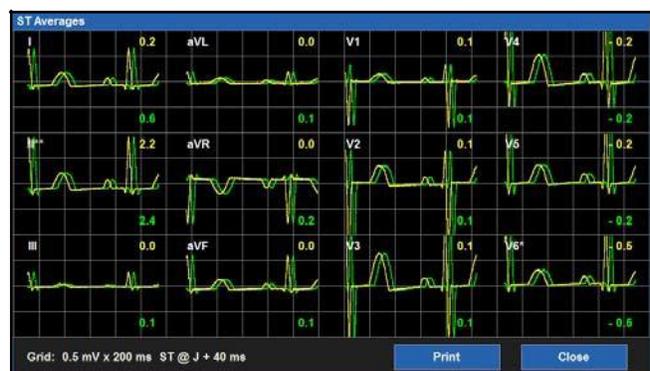
To adjust the ST alarm limits:

1. Select the ST numeric parameter tile to display the Setup ST dialogue.
2. Locate the ST Change Alarm Limit button.
3. Select the up/down arrows to move the alarm limit box until the desired value is reached.
  - a. The value selected is the Delta ST alarm limit absolute value.
  - b. Choices include 1-9mm in steps of 0.5mm.
  - c. The factory default is 2mm.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Display Averages

The ST Averages dialogue replaces the ST menu and displays the overlapped current and referenced ST templates for all ECG leads available. The current ST templates are displayed in green and the referenced ST templates are displayed in yellow. Next to each ECG lead label is the current ST-value and the reference-ST value. A double and single star indicates the two leads that currently have the most significant ST change. The ST Averages dialogues is updated with fresh information every 30 seconds. The ST Averages dialogue remains displayed on the screen until manually closed by the clinician.

**Figure 47 ST Average Dialogue**



To display the ST Averages dialogue:

1. Select the ST numeric parameter tile to display the Setup ST dialogue.
2. Select the Averages button.
3. The ST averages dialogue displays showing the Current ST templates and numeric values in green and the Reference ST templates and numeric values in yellow.
4. Select the Print button in the ST Averages dialogue to print the templates to the bedside recorder (optional). The ST templates do not print to the Surveyor Central Station's printer.
5. When printed at the bedside recorder, both the Current and Reference ST templates and numeric values are printed.
6. Select the Close button in the ST Averages dialogue to close the window and return to Setup ST dialogue.

## ST Display

The ST numeric parameter tile on the main screen displays valuable ST information.

### ST Reference Time

The ST reference time is the time when the ST algorithm last learned and established the ST baseline. This learned baseline is used as the reference baseline. The ST tile displays the ST reference time and "REF" label. If the ST reference is more than 24 hours old, it will be indicated as such. For ECG leads that are not available (such as during a Lead Off situation), the ST value will be displayed as invalid "---."

### ST Numeric Values

ST numeric values are displayed as either Delta or Current.

**Delta ST** – Delta ST values are defined as the ST segment location changes between the learned/referenced ST templates and the current ST segments. The Delta ST signifies how much the ST has changed when compared to the reference ST templates. Delta ST values are yellow and labeled "⊗ST."

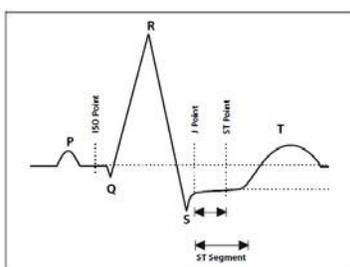
**Current ST** – Current ST values are defined as the ST segment locations currently observed in the ECG leads. Current ST values are green and labeled "ST."

To select the ST numeric values displayed in the ST numeric parameter tile on the main screen:

1. Select the ST numeric parameter tile to display the Setup ST dialogue.
2. Locate the ST Display button.
3. Select the arrow to display the drop down list box.
  - a. Select Delta to display the delta ST numeric values.
  - b. Select Current to display the current ST numeric values.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### ST Delay After J-Point

As previously discussed in this manual, the ST algorithm uses the ISO point as the baseline for determining the isoelectric line. The ST segment is defined as beginning at a fixed distance after the QRS complex (the “J point”) and the ST point. The algorithm compares the subsequent ST segment location relative to the learned ISO point. The algorithm then reports the ST location value as equal to (the same as) the isoelectric line, elevated, or depressed.



By factory default configuration, the ST algorithm automatically uses a 60 ms delay after the detected J point to define the start of the ST segment. This J point setting can be manually adjusted by the clinician.

To select the ST numeric value displayed in the ST numeric parameter tile on the main screen:

1. Select the ST numeric parameter tile to display the Setup ST dialogue.
2. Locate the ST Delay After J Point button.
3. Select the arrow to rotate through the choices of 1-200 ms.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### Enable ST Leads

The ECG leads on which the ST analysis is performed can be independently configured by the clinician. The clinician can choose to exclude particular ECG leads from ST monitoring based on the patient’s monitoring needs and condition. ECG leads that are excluded for ST monitoring continue to have their values appear in the ST numeric parameter tile but are displayed in a different color.

**NOTE:** ST alarm surveillance will not be performed on ECG leads that have been excluded from ST monitoring.

To enable/disable ST leads for monitoring and alarm surveillance:

1. Select the ST numeric parameter tile to display the Setup ST dialogue.
2. Locate the ECG lead labels.
  - a. Select Yes next to the ECG lead to include for ST alarm surveillance.
  - b. Select No next to the ECG lead label to not include in ST alarm surveillance.
3. To enable ALL ECG leads for ST alarm surveillance.
  - a. Locate the Enable All Leads button.
  - b. Select the Enable All Leads button to include all available ECG leads for ST alarm surveillance.



## 17. NON-INVASIVE BLOOD PRESSURE MONITORING

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### Overview

The Non-invasive Blood Pressure (NIBP) monitoring capabilities of the Surveyor patient monitor include calculating the patient's systolic, mean, and diastolic non-invasive blood pressures. The clinician can use the Surveyor patient monitor to obtain the patient's blood pressure by a manual method, a stat acquisition, and through an automatic interval acquisition setting.

The Surveyor S12 and S19 patient monitors function according to specifications in the presence of common arrhythmias such as atrial or ventricular premature beats or atrial fibrillation. The Surveyor S12 and S19 patient monitors can determine blood pressure over a heart rate range of 30 bpm to 240 bpm.

Blood pressure measurements can be affected by several factors including body position (ex. standing, sitting, supine, etc.), exercise, mood, diet, medications, and other physiological conditions.



**WARNING** – *In some cases, frequent and prolonged measurements can result in petechia, ischemia, purpura or neuropathy. You should check the cuff site regularly when taking frequent measurements over an extended time period. You should also check the patient for any signs of restricted circulation in the extremities of the limb where the NIBP cuff is wrapped. Switch the blood pressure cuff site as per hospital protocol or at least every few hours.*



**WARNING:** *Be sure that the NIBP hose is not compressed or kinked during a measurement. Kinks in the hose could lead to excessive pressure in the blood pressure cuff, which could cause limb damage to the patient.*



**CAUTION:** *Do not apply the NIBP cuff on the same limb as the SpO2 sensor. During blood pressure measurements, the perfusion is temporarily reduced, which can result in inaccurate pulse oximetry readings.*



**CAUTION:** *Do not allow the NIBP cuff or hose to come into contact with fluids. If this occurs, consult the Cleaning section of this manual for drying instructions. Check the hose and cuff frequently for signs of damage or debris. An obstruction in the hose may interfere with inflation and deflation, resulting in inaccurate NIBP readings.*



**CAUTION:** *To obtain accurate blood pressure readings, keep the limb and the cuff motionless.*



**CAUTION:** *The NIBP cuff should be at the same level as the patient's heart.*



**CAUTION:** NIBP measurements may not be accurate if the patient is convulsive, experiencing tremors, or is defibrillated during the measurement.



**CAUTION:** NIBP measurements may be affected by extremes of temperature, humidity and altitude. Always ensure that the Surveyor patient monitor is operated and stored within its specified environmental conditions.

## Blood Pressure Technology

The Surveyor patient monitor uses an oscillometric method to measure the patient's blood pressure. In this method, a blood pressure cuff is quickly inflated above the patient's systolic pressure and then slowly releases the cuff pressure in a series of steps. This is referred to as a "stair step" method of obtaining the patient's blood pressure. At each cuff pressure step, oscillations in the cuff pressure are measured. These oscillations are made by the underlying blood vessels that are pushing on the cuff during the cardiac cycle. From these oscillations, the patient's blood pressure can be derived.

This blood pressure technology works best when the patient is reminded to relax and lie still during the NIBP acquisition. Encourage the patient to remain quiet during the NIBP acquisition.

Once the Surveyor patient monitor obtains an initial NIBP measurement, the monitor uses the previous systolic pressure value to select the inflation cuff pressure.

## Pediatric Patient NIBP Considerations

The initial NIBP inflation pressure can be adjusted in the Setup NIBP dialogue. The factory default value for the pediatric patient mode is 120 mmHg. Use clinical discretion to manually adjust the NIBP initial inflation setting for pediatric patients. Correctly setting the NIBP initial inflation pressure may lead to reduced measurement acquisition time and increased patient comfort. The initial inflation pressure can be adjusted in the Setup NIBP dialogue. Refer to the NIBP Initial Inflation Pressure section in this manual for further details.

## Hypertensive Patient Considerations

With certain patients, the first attempt to obtain an NIBP may be unsuccessful. The Surveyor S12 and S19 patient monitors automatically attempt to obtain a second NIBP if the first attempt is unsuccessful. The patient monitor uses a higher inflation pressure on this second measurement attempt. If after the second attempt the monitor still cannot obtain a successful measurement, the NIBP acquisition becomes idle and an NIBP technical message is displayed in the system message area on the monitor's main screen.

For patients known to be hypertensive, the clinician may want to adjust the NIBP inflation pressure to avoid this situation. Correctly setting the NIBP initial inflation pressure may lead to reduced measurement acquisition time and increased patient comfort. The initial inflation pressure can be adjusted in the Setup NIBP dialogue. Refer to the NIBP Initial Inflation Pressure section in this manual for further details.

## NIBP Monitoring Procedure

**NOTE:** To obtain quality NIBP measurements, it is crucial to use the proper NIBP cuff appropriate to the patient's size. Using a NIBP cuff that is too large for the patient may result in erroneous NIBP numeric values. Using an NIBP cuff that is too small for the patient may result in erroneous NIBP numeric values.

To begin NIBP monitoring:

1. Select the appropriate NIBP cuff for the size of the patient. Measure the circumference of the patient's limb. Compare this circumference to the size marked on the NIBP cuff.
2. Attach the NIBP cuff to the patient. Refer to the Accessories section of this manual for a list of approved NIBP cuffs.
3. The patient should be comfortably seated or lying down, and the patient's arm or leg should be relaxed, extended, uncrossed and resting on a stationary support.
4. Wrap the deflated cuff snugly around the patient's arm or leg according to current AHA guidelines, taking care not to restrict blood circulation.
5. If using the arm, wrap the cuff at 2 to 5 cm above the elbow crease at the level of the right atrium of the heart, and place the artery mark (↓) over the patient's brachial artery, pointing to the patient's hand.
6. If using the leg, wrap the cuff around the middle of the thigh, and place the artery mark (↓) over the patient's femoral artery, pointing to the patient's foot.
7. Instruct the patient to remain still, relax as much as possible and not speak during the measurement. For best results, it is recommended that the patient be allowed to relax for 5 minutes before initiating NIBP measurements.
8. Connect the NIBP cuff to the NIBP hose, and connect the hose to the NIBP connection port on the side of the Surveyor patient monitor.
9. Select the NIBP Start/Stop quick-action key on the Surveyor patient monitor front panel to start the NIBP acquisition attempt.

**NOTE:** The Surveyor Central Station user interface allows the clinician to be at the central station and start a blood pressure acquisition on the patient monitor. Use clinical discretion in the use of this feature, always ensuring proper procedure for blood pressure acquisition is followed and that proper patient surveillance exists. Refer to the Surveyor Central Station operator manual for further details.

## NIBP Tile

The NIBP tile is always located in the lower left corner of Numeric Parameter B section on the Surveyor S12 and S19 patient monitor's main screen. When the NIBP measurement completes, the Surveyor patient monitor displays the blood pressure numeric values in the NIBP Numeric Parameter B location. The NIBP tile is always located in the lower left portion of the main screen. The numeric values in the NIBP tile automatically erase when the NIBP measurement is older than 60 minutes.

Figure 48 Example NIBP Tile

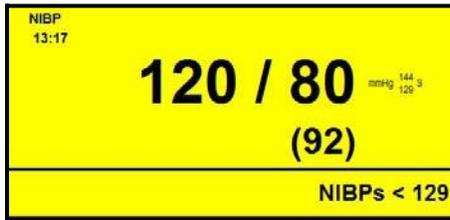


The NIBP tile may display:

- The NIBP parameter label
- The timestamp of the most recent NIBP values
- The systolic, diastolic, and mean arterial pressure numerics (format configurable)
- The “mmHg” NIBP units of measure label
- The systolic alarm limits if NIBP alarm limits are enabled
- The Alarm Off icon if any of the NIBP sub-parameter alarm limits are OFF
- The NIBP numeric values and alarm limits are shown in orange color

## NIBP Alarm Behaviors

Figure 49 Example NIBP Tile in Alarm



The NIBP parameter tile flashes during an NIBP alarm condition. The alarm light, NIBP numeric parameter tile, and NIBP alarm message displays in the color of the configured NIBP alarm level. The alarm audio notification is produced according to the alarm level configured.

## NIBP Start/Stop Quick-Action Key

The NIBP Start/Stop quick-action key on the main screen is used to start and stop blood pressure acquisitions. This quick-action key is a toggle button and changes function based on the NIBP status.

- Selecting this quick-action key during an NIBP idle or deflated status initiates a non-invasive blood pressure (NIBP) measurement.
- Selecting this quick-action key during an NIBP acquire mode (currently inflating status) stops the NIBP measurement and deflates the NIBP cuff.

**NOTE:** The NIBP Start/Stop quick-action key does not stop an active NIBP interval. To suspend an active NIBP interval, the clinician must enter the Setup NIBP dialogue and stop the NIBP interval. Refer to the NIBP Interval section in this manual for further details.

## Setup NIBP Dialogue

Selecting the NIBP parameter tile opens the Setup NIBP dialogue. Use the Setup NIBP dialogue to adjust alarm settings, NIBP interval, initial NIBP inflation pressure, format, and to display the NIBP trends in the main screen.

Figure 50 Setup NIBP Dialogue

The screenshot shows the 'Setup NIBP' dialog box with the following settings:

Parameter	Lower Limit	Upper Limit	Alarms On	Print on Alarm
NIBPs	96	144	Auto	No
NIBPm	74	110	Auto	No
NIBPd	64	96	Auto	No
NIBP Interval	5		Initial Inflation Pressure	160
Format	Sys / Dia		Show NIBP trends	No

### NIBP Alarm Limits

High and low NIBP alarm limits can be configured independently for the Systolic (“NIBPs”), Mean (“NIBPm”), and Diastolic (“NIBPd”) blood pressure parameters.

To adjust the NIBPx (where x= s, d, or m) alarm limits:

1. Select the NIBP numeric parameter tile to display the Setup NIBP dialogue
2. Locate the NIBPx label
  - a. Adjust the Lower alarm limit by selecting the up/down arrows to move the lower alarm limit box until the desired value is reached
  - b. Adjust the Upper alarm limit by selecting the up/down arrows to move the upper alarm limit box until the desired value is reached
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes

The NIBPx alarm limits may also be adjusted via the Settings quick-action key. Refer to the Settings Alarm Limits section in this manual for further details.

### Auto Set NIBP Alarm Limits

The Auto Set feature for the NIBP alarm limits can be configured independently for the Systolic (“NIBPs”), Mean (“NIBPm”), and Diastolic (“NIBPd”) blood pressure parameters. The Auto set feature automatically calculates the high and low NIBPx alarm limits based on the current value.

Parameter	Lower limit adjustment	Upper limit adjustment
NIBP – Systolic, Mean & Diastolic	Changed to 80% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Changed to 120% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)

To Auto set an NIBPx (where x= s, d, or m) alarm:

1. Select the NIBP numeric parameter tile to display the Setup NIBP dialogue
2. Locate the NIBPx label
3. Select the Auto button next to the NIBPx label. Notice the limit values in the Lower Limit window and the Higher Limit window adjust
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes

### NIBP Alarms On

The Alarms On feature for the NIBP alarms can be configured independently for the Systolic (“NIBPs”), Mean (“NIBPm”), and Diastolic (“NIBPd”) blood pressure parameters.



**WARNING:** *Disabling the NIBPx alarm limits means that NO low or high NIBPx alarm conditions will produce alarm notifications. Use this feature with extreme caution.*

To enable/disable the NIBPx (where x =s, m, or d) alarm limits:

1. Select the NIBP numeric parameter tile to display the Setup NIBP dialogue
2. Locate the NIBPx label
3. Locate the Alarms On button next to the NIBPx label
  - a. Select Yes to enable NIBPx alarms
  - b. Select No to disable NIBPx alarms
    - The Alarm Off icon displays in the NIBP numeric parameter tile

**NOTE:** *The Lower Limit and Higher Limit windows in the Setup NIBP dialogue may contain limit values but these alarms ARE disabled if the NIBPx Alarms On button is set to NO.*

4. Select the OK button to enter that change OR select the Cancel button to cancel the changes

### NIBP Print on Alarm

To enable/disable the NIBPx (where x =s, m, or d) alarm limit conditions to automatically print:

1. Select the NIBP numeric parameter tile to display the Setup NIBP dialogue.
2. Locate the NIBPx label.
3. Locate the Print On Alarm button next to the NIBPx label.
  - a. Select Yes to enable the Print On Alarm.
  - b. Select No to disable the Print On Alarm.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The Print On Alarm feature for the NIBP alarm limit conditions may also be adjusted via the Settings quick-action key. Refer to the Print On Alarm section in this manual for further details.

### NIBP Interval

The Surveyor patient monitor can be configured to acquire NIBP measurements automatically at a preset interval. The patient monitor automatically attempts to obtain an NIBP measurement according to the interval configured. The clinician must manually change the interval to OFF to discontinue a previously active NIBP interval.

To select an automatic NIBP interval:

1. Select the NIBP numeric parameter tile to display the Setup NIBP dialogue.
2. Locate the NIBP Interval label.
3. Select the arrow to display the drop down list box choices (OFF, 2m, 3 m, 5m, 10m, 15m, 30m, and 60 minutes).
4. Select the appropriate choice.
5. Select the OK button to enter that change OR select the Cancel button to cancel the changes.
  - Selecting OK with an interval chosen prompts the patient monitor to begin that interval.
  - Selecting OK with an interval chosen displays that interval in the system message area below the NIBP tile.

When in an active NIBP interval, the patient monitor attempts to acquire the blood pressure measurements based on the o'clock as per the system time.

To stop an automatic NIBP interval:

1. Select the NIBP numeric parameter tile to display the Setup NIBP dialogue.
2. Locate the NIBP Interval label.
3. Select the arrow to display the drop down list box.
  - Select the OFF NIBP interval choice.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.
  - Selecting OK with the OFF interval chosen prompts the patient monitor to discontinue the automatic NIBP mode and places the patient monitor NIBP acquisition into an idle mode.
  - Selecting OK with the OFF interval chosen removes the NIBP interval message from the system message area below the NIBP tile.

#### **NIBP Interval Mode and Standby**

If an NIBP interval is active and then the monitor is placed into a Standby mode, the NIBP interval enters a holding mode during the Standby period. Upon resumption of monitoring post-Standby, select the NIBP Start/Stop quick-action key on the main screen to restart the NIBP interval mode.

#### **NIBP Interval Mode and Power Down/Up**

The NIBP interval setting is remembered between power cycles. Upon resumption of monitoring post Power Up, select the NIBP Start/Stop quick-action key on the main screen to restart the NIBP interval mode.

#### **NIBP Interval Mode and Manual/STAT NIBP Measurements**

Even when in an active NIBP interval mode, a manual or STAT NIBP measurement can be obtained. To begin a manual or STAT NIBP measurement, select the NIBP Start/Stop quick-action key on the main screen. The automatic NIBP interval will resume and continue on the previous o'clock timer.

### **NIBP Initial Inflation Pressure**

The Surveyor S12 and S19 patient monitors are factory defaulted to initially inflate the NIBP up to 160 mmHG when in the Adult mode. When in Pediatric mode, the initial NIBP inflation pressure is factory defaulted to 120 mmHg. For some patients, this initial inflation may not be high enough to quickly obtain an accurate blood pressure measurement. For other patients, this initial inflation may be too high.

The initial inflation pressure can be manually adjusted to a higher or lower pressure setting based on the patient's physiological status. For patients assumed to be hypertensive, the clinician may want to increase the initial inflation setting to a higher mmHg setting. For patients assumed to be hypotensive, the clinician may prefer to decrease the initial inflation setting to a lower mmHg setting. Setting the NIBP initial inflation pressure appropriate to the patient's assumed blood pressure may allow for a quicker NIBP acquisition on the first attempt. Once the patient monitor obtains the initial blood pressure, the monitor automatically adjusts the inflation pressure based on the previously obtained systolic blood pressure.

**NOTE:** Always use clinical discretion when adjusting the NIBP initial inflation pressure.

To manually adjust the NIBP initial inflation pressure:

1. Select the NIBP numeric parameter tile to display the Setup NIBP dialogue.
2. Locate the Initial Inflation Pressure label.
3. Select the up/down arrows to reach the appropriate initial inflation pressure value.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## NIBP Format

The Surveyor S12 and S19 patient monitors provide the capability of display NIBP numeric values in two formats. The format selected determines how the NIBP numeric values are displayed in the NIBP parameter tile.

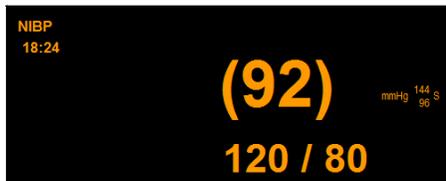
### Systolic/Diastolic Format

- In this format, the systolic and diastolic numeric values are in a larger, more prominent font in the NIBP parameter tile.
- The systolic number is the top or numerator value and the diastolic number is the bottom or denominator value.
- The mean numeric value is display in parenthesis.
- The NIBP Trends List and Tabular Trends always display the NIBP in the SYS/DIA format.
- The SYS/DIA format is the factory default NIBP format.

### Mean Format

- In this format, the mean numeric value is in a larger, more prominent font in the NIBP parameter tile.
- The systolic number is the top or numerator value with the diastolic number as the bottom or the denominator value.
- The mean numeric value displays in parenthesis.
- The NIBP Trends List and Tabular Trends always display the NIBP in the SYS/DIA format.

**Figure 51 Example of NIBP Mean Format**



To select the NIBP Format:

1. Select the NIBP numeric parameter tile to display the Setup NIBP dialogue.
2. Locate the NIBP Format label.
3. Select the arrow to display the drop down list box (Choices of SYS/DIA and MEAN).
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Show NIBP Trends

The Surveyor S12 and S19 patient monitors can display a mini-trend list of the most recent NIBP measurements on the main screen. This “NIBP Trends” displays on the right side of the NIBP numeric parameter tile. The number of recent NIBP measurements displayed in the NIBP Trend is based on the number of waveform parameters currently being displayed.

**Figure 52 Example of NIBP Parameter Tile with NIBP Trends List**



To enable/disable the display of the NIBP Trends list:

1. Select the NIBP numeric parameter tile to display the Setup NIBP dialogue.
2. Locate the Show NIBP Trends label.
  - a. Select Yes to display the NIBP Trends list in the NIBP parameter tile on the main screen.
  - b. Select No to not display the NIBP Trends list in the NIBP parameter tile on the main screen.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Cuff Overpressure

During a measurement, a variety of safety checks are performed. If the monitor detects a cuff overpressure situation, the NIBP measurement cancels and the cuff deflates automatically. The safety checks include an overpressure check (to make sure the cuff pressure is not greater than 270 mmHg), a check to make sure the measurement does not take longer than 2 minutes, and other checks for technical problems such as a blocked line. An error message is displayed on the patient monitor should a cuff overpressure condition exist. If a cuff overpressure situation occurs, the NIBP acquisition becomes idle and an NIBP technical message is displayed in the system message area on the monitor’s main screen.



## 18. SPO2 MONITORING

---

### Overview

Pulse oximetry monitoring works by shining light of two different wavelengths through the patient's tissues (such as a fingertip) and measuring the absorption of the light by the hemoglobin in the patient's arterial blood. The way the blood absorbs the different wavelengths indicates the amount of oxygen in the blood. Since this amount is constantly changing during each beat of pulse as new blood comes in and old blood returns to the heart, it is also possible to detect a pulse rate from this signal.

The Surveyor patient monitor can monitor functional oxygen saturation of arterial hemoglobin (SpO<sub>2</sub>) and pulse rate (PR). The patient monitor can display these numeric values and the associated plethysmograph ("Pleth") waveform. The pleth waveform corresponds to but is NOT proportional to the arterial pressure waveform.

Depending on the configuration of your Surveyor patient monitor, you will have one of the following two supported technology and sensors:

- Mortara SpO<sub>2</sub>
- Nellcor OxiMax SpO<sub>2</sub>

The SpO<sub>2</sub> parameter incorporates automatic calibration mechanisms. No other calibration is required.

### Mortara SpO<sub>2</sub> Technology

When using Mortara SpO<sub>2</sub>, the SpO<sub>2</sub> algorithm uses the qualified pulsatile data averaged over a 60 second period to report the SpO<sub>2</sub> value.

### Nellcor OxiMax Technology

The Nellcor OxiMax algorithm automatically extends the amount of data required for measuring SpO<sub>2</sub> and pulse rate depending on the measurement conditions.

- During normal measurement conditions in the normal response mode, the averaging time is 6 to 7 seconds.
- During difficult measurement conditions such as low perfusion, motion, ambient light, electrocautery, other interference, or a combination of these factors, the OxiMax algorithm automatically extends the dynamic averaging time required beyond 7 seconds.
- If the resulting dynamic averaging time exceeds 20 seconds, the pulse search condition will be set, while SpO<sub>2</sub> and pulse rate values continue to be updated every second.
- As the measurement conditions become even more difficult, the amount of data required continues to expand. If dynamic averaging time reaches 40 seconds, the pulse timeout condition will be set and the module will report a zero saturation indicating a loss-of-pulse condition.

## SpO2 Monitoring Procedure

1. Select the appropriate sensor and attach to the patient site (e.g., finger, ear, etc.) Reusable and disposable sensors are available for specific sites on patients with designated sizes and/or weight ranges. To select the appropriate sensor, consider the patient's weight, level of activity, adequacy of perfusion, which sensor sites are available, whether sterility is required, and the anticipated duration of monitoring.



**CAUTION:** It is important to select a SpO2 sensor that is appropriate for the size and weight of the patient. For example, a clean pulse oximetry waveform may not be obtainable when an adult sensor is used on a small child.

2. Attach the SpO2 patient cable to the sensor and plug the other end of the patient cable into the SpO2 connector located on the side panel of the Surveyor patient monitor.
3. The pleth waveform and numeric SpO2 value will be available as the third waveform and parameter area. If the pleth waveform is not shown, it may be necessary to assign SpO2 to this slot in the Setup – Waveforms menu.

## SpO2 Display

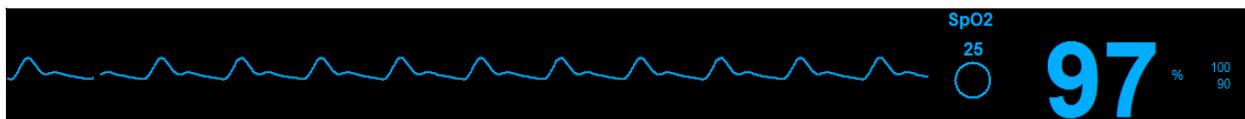
### Pleth Waveform Parameter Tile

The SpO2 pleth waveform may be shown in one of the available waveform slots. The amplitude of the pleth wave is self-adjusted according to the height of the waveform area. The Pleth waveform can be located to the left of the SpO2 numeric parameter tile. The SpO2 numeric parameter tile can be displayed independent of the Pleth waveform location.

Under normal conditions, the SpO2 waveform corresponds to but is not proportional to the arterial pressure waveform. Observing the SpO2 waveform can help the clinician find a sensor location with the fewest noise spikes.

### SpO2 Numeric Parameter Tile

**Figure 53 Example Nellcor SpO2 Waveform and Numeric Tile**



The SpO2 numeric parameter tile may display:

- The SpO2 parameter label.
- The current SpO2 numeric value.
- The “%” SpO2 unit of measure.
- The SpO2 alarm limits if the SpO2 alarm limits are enabled.
- The Alarm Off icon if any of the SpO2 alarm limits are disabled.
- The SatSeconds indicator when using the Nellcor SpO2 technology and the SatSeconds indicator is configured for display.
- The SpO2 numeric values and alarm limits are shown in cyan color.

## SpO2 Alarm Behaviors

The Surveyor S12 and S19 patient monitors do not produce SpO2 alarms until a valid SpO2 signal is obtained. This is intended to reduce nuisance alarms during initial patient hookup. The SpO2 numeric parameter tile flashes during an SpO2 alarm condition. The alarm light, SpO2 numeric parameter tile, and SpO2 alarm message displays in the color of the configured SpO2 alarm level. The alarm audio notification is produced according to the alarm level configured.

## Setup SpO2 Dialogue

Selecting the SpO2 numeric parameter tile opens the Setup SpO2 dialogue. Use the Setup SpO2 dialogue to adjust alarm settings and to enable/disable the HR/PR tone.

### SpO2 Alarm Limits

High and low SpO2 alarm limits can be configured independently.

To adjust the SpO2 alarm limits:

1. Select the SpO2 numeric parameter tile to display the Setup SpO2 dialogue.
2. Locate the SpO2 label.
  - a. Adjust the Lower alarm limit by selecting the up/down arrows to move the lower alarm limit box until the desired value is reached.
  - b. Adjust the Upper alarm limit by selecting the up/down arrows to move the upper alarm limit box until the desired value is reached.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The SpO2 alarm limits may also be adjusted via the Settings quick-action key. Refer to the Settings Alarm Limits section in this manual for further details.

### SpO2 Auto Set Alarms

The Auto set feature automatically calculates the high and low SpO2 alarm limits based on the current value.

Parameter	Lower limit adjustment	Upper limit adjustment
SpO <sub>2</sub>	Changed to 95% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Set to 100%

To Auto set the SpO2 alarm:

1. Select the SpO2 numeric parameter tile to display the Setup SpO2 dialogue.
2. Locate the SpO2 label.
3. Select the Auto button next to the SpO2 label. Notice the limit values in the Lower Limit window and the Higher Limit window adjust.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## SpO2 Alarms On



**WARNING:** Use this feature with extreme caution. Patients must be closely observed if the SpO2 alarm limits are disabled.

**NOTE:** Follow hospital standard of care for the use of this feature. This feature is only intended to be used during end of life situations and only based on the hospital standard of care.

To enable/disable the SpO2 alarm limits:

1. Select the SpO2 numeric parameter tile to display the Setup SpO2 dialogue.
2. Locate the Alarms On button.
  - a. Select Yes to enable SpO2 alarms.
  - b. Select No to disable SpO2 alarms.
    - The Alarm Off icon displays in the SpO2 numeric parameter tile.

**NOTE:** The Lower Limit and Higher Limit windows in the SpO2 dialogue may contain limit values but these alarms ARE disabled if the Alarms On button is set to NO.

3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## SpO2 Print on Alarm

To enable/disable the SpO2 alarm limit conditions to automatically print:

1. Select the SpO2 numeric parameter tile to display the Setup SpO2 dialogue.
2. Locate the SpO2 label.
3. Locate the Print On Alarm button next to the SpO2 label.
  - a. Select Yes to enable the Print On Alarm.
  - b. Select No to disable the Print On Alarm.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The Print On Alarm feature for the SpO2 alarm limit conditions may also be adjusted via the Settings quick-action key. Refer to the Print On Alarm section in this manual for further details.

## SpO2 Alarm Pause

The Surveyor S12 and S19 patient monitors do not produce SpO2 alarms until a valid SpO2 signal is obtained. This is intended to reduce nuisance alarms during initial patient hookup. Once a valid SpO2 alarm is obtained and the SpO2 sensor is removed, the patient monitor produces a technical message to inform the clinician that no SpO2 data is being monitored. The clinician can remove and acknowledge the “SpO2 Check Sensor” technical message via the Setup SpO2 dialogue if the monitoring of SpO2 data is no longer desired and the removal of the SpO2 sensor is intentional.

To acknowledge the removal of the SpO2 sensor is intentional and to remove the “SpO2 Check Sensor” technical alarm:

1. Select the SpO2 numeric parameter tile to display the Setup SpO2 dialogue.
2. Locate the SpO2 Alarm Pause button.
3. The “SpO2 Alarms Paused” message is briefly display in the system message area of the main screen.

The SpO2 alarms reactivate when the SpO2 sensor is reconnected to the patient.

## HR/PR Tone

When the systole pulse tones are coming from SpO2, the tone pitch is a function of the SpO2 value, with decreasing pitch as the SpO2 value goes from 100% down to 75%.

To enable/disable the systole audio tone:

1. Select the SpO2 numeric parameter tile to display the Setup SpO2 dialogue.
2. Locate the HR/PR label.
  - a. Select Yes to enable the HR/PR systole tone.
  - b. Select No to disable the HR/PR systole tone.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Sat Seconds (Nellcor only)

When the Nellcor OxiMax Technology and sensors are utilized, the Surveyor patient monitor can display Nellcor's SatSeconds indicator.

Nellcor's SatSeconds™ Alarm Management feature offers an effective means of managing nuisance or false alarms without sacrificing patient safety. Nuisance alarms are often triggered by minor and brief desaturation events that are clinically insignificant and are often managed by widening alarm limits, turning OFF the alarm or monitor, or simply ignoring the alarm. The SatSeconds feature distinguishes clinically insignificant events from events of consequence.

When a SpO2 measurement exceeds the alarm limit, the SatSeconds indicator begins to fill clockwise. The difference between the measurement and the limit multiplied by the time the measurement remains outside the limit determines if or when the SatSeconds alarm occurs.

For example:

- The low SpO2 alarm is set at 90% and the SatSeconds "clock" is set to 25.
- If the measurement is 85% for 4 seconds (i.e., 5% below the limit for 4 seconds), then  $5\% \times 4 \text{ seconds} = 20 \text{ SatSeconds}$ . This is less than the 25 SatSeconds setting, therefore no alarm will occur.
- If the measurement is 85% for 7 seconds (i.e., 5% below the limit for 7 seconds), then  $5\% \times 7 \text{ seconds} = 35 \text{ SatSeconds}$ . This is greater than the 25 SatSeconds setting, therefore an alarm occurs at 5 seconds because  $5\% \times 5 \text{ seconds} = 25 \text{ SatSeconds}$ . The alarm continues for another 2 seconds.

When the SpO2 measurement returns to within the alarm limits, the SatSeconds indicator clears (empties) in a counter-clockwise fashion. The clearing of the SatSeconds indicator takes the same amount of time it took for the SatSeconds alarm condition to be acquired. The SatSeconds "clear" time is equivalent to the acquire time.

To configure the SatSeconds time:

1. Select the SpO2 numeric parameter tile to display the Setup SpO2 dialogue.
2. Locate the SatSeconds label.
3. Select the arrow to display the drop down list box (Choices of Off, 10s, 25s, 50s, 100 seconds).
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Response Mode (Nellcor only)

The Nellcor OxiMax algorithm automatically adjusts the signal processing during degradation conditions such as those caused by low perfusion, interference (e.g. external interference such as ambient light, electromagnetic interference, and patient motion), or a combination of these. The automatic adjustment in the signal processing results in an increase in the dynamic averaging beyond the minimum as set by the Response Mode. If the result of the dynamic averaging time exceeds 20 seconds for SpO<sub>2</sub>, the algorithm continues to search and displays the pulse every second. As these conditions extend, the amount of data required continues to increase. If the dynamic averaging time for SpO<sub>2</sub> reaches 40 seconds, and/or reaches 50 seconds for Pulse Rate, a low priority alarm state results.

The Nellcor OxiMax signal processing algorithm automatically extends the amount of data required for measuring SpO<sub>2</sub> and pulse rate depending on the measuring conditions. During normal measurement conditions, the SpO<sub>2</sub> averaging time is six to seven seconds in Normal Mode and approximately three seconds in Fast Mode. The OxiMax algorithm's calculation of pulse rate is unaffected by the response mode setting.

To configure the Response Mode:

1. Select the SpO<sub>2</sub> numeric parameter tile to display the Setup SpO<sub>2</sub> dialogue.
2. Locate the Response Mode label.
3. Select the up/down arrows to display the drop down list box (Choices of Normal and Fast).
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## SpO<sub>2</sub> Functional Testing

To manually test a SpO<sub>2</sub> alarm test conditions: apply probe to finger, wait for SpO<sub>2</sub> value to appear, lower the high alarm limit below the value shown, and verify that the "SpO<sub>2</sub> < [lower limit]" alarm is annunciated.

Some models of commercially available bench-top functional testers and patient simulators can be used to verify proper functionality of pulse oximeter sensors, cables and monitors. While such units may be useful for verifying that the pulse oximetry system is functional, they are incapable of providing the data required to properly evaluate the accuracy of the system's SpO<sub>2</sub> measurements.

Many functional testers and patient simulators are designed to interface with the pulse oximeter's expected calibration curves, and may be suitable for use with the pulse oximeter monitor and sensors. Not all units, however, are adapted for use with all digital calibration systems. While this will not affect use of the simulator for verifying system functionality, the displayed SpO<sub>2</sub> measurement values may differ from the setting of the patient monitor. For a properly functioning monitor, this difference is reproducible over time and from unit to unit within the performance specifications of the test unit.

## 19. TEMPERATURE MONITORING

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### Overview

The Surveyor S12 and S19 patient monitors can monitor up to two continuous temperatures using 400 series compatible probes. Note that 700 series probes are NOT compatible with the Surveyor patient monitor. The temperatures are shown as T1 and T2 or alternately represented as T1 and  $\Delta T$  – the absolute value of the difference between the two temperature probes.

The Temperature parameters at the patient monitors can be configured as in °C or °F via the Administrative Setup menu.

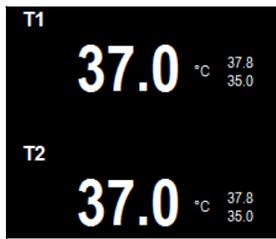
*NOTE: The units of measure for the temperature parameters are not bidirectional when the patient monitor is communicating to the Surveyor central station.*

### Temperature Monitoring Procedure

Follow hospital standard of care and clinical discretion when monitoring continuous temperatures. Follow the temperature probe instructions for use provided with the probe packaging for proper use and any warnings and precautions noted therein.

### Temperature Display

Figure 54 Example Temperature Tile



The Temperature numeric parameter tile may display:

- The parameter label.
- The current temperature numeric value(s).
- The temperature units of measure.
- The temperature alarm limits if the temperature alarm limits are enabled.
- The Alarm Off icon if any of the temperature alarm limits are disabled.
- The temperature numeric values and alarm limits are shown in white color.

### Temperature Alarm Behaviors

The Temperature numeric parameter tile flashes during a temperature alarm condition. The alarm light, temperature numeric parameter tile, and temperature alarm message displays in the color of the configured temperature alarm level. The alarm audio notification is produced according to the alarm level configured.

### Setup Temperature Dialogue

Selecting the Temperature numeric parameter tile opens the Setup Temperature dialogue. Use the Setup Temperature dialogue to adjust alarm settings and the temperature display format.

Figure 55 Example Setup Temperature Dialogue (T1 and T2 Display Mode)

	Lower Limit	Upper Limit		Alarms On	Print on Alarm
NIBPs	96	144	Auto	No Yes	No Yes
NIBPm	74	110	Auto	No Yes	No Yes
NIBPd	64	96	Auto	No Yes	No Yes
NIBP Interval	5	Initial Inflation Pressure	160		
Format	Sys / Dia	Show NIBP trends		No Yes	

### Temperature Alarm Limits

The Temperature Display Mode selected determines which Temperature alarm limits are available for alarm notifications and alarm configurations. Refer to the Temperature Display Mode section in this manual for further details.

To adjust the temperature alarm limits:

1. Select the Temperature numeric parameter tile to display the Setup Temperature dialogue.
2. Locate the Temperature label.
  - a. Adjust the Lower alarm limit by selecting the up/down arrows to move the lower alarm limit box until the desired value is reached.
  - b. Adjust the Upper alarm limit by selecting the up/down arrows to move the upper alarm limit box until the desired value is reached.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The Temperature alarm limits may also be adjusted via the Settings quick-action key. Refer to the Settings Alarm Limits section in this manual for further details.

### Temperature Alarms On



**WARNING:** Disabling the Temperature alarm limits means that NO low or high Temperature alarm conditions will produce alarm notifications.

To enable/disable the Temperature alarm limits:

1. Select the Temperature numeric parameter tile to display the Setup SpO2 dialogue.
2. Locate the Alarms On button.
  - a. Select Yes to enable Temperature alarms.
  - b. Select No to disable Temperature alarms.
    - The Alarm Off icon displays in the Temperature numeric parameter tile.

**NOTE:** *The Lower Limit and Higher Limit windows in the Temperature dialogue may contain limit values but these alarms ARE disabled if the Alarms On button is set to NO.*

3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### Temperature Print on Alarm

To enable/disable the Temperature alarm limit conditions to automatically print:

1. Select the Temperature numeric parameter tile to display the Setup Temperature dialogue.
2. Locate the Temperature label.
3. Locate the Print On Alarm button next to the Temperature label.
  - a. Select Yes to enable the Print On Alarm.
  - b. Select No to disable the Print On Alarm.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The Print On Alarm feature for the Temperature alarm limit conditions may also be adjusted via the Settings quick-action key. Refer to the Print On Alarm section in this manual for further details.

### Temperature Display Mode

The Surveyor S12 and S19 patient monitors provide the capability of display Temperature numeric values in three formats. The format selected determines how the Temperature numeric values are displayed in the Temperature parameter tile. The format selected determines which temperature parameters are available for alarm notifications and configurations.

#### **T1 Only Format**

In this format, the Temperature1 parameter is the only parameter displayed in the Temperature parameter tile.

#### **T1 and T2 Format**

In this format, the Temperature1 and Temperature2 parameters are displayed in the Temperature parameter tile.

#### **T1 and $\Delta T$ Format**

- In this format, the Temperature1 parameter and the  $\Delta T$ Temp displays in the Temperature parameter tile.
- The  $\Delta T$ Temp is the absolute value difference between the Temperature2 parameter and Temperature1 parameter.

To select the Temperature Display Mode format:

1. Select the Temperature numeric parameter tile to display the Setup Temperature dialogue.
2. Locate the Temperature Display Mode label.
3. Select the arrow to display the drop down list box choices (T1 Only, T1 and T2, and T1 and  $\Delta T$ ).
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.



## 20. RESPIRATION MONITORING

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### Overview

The Surveyor S12 and S19 patient monitors can monitor respirations, provide a breath per minute rate, and display a respiration waveform.

### Respiration Acquisition

The Surveyor S12 and S19 patient monitors can monitor respirations two ways:

- Via Thoracic Impedance using the 3/5 Lead ECG cable, if available, connected and enabled. The same electrodes as 3/5 Lead ECG are used for respiration monitoring.
- Via the CO2 parameter, if available and connected. The capnography sensors are used for respiration monitoring. This method takes precedence if present.

### Respirations: ECG Thoracic Impedance

Respiration monitoring works by measuring the impedance between the LL and RA electrodes (or the R and F electrodes for IEC lead designations). The impedance changes as the patient's chest expands and contracts during the breath cycle. To measure the changes in impedance, the Surveyor patient monitor passes a very small, high-frequency current between the electrodes. This current is too small to cause any harm to the patient or any interference with ECG monitoring.

When you have correctly connected the ECG to the patient, the monitor should display a clean, slowly oscillating respiration signal. This may take up to 30 seconds after the patient has been connected. The Surveyor patient monitor should also display a numeric value for the patient's respiration rate (RR).

***NOTE:** If the Respiration waveform is not currently selected for display on the Surveyor patient monitor, follow the instructions in this manual to select this waveform for display.*

**Pediatric Considerations** - Cardiogenic artifact (heart rate pulsations that appear as “breaths” in the respiration signal) can be quite pronounced in pediatric patients. This can cause the respiration rate to be artificially high (approaching the heart rate). To reduce cardiogenic artifact, move the White RA electrode (AHA lead designation) or the Red R electrode (IEC lead designation) from the right clavicle down to the right mid-clavicular line, 4th intercostal space.

***NOTE:** The Respiration parameter is not available via ECG thoracic impedance when using the AM12 12-Lead Acquisition Module.*



**WARNING:** Respiration monitoring via ECG thoracic impedance is not intended to replace clinical assessment, observation, and monitoring.

### Respirations: CO2 Measurement

Refer to the CO2 section of this manual for further details.

## Respiration Alarm Behaviors

The Respiration numeric parameter tile flashes during a Respiration alarm condition. The alarm light, Respiration numeric parameter tile, and Respiration alarm message displays in the color of the configured Respiration alarm level. The alarm audio notification is produced according to the alarm level configured.

## Respiration Display

### Respirations Waveform Parameter Tile

The Respiration waveform may be shown in one of the available waveform slots when the respiration source is ECG. When the respiration source is CO<sub>2</sub>, the capnography waveform is displayed instead of the respiration waveform.

### Respirations Numeric Parameter Tile

When the respiration source is CO<sub>2</sub>, the Respiration Rate (RR) numeric value is displayed in the CO<sub>2</sub> numeric parameter tile.

The Respiration numeric parameter tile may display:

- The parameter label “RR-x” (where x = respiration source).
- The current respiration numeric value(s).
- The “RPM” (respirations per minute) units of measure.
- The respiration alarm limits if the respiration alarm limits are enabled.
- The Alarm Off icon if any of the respiration alarm limits are disabled.
- The respiration numeric values and alarm limits are shown in white color when the Resp source is ECG.
- The respiration numeric values and alarm limits are shown in yellow color when the Resp source is CO<sub>2</sub>.

**Figure 56 Respiration Numeric Tile (ECG as Resp Source)**



**Figure 57 Example Respiration/CO<sub>2</sub> Numeric Tile (CO<sub>2</sub> as Resp Source)**



## Setup Respiration (RR) Dialogue

Selecting the Respiration numeric parameter tile opens the Setup Respiration Rate (RR) dialogue. Use the Setup Respiration dialogue to adjust alarm settings and to enable/disable the respiration parameter.

Figure 58 Example Setup Respiration Dialogue (ECG as Resp Source)

### Respiration Alarm Limits

To adjust the Respiration alarm limits:

1. Select the Respiration numeric parameter tile to display the Setup Respiration dialogue.
  - a. Adjust the Upper alarm limit by selecting the up/down arrows to move the upper alarm limit box until the desired value is reached.
  - b. Adjust the Lower alarm limit, select the up/down arrows to move the lower alarm limit box until the desired value is reached.
2. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The Respiration alarm limits may also be adjusted via the Settings quick-action key. Refer to the Settings Alarm Limits section in this manual for further details.

### Respiration Alarms On



**WARNING:** Disabling the Respiration alarm limits means that NO low or high Respiration alarm conditions will produce alarm notifications. Use this feature with extreme caution. Patients must be closely observed if the Respiration alarm limits are disabled.

**NOTE:** Follow hospital standard of care for the use of this feature. This feature is only intended to be used during end of life situations and only based on the hospital standard of care.

To enable/disable the Respiration alarm limits:

1. Select the Respiration numeric parameter tile to display the Setup Respiration dialogue.
2. Locate the Alarms On button.
  - a. Select Yes to enable Respiration alarms.
  - b. Select No to disable Respiration alarms.
    - The Alarm Off icon displays in the Respiration numeric parameter tile.

**NOTE:** The Lower and Higher Limit windows in the Setup Respiration dialogue may contain limit values but these alarms ARE disabled if the Alarms on button is set to NO.

3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Respiration Print on Alarm

High and Low Respiration alarm limit conditions can be configured to automatically print a real-time waveform report when the alarm occurs.

To enable/disable the Respiration alarm limit conditions to automatically print:

1. Select the Respiration numeric parameter tile to display the Setup Respiration dialogue.
2. Locate the Print On Alarm button.
  - a. Select Yes to enable the Print On Alarm.
  - b. Select No to disable the Print On Alarm.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The Print On Alarm feature for the Respiration alarm limit conditions may also be adjusted via the Settings quick-action key. Refer to the Print On Alarm section in this manual for further details.

## Respiration Enabled (Disabled)



**WARNING:** *Disabling the Respiration parameter means that NO low or high Respiration alarm conditions will produce alarm notifications. Use this feature with extreme caution. Patients must be closely observed if the Respiration parameter is disabled.*

**NOTE:** *Follow hospital standard of care for the use of this feature. This feature is only intended to be used during end of life situations and only based on the hospital standard of care.*

**NOTE:** *The Respiration Enabled (Disabled) feature only applies when the respiration source is ECG thoracic impedance. When capnography is the respiration source, respirations cannot be disabled using this feature.*

To enable/disable the Respiration parameter:

1. Select the Respiration numeric parameter tile to display the Setup Respiration dialogue.
2. Locate the RESP Enabled button.
  - a. Select Yes to enable the Respiration parameter.
  - b. Select No to disable the Respiration parameter.
    - The “RR-ECG (Disabled)” message displays in the Respiration numeric parameter tile.
    - The Respiration waveform does not display on the main screen.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## 21. CO2 MONITORING

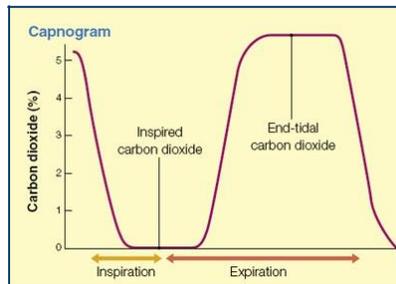
### Overview

The Surveyor S12 and S19 patient monitors use Oridion Microstream® CO2 Capnography technology as well as its patented FilterLine® and Capnoline® ETCO2 consumables. The CO2 capabilities of the Surveyor patient monitor's support the continuous monitoring of the patient's:

- End tidal carbon dioxide (ETCO2) - level of carbon dioxide in exhaled breath.
- Respirations via the CO2 source (RR-CO2).
- Respiration rate per minute (RPM).
- Fractional inspired carbon dioxide (FICO2) - level of carbon dioxide present during inhalation.
- Integrated Pulmonary Index (IPI).

### Principles of Operation

Capnography is a non-invasive method for monitoring the level of carbon dioxide in exhaled breath (EtCO2) to assess a patient's ventilation status. The sample line is typically placed on the mouth or nose for non-intubated patients and in-line with airway tubing for intubated patients.



The Surveyor S12 and S19 patient monitors use Microstream® non-dispersive infrared (NDIR) spectroscopy to continuously measure the amount of CO2 during every breath, the amount of CO2 present at the end of exhalation (ETCO2), the amount of CO2 present during inhalation (FICO2), and the Respiratory Rate.

Infrared spectroscopy is used to measure the concentration of molecules that absorb infrared light. Because the absorption is proportional to the concentration of the absorbing molecule, the concentration can be determined by comparing its absorption to that of a known standard.

The Microstream® ETCO2 consumables deliver a sample of the inhaled and exhaled gases from the ventilator consumable or directly from the patient (via an oral/nasal cannula) into the monitor for CO2 measurement. Moisture and patient secretions are extracted from the sample, while maintaining the shape of the CO2 waveform.

The 50 ml/min. sampling flow rate reduces liquid and secretion accumulation, decreasing the risk of obstruction in the sample pathway in humid ICU environments.

Once inside the Microstream® CO2 sensor, the gas sample goes through a micro-sample cell (15 microliters). This extremely small volume is quickly flushed, allowing for fast rise time and accurate CO2 readings, even at high respiration rates.

The Micro Beam IR source illuminates the micro-sample cell and the reference cell. This proprietary IR light source generates only the specific wavelengths characteristic of the CO<sub>2</sub> absorption spectrum. Therefore, no compensations are required when different concentrations of N<sub>2</sub>O, O<sub>2</sub>, anesthetic agents and water vapor are present in the inhaled and exhaled breath. The IR that passes through the micro-sample cell and the IR that passes through the reference cell are measured by the IR detectors.

The microprocessor in the monitor calculates the CO<sub>2</sub> concentration by comparing the signals from both detectors.

## Integrated Pulmonary Index (IPI) Parameter

The Integrated Pulmonary Index (IPI) is a parameter that uses capnography, respiration rate, pulse rate, and pulse oximetry to articulate a single numeric value to describe the patient's overall ventilatory status. The IPI algorithm integrates ETCO<sub>2</sub>, RR, PR, and SpO<sub>2</sub> values into a single value that provides an uncomplicated, inclusive assessment of a patient's ventilatory status. All four values are necessary to calculate the IPI parameter. The IPI may provide an early indication of ventilatory changes that may not be evident in any of the four parameters individually. The IPI is only available if the patient is monitored with pulse oximetry and capnography, and the IPI parameter is enabled.

***NOTE:** The IPI is not intended to replace accurate clinician assessment of the patient's ventilatory status. The IPI is can be used as another data point in the overall patient assessment.*

The IPI is a numeric value ranging from 1 to 10, where 10 indicates optimal pulmonary status. According to Oridion Medical (2009), the following table presents a guide for clinical intervention based on IPI numeric values. Contact Oridion Medical for further details on IPI clinical intervention.

IPI	Patient Status
10	Normal
8-9	Within normal range
7	Close to normal range – requires attention
5-6	Requires attention and may require intervention
3-4	Requires intervention
1-2	Requires immediate intervention

Oridion Medical. (2009). *Integrated Pulmonary Index TM*. Retrieved from <http://www.oridion.com/Assets/Products/Technology/IPICChart.jpg>

## CO2 Monitoring Procedure

To monitor CO2 with the Surveyor patient monitor:

1. Select the proper Oridion Filterline single-use sample line based on clinical guidelines and hospital standard of care.
2. Open Surveyor's CO2 input connector located on the side panel of the S12 and S19 patient monitors.
3. Connect the orange or yellow connector of the FilterLine® sample line into the Surveyor's CO2 input port.
  - a. Turn the sampling line connector clockwise into the Surveyor's CO2 input port gently to ensure a secure connection. **DO NOT OVER TIGHTEN**. Over tightening the connector may warp the filterline connector and affect the ability to measure CO2.
  - b. This assures that there is no leak of gases during measurement at the connection point and that measurement accuracy is not compromised. Loose or damaged connections may compromise ventilation or cause an inaccurate measurement of respiratory gases.
4. Securely connect all components and check connections for leaks according to standard clinical procedures.
5. Connect the patient end of the filterline to the patient as per instructions included with the filterline tubing.
6. The CO2 waveform and numeric parameter values should appear within approximately 10 seconds.

## CO2 Display

### CO2 Waveform Parameter Tile

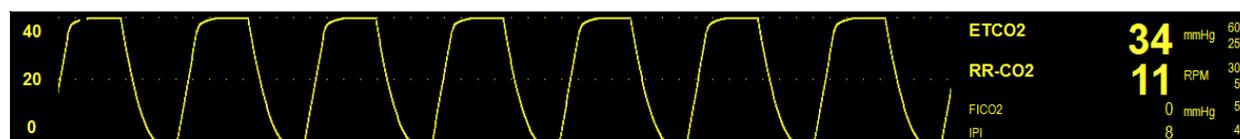
The CO2 waveform may be shown in one of the available waveform slots. The CO2 waveform can be located to the left of the CO2 numeric parameter tile.

### CO2 Numeric Parameter Tile

The CO2 numeric parameter tile may display:

- The CO2 parameter label.
- The current inspired and end-tidal CO2 numeric values.
- The “mmHg” CO2 unit of measure.
- The CO2 alarm limits if the CO2 alarm limits are enabled.
- The Alarm Off icon if any of the CO2 alarm limits are disabled.
- The “RPM” respirations rate per minute unit of measure.
- The “RR-CO2” respiration numeric value using CO2 as the source.
- The respiration alarm limits if the respiration alarms limits are enabled.
- The Alarm Off icon if any of the respiration alarm limits are disabled.
- If enabled, the IPI label.
- If enabled, the IPI numeric value.
- The CO2 numeric values and alarm limits are shown in yellow color.

Figure 59 Example CO2 Waveform and Numeric Parameter Tiles



## CO2 Alarm Behaviors

The Surveyor S12 and S19 patient monitors do not produce CO2 alarms until a valid CO2 signal is obtained. This is intended to reduce nuisance alarms during initial patient hookup. The CO2 numeric parameter tile flashes during a CO2 alarm condition. The alarm light, CO2 numeric parameter tile, and CO2 alarm message displays in the color of the configured CO2 alarm level. The alarm audio notification is produced according to the alarm level configured.

## Setup CO2 Dialogue

Selecting the CO2 numeric parameter tile opens the Setup CO2 dialogue. Use the Setup CO2 dialogue to adjust alarm settings, to adjust the CO2 wave gain, and to configure the IPI parameter.

**Figure 60 Example Setup ETCO2 Dialogue**

	Lower Limit	Upper Limit		Alarms On	Print on Alarm
ETCO2	25	60	Auto	No Yes	No Yes
RR	5	30	Auto	No Yes	No Yes
FICO2		5	Auto	No Yes	No Yes
IPI	4		Auto	No Yes	No Yes
Size	0 to 40 mmHg			IPI Enabled	No Yes
				IPI Age Range	

## CO2 Alarm Limits

The High and Low End-Tidal CO2 (ETCO2), high and low Respiration Rate (RR), and high Fraction of Inspired CO2 (FICO2) alarm limit conditions can be configured independently. Refer to the Alarm Limits section in this manual for further details.

To adjust the CO2x (where x = ETCO2, RR, and FICO2) alarm limits:

1. Select the CO2 numeric parameter tile to display the Setup CO2 dialogue.
  - a. Adjust the Upper alarm limit by selecting the up/down arrows to move the upper alarm limit box until the desired value is reached.
  - b. Adjust the Lower alarm limit, select the up/down arrows to move the lower alarm limit box until the desired value is reached.
2. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The CO2x alarm limits may also be adjusted via the Settings quick-action key. Refer to the Settings Alarm Limits section in this manual for further details.

## IPI Low Alarm Limit

The Surveyor S12 and S19 patient monitors support an IPI low alarm limit. The IPI low alarm limit produces alarm notifications when the IPI value drops below the configured IPI low alarm limit setting.

To enable the patient monitor to alarm when the IPI gets below a specific value:

1. Select the CO2 numeric parameter tile to display the Setup CO2 dialogue.
2. Locate the IPI low alarm limit label.
  - Select the up/down arrows to move the lower alarm limit box until the desired value is reached.
  - Choices include OFF, 1-9 in increments of 1.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The IPI alarm limits may also be adjusted via the Settings quick-action key. Refer to the Settings Alarm Limits section in this manual for further details.

## CO2 Auto

The Auto set feature automatically calculates the high and low CO2 alarm limits based on the current values.

Parameter	Lower limit adjustment	Upper limit adjustment
ETCO2	Changes to 80% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Changes to 120% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)
RR-CO2	Changes to 80% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Changes to 125% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)
FiCO2	N/A	Changes to 110% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)
IPI	Changes to 80% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	N/A

To Auto set an alarm:

1. Select the CO2 numeric parameter tile to display the Setup CO2 dialogue.
2. Select the Auto button. Notice the limit values in the Lower Limit window and the Higher Limit window adjust.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## CO2 Alarms On

The Alarms On feature for the CO2 alarms can be configured independently for the End-Tidal CO2 (ETCO2), Respiration Rate (RR), and Fraction of Inspired CO2 (FICO2) parameters.



**WARNING:** *Disabling the CO2x (where x = ETCO2, RR, and FICO2) alarm limits means that NO low or high CO2x alarm conditions will produce alarm notifications. Use this feature with extreme caution.*

To enable/disable the CO2x (where x = ETCO2, RR, and FICO2) alarm limits:

1. Select the CO2 numeric parameter tile to display the Setup CO2 dialogue.
2. Locate the CO2x label.
3. Locate the Alarms On button next to the CO2x label.
  - a. Select Yes to enable CO2x alarms.
  - b. Select No to disable CO2x alarms.
    - The Alarm Off icon displays in the CO2 numeric parameter tile.

**NOTE:** *The Lower Limit and Higher Limit windows in the Setup CO2 dialogue may contain limit values but these alarms ARE disabled if the Alarms On button is set to NO.*

4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## CO2 Print on Alarm

The High and Low End-Tidal CO2 (ETCO2), high and low Respiration Rate (RR), and high Fraction of Inspired CO2 (FICO2) alarm limit conditions can be configured to automatically print a real-time waveform report when the alarm occurs. The Print on Alarm feature for the CO2 alarms can be configured independently for the End-Tidal CO2 (ETCO2), Respiration Rate (RR), and Fraction of Inspired CO2 (FICO2) parameters.

To enable/disable a CO2x (where x = ETCO2, RR, and FICO2) alarm limit conditions to automatically print:

1. Select the CO2 numeric parameter tile to display the Setup CO2 dialogue.
2. Locate the CO2x label.
3. Locate the Print On Alarm button.
  - a. Select Yes to enable the Print On Alarm.
  - b. Select No to disable the Print On Alarm.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The Print On Alarm feature for the CO2x alarm limit conditions may also be adjusted via the Settings quick-action key. Refer to the Print On Alarm section in this manual for further details.

## CO2 Waveform Size

To adjust the size or gain of the CO2 waveform:

1. Select the CO2 numeric parameter tile to display the Setup CO2 dialogue.
2. Locate the CO2 Size label.
3. Select the arrow to display the drop down list box choices (0-40 mmHg, 0-60 mmHg, and 0-80 mmHg).
4. Select the desired waveform size.
5. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## IPI Enabled/Disabled



**WARNING:** *Disabling the IPI parameter means that the monitor will NOT produce any IPI alarm notifications. Use this feature with extreme caution.*

For the patient monitor to perform IPI low alarm surveillance, the IPI parameter must be enabled via the Setup CO2 dialogue.

To enable/disable the surveillance of the IPI parameter:

1. Select the CO2 numeric parameter tile to display the Setup CO2 dialogue.
2. Locate the IPI Enabled label.
  - a. Select Yes to enable the display/alarm surveillance of the IPI parameter.
  - b. Select No to disable the display/alarm surveillance of the IPI parameter.
    - The IPI numeric value is removed from display in the CO2 numeric parameter tile.
    - The IPI low alarm limit is disabled.

**NOTE:** *If the IPI is disabled, NO low IPI alarm notifications are produced.*

3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## IPI Age Range (Pediatric Only)

Because normal values for physiological parameters are different for different age categories, the IPI algorithm differs for different age groups.

When the Surveyor S12 and S19 patient monitors are configured for the Pediatric mode, the appropriate IPI age range must be configured.

**NOTE:** *Entering the date of birth in the Patient Information dialogue does NOT set the IPI age range for the Pediatric patient.*

To configure the appropriate IPI age range:

1. Select the CO2 numeric parameter tile to display the Setup CO2 dialogue.
2. Locate the IPI Age Range label (Only available when in Pediatric mode).
3. Select the arrow to display the drop down list box.
  - Choices include 1-3 years, 3-6 years, and 6-12 years.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

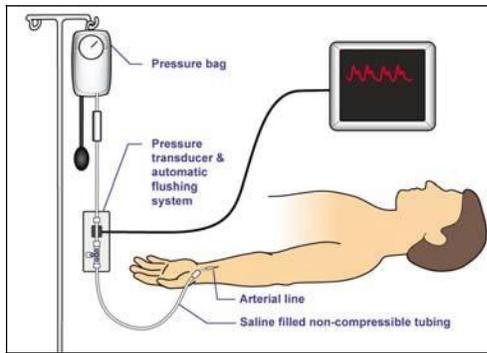


## 22. INVASIVE PRESSURE MONITORING

### Overview

Invasive pressure monitoring (Px) is a direct measurement of the patient's arterial or venous pressure. The invasive pressure setup, consisting of connecting tubing, a pressure transducer, and a fluid source to maintain pressure (all connected together by stopcocks) is attached to the catheter. The transducer is placed at the same level with the heart, and is electrically zeroed. The transducer is a piezo-resistive device that converts the pressure signal to a voltage. The monitor interprets the voltage signal so that pressure data and pressure waveforms can be displayed.

**Figure 61 Example of an Arterial Line Manifold Setup**



The Surveyor patient monitor can display the invasive pressure waveform and numeric parameters. The invasive pressure may be displayed as Systolic, Diastolic and/or Mean values based on the invasive pressure label. All invasive pressure numeric values use “mmHg” for the units of measure. Pulse rate can be monitored with any arterial site labeled as ART. PAWP can be measured for an invasive pressure site labeled as PA.

The Surveyor S12 and S19 bedside monitors may monitor up to 4 channels of invasive pressures depending upon the monitor configuration.

### Invasive Pressure Monitoring Procedure



**WARNING:** Always follow the hospital standard of care and prudent clinical discretion for connecting, zeroing, and monitoring invasive pressure lines.

To begin invasive pressure monitoring:

1. Connect the invasive pressure cable to the invasive pressure port on the side of the Surveyor patient monitor. If your monitor supports multiple invasive pressure channels, the cable will be supplied with a Y-cable where the pressure sensor will connect to two invasive pressure sensors.
2. Connect the transducer manifold to the invasive pressure cable.
3. Open the Setup Invasive Pressure dialogue for this particular channel.
4. Define the invasive pressure label for this channel as appropriate.
5. Verify the parameter format (Sys/Dia or Mean) and the waveform size is appropriate.
6. Zero the pressure by opening the transducer vent, and pressing “Zero Set” in the Setup Invasive Pressure dialogue for that particular channel or “Zero All” in any of the Setup Invasive Pressure dialogues.

7. Close the transducer vent.
8. Verify the alarm limits for this invasive pressure channel as appropriate.
9. Connect the transducer to the patient per clinical guidelines. Follow standard hospital procedures for zeroing and flushing the pressure line.

**Best Practice Recommendation:** If a bedside recording is needed for documenting the insertion of an invasive pressure such as is common when inserting a Pulmonary Artery catheter, prior to patient insertion ensure the PA waveform is chosen for printing in the Setup>Setup Recorder dialogue. Selecting the Print quick-action key on the main screen during PA insertion can produce the bedside printouts.

## Invasive Pressure Display

Figure 62 Main Screen Example: Four Invasive Pressures



### Invasive Pressure Waveform Parameter Tile

The invasive pressure waveform may be shown in one of the bottom four available waveform slots. The invasive pressure waveform is located to the left of the corresponding invasive pressure numeric parameter tile

### Invasive Pressure Numeric Parameter Tile

The invasive pressure numeric parameter tile may display:

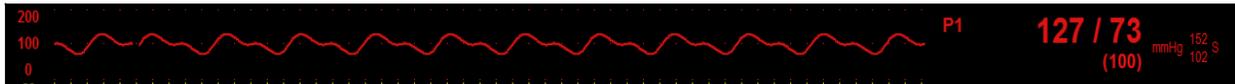
- The invasive pressure parameter label.
- The current systolic, diastolic, and mean invasive pressure numeric values.
- The “mmHg” unit of measure.
- The systolic invasive pressure alarm limits if the systolic invasive pressure alarm limits are enabled.
- The Alarm Off icon if any of the invasive pressure alarm limits are disabled.
- If the invasive pressure is labeled as the Pulmonary Artery (PA) parameter, the PAWP numeric value in the PA tile automatically erases when the PAWP measurement is older than 60 minutes.

The invasive pressure parameter colors are

- P1: Red
- P2: Light Blue
- P3: Yellow
- P4: Magenta
- ART: Red
- PA: Yellow

- RA: Light Blue
- LA: Light Blue
- CVP: Light Blue
- ICP: Magenta
- PAWP: Yellow
- LA: Light Blue
- CVP: Light Blue
- ICP: Magenta
- PAWP: Yellow

Figure 63 Example Invasive Pressure Waveform and Numeric Parameter Tiles



### Invasive Pressure Alarm Behaviors

The invasive pressure numeric parameter tile flashes during an invasive pressure alarm condition. The alarm light, invasive pressure numeric parameter tile, and invasive pressure alarm message displays in the color of the configured invasive pressure alarm level. The alarm audio notification is produced according to the alarm level configured.

### Setup Invasive Pressure Dialogue

To access the invasive pressure setup dialogue, select the invasive pressure numeric tile. The invasive pressure setup dialogue provides controls for configuring the selected invasive pressure.

Figure 64 Invasive Pressure Setup Dialogue

### Invasive Pressure Alarm Limits

High and low invasive pressure alarm limits can be configured independently for the Systolic (“Ps”), Mean (“Pm”), and Diastolic (“Pd”) invasive pressure parameters.

To adjust the Px (where x= s, d, or m) alarm limits:

1. Select the invasive pressure numeric parameter tile to display the Setup Invasive Pressure dialogue.
2. Locate the Px label.
  - a. Adjust the Lower alarm limit by selecting the up/down arrows to move the lower alarm limit box until the desired value is reached.
  - b. Adjust the Upper alarm limit by selecting the up/down arrows to move the upper alarm limit box until the desired value is reached.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

The Px alarm limits may also be adjusted via the Settings quick-action key. Refer to the Settings Alarm Limits section in this manual for further details.

### Auto Set Invasive Pressure Alarm Limits

The Auto Set feature for the invasive pressure alarm limits can be configured independently for the Systolic (“Ps”), Mean (“Pm”), and Diastolic (“Pd”) blood pressure parameters. The Auto set feature automatically calculates the high and low Px alarm limits based on the current value.

Parameter	Lower limit adjustment	Upper limit adjustment
Invasive Pressure (P) – Systolic, Mean & Diastolic	Changed to 80% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)	Changed to 120% of the current parameter value (or the nearest allowable value given the alarm limit settings rules)

To Auto set an Px (where x= s, d, or m) alarm:

1. Select the invasive pressure numeric parameter tile to display the Setup Invasive Pressure dialogue.
2. Locate the Px label.
3. Select the Auto button next to the Px label. Notice the limit values in the Lower Limit window and the Higher Limit window adjust.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### Invasive Pressure Alarms On

The Alarms On feature for the invasive pressure alarms can be configured independently for the Systolic (“Ps”), Mean (“Pm”), and Diastolic (“Pd”) invasive pressure parameters.



**WARNING:** *Disabling the Px alarm limits means that NO low or high Px alarm conditions will produce alarm notifications. Use this feature with extreme caution.*

To enable/disable the Px (where x =s, m, or d) alarm limits:

1. Select the invasive pressure numeric parameter tile to display the Setup Invasive Pressure dialogue.
2. Locate the Px label.
3. Locate the Alarms On button next to the Px label.
  - a. Select Yes to enable Px alarms.
  - b. Select No to disable Px alarms.
    - The Alarm Off icon displays in the invasive pressure numeric parameter tile.

**NOTE:** The Lower Limit and Higher Limit windows in the Setup Invasive Pressure dialogue may contain limit values but these alarms ARE disabled if the Px Alarms On button is set to NO.

4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### Invasive Pressure Print on Alarm

The Print on Alarm feature for the invasive pressure alarms can be configured independently for the Systolic (“Ps”), Mean (“Pm”), and Diastolic (“Pd”) invasive pressure parameters.

To enable/disable the Px (where x =s, m, or d) alarm limit conditions to automatically print:

1. Select the invasive pressure numeric parameter tile to display the Setup Invasive Pressure dialogue.
2. Locate the Px label.
3. Locate the Print On Alarm button next to the Px label.
  - a. Select Yes to enable the Print On Alarm.
  - b. Select No to disable the Print On Alarm.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

If the clinician requires the invasive waveform to be the waveform to print at the beside recorder when the invasive pressure alarm occurs, ensure the correct invasive pressure waveform is selected for printing via the Setup>Setup Recorder dialogue. Refer to the Setup Recorder dialogue section in this manual for further details.

The Print On Alarm feature for the invasive pressure alarm limit conditions may also be adjusted via the Settings quick-action key. Refer to the Print On Alarm section in this manual for further details.

### Invasive Pressure Label

Use the label field to assign the particular label to each invasive pressure input. Note that labels must be unique across various different invasive pressure inputs. When changing labels, the associated ranges and alarm limits will automatically change based on pre-defined values.

By default, the invasive pressure channels are labeled generically and displayed as P1 through P4. The pressure channels can be assigned to any of the following labels:

Label	Definition
Art	Arterial Blood Pressure
PA	Pulmonary Artery Pressure
RA	Right Atrial Pressure
LA	Left Atrial Pressure
CVP	Central Venous Pressure
ICP	Intracranial Pressure

To label an invasive pressure channel:

1. Select the invasive pressure numeric parameter tile to display the Setup Invasive Pressure dialogue.
2. Locate the invasive pressure label.
3. Select the arrow to display the drop down list box.
  - Choices include a generic P1-4 (dependent on channel chosen), ART, PA, RA, LA, CVP and ICP.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### Invasive Pressure Format

Generic invasive pressure inputs are those that have not been assigned a specific label. The generic invasive pressure labels are P1, P2, P3, and P4. When using a generic invasive pressure inputs, the values can be displayed in two formats:

- Sys/Dia with Mean pressure shown in parenthesis underneath.
- Mean pressure in parenthesis with the Sys/Dia shown underneath.

When the invasive pressure is labeled, the format is determined by the label chosen.

Label	Format
Art	Sys/Dia (Mean)
PA	Sys/Dia (Mean)
RA	Mean
LA	Sys/Dia (Mean)
CVP	Mean
ICP	Mean

To choose a invasive pressure format for a generic invasive pressure (P1-P4):

1. Select the invasive pressure numeric parameter tile to display the Setup Invasive Pressure dialogue.
2. Locate the invasive pressure format label.
3. Select the arrow to display the drop down list box choices (Sys/Dia, Mean).
4. Select the desired label.
5. Select the OK button to enter that change OR select the Cancel button to cancel the changes

### Invasive Pressure Waveform Size

To adjust the size of the invasive pressure waveform:

1. Select the invasive pressure numeric parameter tile to display the Setup Invasive Pressure dialogue.
2. Locate the invasive pressure size label.
3. Select the arrow to display the drop down list box.
  - Choices include:
    - (-10 to 20 mmHg)
    - (-10 to 60 mmHg)
    - (0-150 mmHg)
    - (0-200 mmHg)
    - (0-300 mmHg)
4. Select the desired waveform size.
5. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### Invasive Pressure Zero Set



**WARNING:** Intracranial Pressure (ICP) monitoring should only be zeroed prior to patient insertion. Follow hospital standard of care and clinical guidelines for maintenance of ICP monitoring.

As part of initial invasive pressure manifold setup prior to monitoring, the invasive pressure transducer must be zeroed before initial patient measurements are taken.

**NOTE:** Always follow hospital standard of care and clinical guidelines when zeroing an invasive pressure.

A general recommendation for zeroing a non-ICP invasive pressure is to zero:

- Upon initial startup prior to patient connection.
- When replacing an existing transducer with a new manifold set up.
- When connecting a new transducer, cable or tubing manifold set up.
- When replacing an existing transducer with a new manifold set up.
- When restarting the Surveyor patient monitor after a Standby Mode.
- Before initiating treatment changes reliant upon pressures data.
- Whenever the patient's body position changes.
- In the event of incorrect or questionable pressure readings.

The Zero Set button allows the clinician to zero that particular invasive pressure. To zero a particular invasive pressure:

1. Ensure the invasive pressure cable, pressure transducer, and flush tubing manifold is connected properly as per hospital standard of care and clinical guidelines.
2. Ensure the invasive pressure cable is inserted into the proper invasive pressure port on the side of the Surveyor S12/S19 patient monitor.
3. Select the invasive pressure numeric parameter tile to display the Setup Invasive Pressure dialogue.
4. Open the non-ICP pressure transducer vent to atmosphere.
5. Select the Zero Set button in the Setup Invasive Pressure dialogue.
6. Observe the patient monitor for the following:
  - A Zeroing in Progress message appears in the system message area briefly.
  - The numerics in the invasive pressure tile goes to "0".
  - A Zeroing Complete message appears in the system message area briefly.
7. Close the pressure transducer vent from atmosphere.
8. If connected to the patient, the patient's invasive waveform and numeric parameters should display as configured.

**NOTE:** To reduce nuisance alarms, the invasive pressure alarms are inactivated for a few seconds during the zeroing process. Invasive pressure alarms are reactivated shortly after the zeroing process has been completed.

### Invasive Pressure Zero All



**WARNING:** Intracranial Pressure (ICP) monitoring should only be zeroed prior to patient insertion. Follow hospital standard of care and clinical guidelines for maintenance of ICP monitoring.

**NOTE:** Always follow hospital standard of care and clinical guidelines when zeroing an invasive pressure.

Refer to the Zero Set section in this manual for further details on zeroing invasive pressures.

The Zero All button allows the clinician to zero all invasive pressure at one time. To zero all invasive pressures at one time:

1. Ensure the invasive pressure cables, pressure transducers, and flush tubing manifolds are connected properly as per hospital standard of care and clinical guidelines.
2. Ensure the invasive pressure cables are inserted into the proper invasive pressure ports on the side of the Surveyor S12/S19 patient monitor.
3. Select an invasive pressure numeric parameter tile to display the Setup Invasive Pressure dialogue.

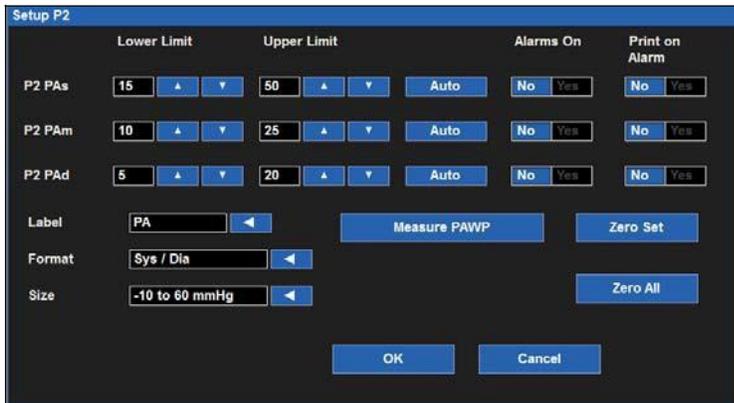
4. Open the appropriate non-ICP pressure transducer vents to atmosphere.
5. Select the Zero All button in the Setup Invasive Pressure dialogue.
6. Observe the patient monitor for the following:
  - A Zeroing in Progress message for appears in the system message area briefly.
  - The numerics in the invasive pressure tiles goes to “0”.
  - A Zeroing Complete message appears in the system message area briefly.
7. Close the pressure transducer vents from atmosphere.
8. The patient’s invasive waveforms and numeric parameters should display as configured.

*NOTE: To reduce nuisance alarms, the invasive pressure alarms are inactivated for a few seconds during the zeroing process. Invasive pressure alarms are reactivated shortly after the zeroing process has been completed.*

## Measuring PAWP

When an invasive pressure channel is labeled as Pulmonary Artery (“PA”), a pulmonary artery wedge pressure (“PAWP”) can be obtained. The Measure PAWP dialogue is not available until an invasive pressure is labeled as a PA waveform.

**Figure 65 Example Pulmonary Artery Invasive Pressure Dialogue**



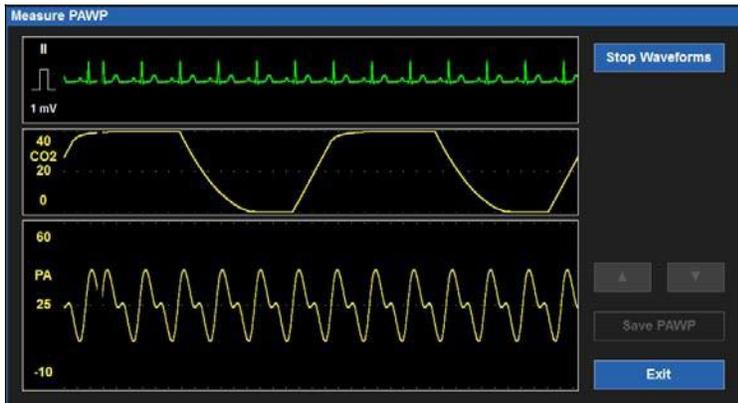
The PA invasive pressure dialogue contains a Measure PAWP button that when selected accesses the PAWP dialogue.

The Measure PAWP dialogue can also be accessed via the Setup CO dialogue. Refer to the Setup CO dialogue section in this manual for further details.

To access the Measure PAWP dialogue:

1. Select the PA invasive pressure numeric parameter tile to display the Setup PA(Px) Invasive Pressure dialogue.
2. Select the Measure PAWP button.
3. The Measure PAWP dialogue displays.

Figure 66 Example Measure PAWP Dialogue



The Measure PAWP dialogue displays three real-time waveforms:

- The ECG tracing located in waveform position 1 of the main screen.
- The CO2 waveform (if being monitored) or the Respiration waveform.
- The PA waveform.

These three real-time waveforms can be used to sync the end-expiration phase of the patient's breathing cycle with the correct timing for obtaining the PAWP parameter.

***NOTE:** Always follow hospital standard of care and clinical guidelines for PAWP measuring.*

To obtain a PAWP measurement:

1. Correlate the end-expiration point of the patient's breathing pattern by clinical palpation of the patient's chest while viewing the CO2/Resp waveform.
2. Inflate the PAWP balloon of the PA catheter just until the PA waveform dampens.

***NOTE:** Always follow the manufacturer's recommended instructions, hospital standard of care, and clinical guidelines for using, inflating, and deflating the PAWP balloon of the Pulmonary Artery catheter.*

3. Select the Stop Waveforms button in the Measure PAWP dialogue to freeze the waveforms.
4. Passively allow the PAWP balloon to deflate.

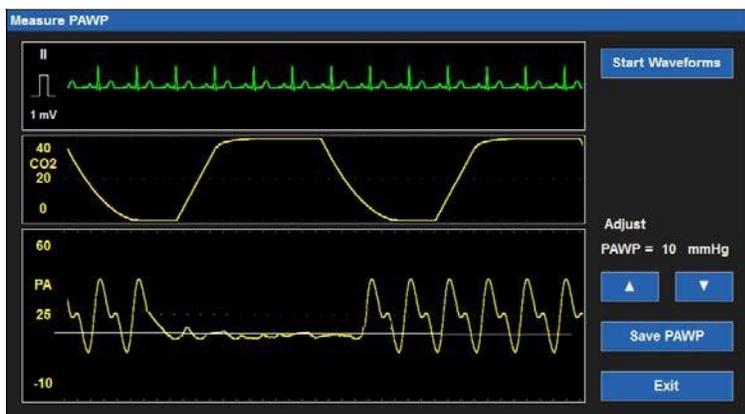


**WARNING:** Leaving the PAWP balloon inflated for longer than 3 seconds can cause serious patient consequences. Ensure the PAWP balloon is inflated for less than 3 seconds. If the PA waveform does not dampen appropriately upon PAWP balloon inflation, stop, deflate the balloon, and consult the physician as per hospital standard of care and clinical guidelines.

5. With the waveforms stopped (frozen), the Measure PAWP dialogue changes:
  - a. A white cursor line is placed in the PA/PAWP waveform close to where the dampened PAWP is located.
  - b. Use the Up and Down arrows to fine tune the location of the PAWP cursor line.

- c. Notice the PAWP numeric changes as the PAWP cursor is adjusted.
  - d. When the PAWP cursor is placed in the desired location, select Save PAWP:
    - Once saved, the waveforms in the Measure PAWP dialogue go to a real-time view.
    - The PAWP numeric and timestamp displays in the PA numeric parameter tile in the main screen.
    - The PAWP numeric value and timestamp automatically erase when the PAWP measurement is older than 60 minutes.
    - The PAWP numeric is placed into the Hemodynamics Calcs dialogue.
6. Select the Exit button to close the Measure PAWP dialogue.

**Figure 67 Example Measure PAWP Dialogue: Stop Waveform**



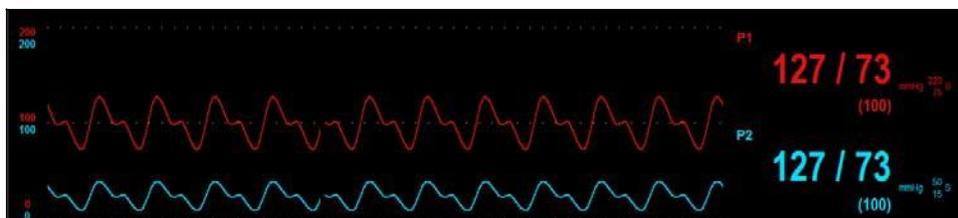
### Printing the PAWP Waveform

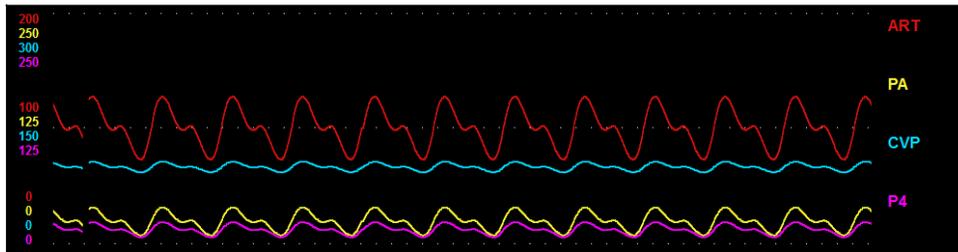
Prior to measuring the PAWP, select the PA waveform as one of the waveforms to print to the bedside recorder via the Setup> Setup Recorder dialogue. Refer to the Setup Recorder dialogue in this manual for further details. When in the Measure PAWP dialogue, select the Print quick-action key on the main screen during the wedging process to print the dampening PA waveform to the bedside recorder.

### Overlapping Invasive Pressures

The Surveyor S12 and S19 patient monitors provide the ability to overlap invasive pressures in one expanded waveform area. This feature allows the clinician to place the synchronized invasive pressure waveforms into one large waveform area to check for the alignment of a waves, c waves, dicrotic notches, and other fluctuations in the invasive waveforms. When selected to overlap, any available invasive pressure waveform will overlap into one expanded waveform area.

**Figure 68 Example of Two Overlapped Invasive Pressure Waveforms**



**Figure 69 Example of Four Overlapped Invasive Pressure Waveforms**

To enable/disable overlap invasive pressure waveforms:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Waveforms button to access the Setup Waveform Area dialogue.
3. Locate the Overlap Invasive Pressure label.
  - a. Select Yes to overlap all available invasive pressure.
    - The invasive pressures will occupy the space of four waveform slots.
    - The overlapped invasive pressure have independent waveform sizes.
  - b. Select No to keep the invasive pressure waveforms in separate waveform parameter tiles.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.



## 23. THERMODILUTION CARDIAC OUTPUT

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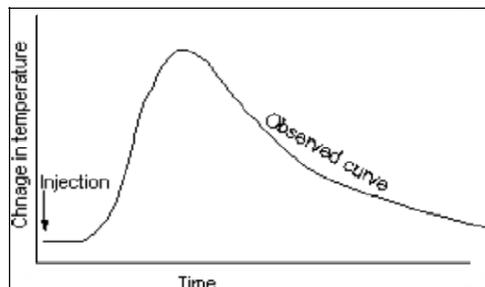
### Overview

The Surveyor S12 and S19 patient monitors can support the use of intermittent thermodilution (bolus) Cardiac Output (CO) based on purchased monitor configuration. Thermodilution Cardiac Output is performed using a Pulmonary Artery (PA) catheter.

Cardiac Output is the amount of blood ejected by the heart over the course of one minute. A cool solution of known temperature and volume (“Injectate”) is injected into the right atrium via the CVP port of the PA catheter. This cooler injectate mixes with the warmer blood as it passes through the ventricle and into the pulmonary artery, thus cooling the blood. So warm blood plus cool injectate equals a change in temperature in the heart for that brief few seconds. The thermistor at the tip of the PA catheter measures the blood temperature. The patient monitor computer measures the change in blood temperature over time as it flows over the thermistor surface. It is looking for how long it takes for the blood temperature to return to its pre-injectate level.

The cardiac output computer in the patient monitor calculates flow (cardiac output from the right ventricle) using the blood temperature information, and the temperature and volume of the injectate. A CO curve is drawn on the patient monitor to show the temperature change over the course of about 1 minute. The faster the change back to the pre-injectate blood temperature, the quicker the blood flow. The slower the change back to pre-injectate values, the slower the blood flow.

The monitor draws an inverse curve with the change in temperature on the y-axis and the time on the x-axis. As the injectate is introduced, mixes with the blood, and the temperature in the right atrium cools, the curve is drawn inversely upwards. As the mixture warms and returns to normal temperature, the curve returns to baseline.



Cardiac Output is the amount of blood ejected from the left ventricle each minute and is expressed in liters per minute (l/min). In addition to Cardiac Output, the Surveyor patient monitors also support the Cardiac Index (CI) parameter. The Cardiac Index is displayed if the patient’s height and weight is entered and the CO parameter is current.

### CO Display

The CO tile is always located in the lower middle of Numeric Parameter B section on the Surveyor S12 and S19 patient monitor’s main screen. When the CO measurement is accepted, the Surveyor patient monitor displays the CO numeric value in the CO tile. The Cardiac Index (CI) numeric value is also displayed if the patient’s height and weight has been entered into the monitor. The CO tile is located in the lower middle portion of the main screen.

Figure 70 Example Cardiac Output Tile



The CO tile may display:

- The CO parameter label.
- The CO numeric value.
- The timestamp of the most recent CO value.
- The “l/min” CO units of measure label.
- The CI numeric value if the patient’s height and weight has been entered.
- The “l/min/m<sup>2</sup>” CI units of measure label.
- The CO numeric values are shown in red color.
- CO/CI numeric values older than 60 minutes are removed from the main screen display.

## CO Alarm Behaviors

There are no alarms associated with cardiac output, cardiac index, or hemodynamic calculation values.

## Setup CO Dialogue

To access the Setup CO dialogue, select the CO numeric tile. The Setup CO dialogue provides controls for configuring the computation constant, the injectate probe type, the ability to measure the CO, and provides access to the Hemodynamic Calculations dialogue.

Figure 71 Setup CO Dialogue

## Computation Constant

The computation constant is a numeric value based on the Pulmonary Artery catheter size, injectate temperature, and volume of injectate. This computation constant must be entered into the Surveyor S12 and S19 patient monitors before a Cardiac Output may be obtained. Once entered, the computation constant remains for that patient until manually changed, the patient is discharged, or the monitor is powered down/on.

Refer to the Pulmonary Artery catheter manufacturer’s package insert for the correct computation constant.

**Best Practice Recommendation:** Always check to ensure the correct computation constant is entered prior to obtaining the cardiac output.

To enter/adjust the CO computation constant:

1. Select the CO numeric parameter tile to display the Setup CO dialogue.
2. Locate the Computation Constant label.
3. Use the Up and Down arrows to fine tune the CO computation constant.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### Injectate Probe Type

To enter/revise the CO injectate probe type:

1. Locate the Injectate Probe Type label.
2. Select the arrow to display the drop down list box.
  - Choices include In-Line, and Bath.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

### Measure PAWP

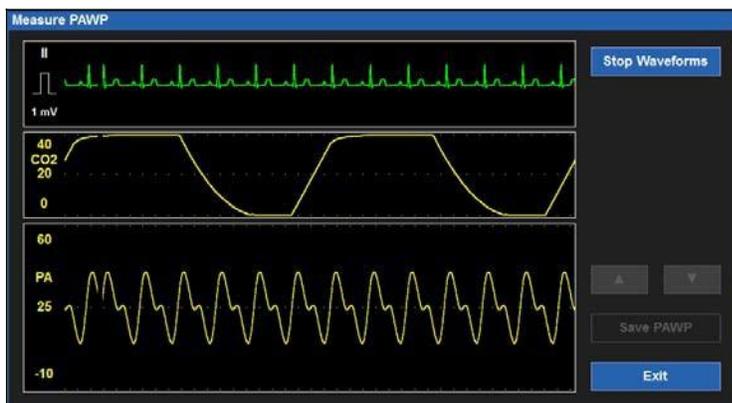
When an invasive pressure channel is labeled as Pulmonary Artery (“PA”), a pulmonary artery wedge pressure (“PAWP”) can be obtained via the Setup CO dialogue.

The Measure PAWP dialogue can also be accessed via the Setup PA Invasive Pressure dialogue. Refer to the Setup PA Invasive Pressure dialogue section in this manual for further details.

To access the Measure PAWP dialogue:

1. Select the PA invasive pressure numeric parameter tile to display the Setup PA Invasive Pressure dialogue.
2. Select the Measure PAWP button.
3. The Measure PAWP dialogue displays.

**Figure 72 Example Measure PAWP Dialogue**



The Measure PAWP dialogue displays three real-time waveforms:

- The ECG tracing located in waveform position 1 of the main screen.
- The CO<sub>2</sub> waveform (if being monitored) or the Respiration waveform.
- The PA waveform.

These three real-time waveforms can be used to sync the end-expiration phase of the patient's breathing cycle with the correct timing for obtaining the PAWP parameter.

**NOTE:** Always follow hospital standard of care and clinical guidelines for PAWP measuring.

To obtain a PAWP measurement:

1. Correlate the end-expiration point of the patient's breathing pattern by clinical palpation of the patient's chest while viewing the CO<sub>2</sub>/Resp waveform.
2. Inflate the PAWP balloon of the PA catheter just until the PA waveform dampens.

**NOTE:** Always follow the manufacturer's recommended instructions, hospital standard of care, and clinical guidelines for using, inflating, and deflating the PAWP balloon of the Pulmonary Artery catheter.

3. Select the Stop Waveforms button in the Measure PAWP dialogue to freeze the waveforms.
4. Passively allow the PAWP balloon to deflate.



**WARNING:** Leaving the PAWP balloon inflated for longer than 3 seconds can cause serious patient consequences. Ensure the PAWP balloon is inflated for less than 3 seconds. If the PA waveform does not dampen appropriately upon PAWP balloon inflation, stop, deflate the balloon, and consult the physician as per hospital standard of care and clinical guidelines.

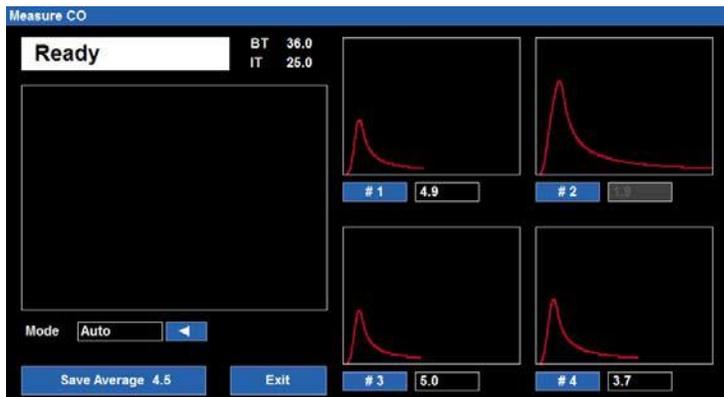
5. With the waveforms stopped (frozen), the Measure PAWP dialogue changes:
  - a. A white cursor line is placed in the PA/PAWP waveform close to where the dampened PAWP is located.
  - b. Use the Up and Down arrows to fine tune the PAWP cursor.
  - c. Notice the PAWP numeric changes as the PAWP cursor is adjusted.
  - d. When the PAWP cursor is placed in the desired location, select Save PAWP.
    - Once saved the waveforms in the Measure PAWP dialogue go to a real-time view.
    - The PAWP numeric and timestamp is displayed in the PA numeric parameter tile in the main screen.
      - The PAWP numeric value and timestamp is removed from the PA numeric parameter tile in the main screen after a lapse of 60 minutes.
    - The PAWP numeric is placed into the Hemodynamics Calcs dialogue.
6. Select the Exit button to close the Measure PAWP dialogue.

## Begin CO Measurement

To begin a CO measurement:

1. Select the CO numeric parameter tile to display the Setup CO dialogue.
2. Locate the Begin CO Measurement button.
3. Selecting the Begin CO Measurement button opens the Measure CO dialogue.

Figure 73 Measure CO Dialogue



### Measure CO Dialogue Overview

The Measure CO dialogue contains:

- A CO status message area in the top left corner of the dialogue.
- The core Blood Temperature obtained from the Pulmonary Artery catheter (“BT”) in degrees Celsius.
- The injectate temperature (“IT”) in degrees Celsius.
- The CO Mode feature (Choices are Auto, and Manual).
- One large box that shows the current CO measurement curve in progress.
- Four smaller boxes:
  - Each box displays the previous CO curves obtained.
  - The most recent CO curve is displayed in Box #1.
  - The CO curves progress with the oldest CO curve displayed in Box#4.
  - Each box is associated with the box label (#1-#4).
  - Each box is associated with the CO numeric value for that particular CO curve.
- A Save Average action button.
- An Exit button.

The blood and injectate temperatures displays on the Measure CO screen. When the monitor is ready to begin the CO run, a “Ready” message displays in the top left corner of the Measure CO screen.

As the CO solution is injected and sensed by the monitor, the CO curve begins displaying in the large box, drawing from left to right. The CO curve stops drawing when the monitor senses the equilibration of temperature. Once the CO curve stops drawing, it is removed from display in the large box and enters into Box#1. The “Ready” message should display in the CO message area.

This cycle repeats as each CO curve is shot, moving the oldest CO curve into the next oldest box. The Measure CO screen only displays up to four CO curves. If more than four CO curves are shot, the oldest CO curve is deleted to allow room for the newer CO curves.

The CO curve has a fixed full-scale gain of 1 degree C (no auto-scaling) without waveform scales. The CO curve has a fixed sweep speed of 6.25 mm/sec.

### CO Mode

The Surveyor patient monitor supports auto and manual CO modes.

To select the CO Mode:

1. Select the CO numeric parameter tile to display the Setup CO dialogue.
2. Locate the Begin CO Measurement button.
3. Selecting the Begin CO Measurement button opens the Measure CO dialogue.
4. Select the CO Mode button.
5. Select the arrow to display the drop down list box.
  - a. Choices include Auto, and Manual.
  - b. If Manual is selected, a Start button appears.
  - c. When in Manual mode, select the Start button to begin the CO curve.

**Auto CO Mode:** In auto mode, the patient monitor prompts the clinician when the patient monitor is ready to begin a search for a thermodilution curve by displaying the “Ready” message in the Measure CO message area. The “Ready” message is accompanied by an audible tone signifying to start injecting the injectate fluid. The “Ready” message and audible tone occurs when the monitor determines the baseline blood temperature is stable.

When a CO value has been calculated, the patient monitor sounds an audible tone. It then transitions back to the ready state and sound a tone to indicate that it is ready for the next injection.

To begin a CO curve when in Auto Mode:

1. Connect the proper Cardiac Output cable and PA catheter.
2. From the PA catheter package insert, verify the correct computation constant for the catheter type, injectate volume, and injectate temperature. Enter the computation constant which by default starts at 0.500 and may be changed as appropriate. Note that the last computation constant is remembered in between various monitoring session. Once entered, the computation constant remains for that patient until manually changed, the patient is discharged, or the monitor is powered down/on.
3. Verify proper PA catheter positioning.
4. When a baseline blood temperature is obtained, the monitor displays “Ready”.
5. Use correct injectate port. Inject correct volume in smooth motion.
6. Once a bolus is injected, the CO curve appears, the resultant CO measurement is displayed.
7. Up to 3 additional cardiac output runs may be performed as desired when the “Ready” message is displayed.
8. When sufficient CO runs are completed, verify that all values are appropriate and deselect those that may be erroneous or unwanted. Select “Save Average” and confirm with “OK” to display the results in the CO tile and save it in the trend data.

**Manual CO Mode:** The manual mode allows the clinician to determine the appropriate time to begin the injection of the solution. In manual mode, the ready status is indicated immediately and it is up to the clinician to inject at the appropriate time. If the monitor cannot identify a change in temperature within 30 seconds, the manual mode times out.

To begin a CO curve when in Manual Mode:

1. Connect the proper Cardiac Output cable and PA catheter.
2. From the PA catheter package insert, verify the correct computation constant for the catheter type, injectate volume, and injectate temperature. Enter the computation constant which by default starts at 0.500 and may be changed as appropriate. Note that the last computation constant is remembered in between various monitoring session. Once entered, the computation constant remains for that patient until manually changed, the patient is discharged, or the monitor is powered down/on.

3. Verify proper PA catheter positioning.
4. Select “Start” to begin the procedure. “Ready” will be displayed. You may begin to inject the bolus within a 30-second period.
5. Use correct injectate port. Inject correct volume in smooth motion.
6. Once a bolus is injected, the CO curve appears, the resultant CO measurement is displayed.
7. Up to 3 additional cardiac output runs may be performed as desired when the “Ready” message is displayed.
8. When sufficient CO runs are completed, verify that all values are appropriate and deselect those that may be erroneous or unwanted. Select “Save Average” and confirm with “OK” to display the results in the CO tile and save it in the trend data.

### Save Average

The monitor automatically averages the CO curves displayed in the Measure CO dialogue. The averaged CO numeric is displayed in the Measure CO in the Save Average label.

If necessary, any of the CO curves may be eliminated from the averaged CO numeric.

To exclude a CO curve from the averaged CO:

1. Select the box # label under the CO to eliminate.
2. Once selected, the CO numeric near the box # label chosen is grayed.
3. To include a CO curve in the averaged CO that has been previously excluded, select the CO box # label a second time.
4. This enables the CO value for that CO curve and includes the value in the averaged CO numeric.

To Save the Averaged CO:

1. Once the clinician is satisfied with the CO curves and numeric values, select the Save Average button.
2. A confirmation dialogue is displayed.
  - a. Selecting Yes to the Save the Averaged CO confirmation message places the CO numeric values in the CO parameter tile on the main screen, into the Trends list, and into the Hemodynamic Calculations dialogue. The Cardiac Index (CI) is also saved if the patient’s height and weight have been previously entered.
  - b. Selecting No to the Save the Averaged CO confirmation message does not save the averaged CO and returns to the Measure CO dialogue.

Once the Measure CO dialogue is exited, the previous CO curves and values are erased from view.

## Hemodynamic Calculations

To enter the Hemodynamics Calculations dialogue:

1. Select the CO numeric parameter tile to display the Setup CO dialogue.
2. Locate the Begin CO Measurement button.
3. Select the Begin CO Measurement button to open the Measure CO dialogue.
4. Select the Hemodynamics Calculations button.

Refer to the Hemodynamics Calculations section in this manual for further details.

## Height

To obtain the Cardiac Index and other indices in the Hemodynamic Calculations dialogue, the patient’s height and weight must be entered. If the height has been previously entered in the Patient Information dialogue then the patient’s height will also appear in the Hemodynamics Profile.

To enter patient height information:

1. Select the Height button.
2. Enter the information using the onscreen keypad.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Weight

To obtain the Cardiac Index and other indices in the Hemodynamic Calculations dialogue, the patient's height and weight must be entered. If the weight has been previously entered in the Patient Information dialogue then the patient's weight will also appear in the Hemodynamics Profile.

To enter patient weight information:

1. Select the Weight button.
2. Enter the information using the onscreen keypad.
3. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## 24. HEMODYNAMIC CALCULATIONS

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### Overview

Hemodynamic Calculations (“HD Calcs”) is a package that takes all of the provided hemodynamic parameters and calculates out other advanced HD parameters. This is typically the “end point” for obtaining hemodynamic information. The patient monitor’s “brain” takes the monitoring data it sees and using industry standard formula and calculates these advanced parameters for the clinicians.

In general, there is a chronology for obtaining hemodynamic parameters:

1. Obtain MAP numeric from the patient monitor.
2. Obtain CVP mean numeric from the patient monitor.
3. Obtain PA systolic, diastolic, and mean numerics from the patient monitor.
4. Obtain PAWP numerics from the patient monitor.
5. Obtain the CO runs using the patient monitor. In some cases, the clinician may shoot 3 or 4 CO runs, delete outliers, and then accept the CO average.
6. Obtain Hemodynamic Calculations using the patient monitor.
7. Print HD Calcs to either strip channel or laser printer at central station (optional).

The PA, ART and CVP numeric values must be available for certain calculations to be made. Alternatively, if known, these can be manually entered to determine the complete calculations. If these pressures are connected, re-sampling may be performed to calculate the hemodynamics based on the latest values. If a PAWP is not measured or manually entered, the values for PVR, LCW and LVSW and associated indices are not shown.

### Hemodynamic Calculation Parameters

The Surveyor S12 and S19 patient monitors support the following hemodynamic calculation parameters:

- Stroke Volume (SV)
- Stroke Volume Index (SVI)
- Systemic Vascular Resistance (SVR)
- Systemic Vascular Resistance Index (SVRI)
- Pulmonary Vascular Resistance (PVR)
- Pulmonary Vascular Resistance Index (PVRI)
- Left Cardiac Work (LCW)
- Left Cardiac Work Index (LCWI)
- Left Ventricular Stroke Work (LVSW)
- Left Ventricular Stroke Work Index (LVSWI)
- Right Cardiac Work (RCW)
- Right Cardiac Work Index (RCWI)
- Right Ventricular Stroke Work (RVSW)
- Right Ventricular Stroke Work Index (RVSWI)

The indices are only displayed if the patient’s height and weight are entered to allow for calculation of the Body Surface Area (BSA).

### Hemodynamic Calculation Dialogue

The Hemodynamic Calculation dialogue is available through the Measure CO dialogue.

To enter the Hemodynamics Calculations dialogue:

1. Select the CO numeric parameter tile to display the Setup CO dialogue.
2. Locate the Begin CO Measurement button.
3. Select the Begin CO Measurement button to open the Measure CO dialogue.
4. Select the Hemodynamics Calculations button.

**Figure 74 Hemodynamics Calculations Dialogue**

Hemodynamic Calculations			
CO	0.8	l/min	
HR	80	bpm	
ARTs	127	mmHg	
ARTd	83	mmHg	
ARTm	101	mmHg	
PAs	40	mmHg	
PAd	10	mmHg	
PAm	20	mmHg	
CVP	20	mmHg	
PAWP	20	mmHg	
Height	70	in	
Weight	156	lb	
BSA	1.86	m <sup>2</sup>	
CI	0.43	l/min/m <sup>2</sup>	
SV	10.00	ml	
SVI	5.35	ml/m <sup>2</sup>	
SVR	8100	dyn·sec/cm <sup>5</sup>	
SVRI	15126	dyn·sec/cm <sup>5</sup> /m <sup>2</sup>	
PVR	0	dyn·sec/cm <sup>5</sup>	
PVRI	0	dyn·sec/cm <sup>5</sup> /m <sup>2</sup>	
LCW	0.88	kg/m	
LCWI	0.47	kg·min/m <sup>2</sup>	
LVSW	11.01	g/m	
LVSWI	5.90	g·min/m <sup>2</sup>	
RCW	0.00	kg/m	
RCWI	0.00	kg·min/m <sup>2</sup>	
RVSW	0.00	g/m	
RVSWI	0.00	g·min/m <sup>2</sup>	

### HD Calcs Input Parameters

The HD Calcs Input Parameters are numeric values that must be entered to perform the HD calculations. The input parameters are used in the formulas to obtain the HD Calcs output parameters.

These input parameters can be entered automatically by the monitor or manually by the clinician.

1. If the monitor “sees” the numeric values (is actively monitoring), the monitor automatically inputs into the HD Calcs dialogue.
2. If the monitor is not actively monitoring these parameters, the clinician can manually input by using the Up/Down arrows.

HD Calcs Input Parameters are:

- CO
- HR
- ARTs
- ARTd
- ARTm
- PAs
- PAd
- PAm
- CVP
- PAWP

## HD Calcs Output Parameters

The HD Calcs Output Parameters are parameters that are calculated based on the input parameters. The ability to calculate certain output parameters is based on the input of the involved input parameters necessary for the calculation formula. For example, if a PWAP is not measured or manually entered, the values for PVR, LCW and LVSW and associated indices are not shown.

As the HD Calcs input numeric parameters are entered, the HD Calcs output numeric parameters automatically update.

HD Calcs Output Parameters include:

- Stroke Volume (SV)
- Stroke Volume Index (SVI)
- Systemic Vascular Resistance (SVR)
- Systemic Vascular Resistance (SVRI)
- Pulmonary Vascular Resistance (PVR)
- Pulmonary Vascular Resistance Index (PVRI)
- Left Cardiac Work (LCW)
- Left Cardiac Work Index (LCWI)
- Left Ventricular Stroke Work (LVSW)
- Left Ventricular Stroke Work Index (LVSWI)
- Right Cardiac Work (RCW)
- Right Cardiac Work Index (RCWI)
- Right Ventricular Stroke Work (RVSW)
- Right Ventricular Stroke Work Index (RVSWI)

## Resample

Once in the HD calculations dialogue, the HD calculations may be re-sampled based on the latest input values. The resampling function is beneficial if the HD calculations are performed but the MAP, for example, was absent or incorrect.

To Resample the HD calculations:

1. Select the Resample button in the HD calculations dialogue.
2. Notice the HD Calcs output numeric values change based on the new updated HD Calcs input values.

## Print

To print the HD Calculations profile:

1. Select the Print button in the HD calculations dialogue.
2. The HD Calcs profile prints to the bedside recorder (optional) as configured.
3. The HD Calcs profile may print to the Surveyor Central Station (optional) as configured.

The HD Calcs numeric values are persistent upon exiting the HD Calcs dialogue until the patient is discharged, the patient mode is changed, or the monitor is powered down/up.



## 25. LIST TRENDS

### Overview

The Surveyor S12 and S19 patient monitors stores numeric parameter values every one minute, each time an NIBP measurement is obtained, and every time an alarm condition occurs. The maximum trend storage is up to 72 hours of tabular list trend data. If the maximum 72 hours has elapsed, the monitor discards the oldest list trend data on a first in/first out basis. This is beneficial to the clinician because newest list trend data is always stored for review. The clinician can determine the Trends display interval to maximize the visibility of the trend values.

The numeric parameter values that may be stored are:

- HR
- ST I, II, III, aVL, aVR, aVF, V1, V2, V3, V4, V5, V6
- RR
- NIBPs, NIBPd, NIBPm, NIBP timestamp
- EtCO<sub>2</sub>, FiCO<sub>2</sub>, IPI
- SpO<sub>2</sub>
- P1s, P1d, P1m
- P2s, P2d, P2m
- P3s, P3d, P3m
- P4s, P4d, P4m
- CO, CO timestamp
- T1, T2,  $\Delta T$

### Trends Dialogue

The list Trends dialogue is where the list trends are displayed. The trends displayed are based on numeric parameters that are currently monitored and those that have been monitored for that patient.

To access the Trends dialogue:

1. Select the Trends quick-action button on the right side of the main screen.
2. The Trends dialogue displays.

Figure 75 Example Trends Dialogue

Date Time	HR	NIBP	RR	SpO <sub>2</sub>	CO <sub>2</sub>	IPI	T1	T2	CO	CI
03/18 10:44	80	120 / 80 (92)	11	97	34	8	37.0	37.0	---	---
10:44	80	120 / 80 (92)	11	97	34	8	37.0	37.0	---	---
10:44	80	120 / 80 (92)	11	97	34	8	37.0	37.0	---	---
10:43	80	120 / 80 (92)	11	97	34	8	---	---	---	---

Date Time	$\Delta$ STI	II	III	aVL	aVR	aVF	V
03/18 10:44	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10:44	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10:44	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10:43	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Date Time	P1	P2	P3	P4
03/18 10:44	127 / 83 (101)	40 / 10 (20)	40 / 10 (20)	24 / 8 (15)
10:44	127 / 83 (101)	40 / 10 (20)	40 / 10 (20)	24 / 8 (15)
10:44	127 / 83 (101)	40 / 10 (20)	40 / 10 (20)	24 / 8 (15)
10:43	127 / 83 (101)	40 / 10 (20)	40 / 10 (20)	24 / 8 (15)

Interval: 4 h

Buttons: [Up], [Down], [Left], [Clear], [Print], [Close]

The Trends dialogue shows list trends in a tabular format. The numeric parameters are displayed in the color of that parameter on the main screen to allow for easier clinician visibility and identification. The most recent trend data is observed at the top of the parameter column with the oldest data seen at the bottom of the parameter column.

### Trends and Alarm Behaviors

Numeric parameters that are associated with an alarm condition are displayed in a reverse background in the color of that parameter.

### Page Up/Page Down Arrows

The page up and page down arrows are used to scroll through the pages of the patient's vital signs trend data. Use the arrows to view more list trend data than is observed on the screen.

To view newer data, select the Page Up arrow.  To view older data, select the Page Down arrow. 

### Interval

The display interval button allows the clinician to determine the display frequency of the trends in the Trends dialogue. The display interval allows the clinician to zoom in and zoom out of trend data. The trend interval setting only affects the display of trends and does not affect the storage of trends. The trends displayed contain the discreet values associated with the displayed time stamp.

To adjust the display Interval of the list trends:

1. Select the Trends quick-action button on the right side of the main screen to display the Trends dialogue.
2. Locate the Interval label.
3. Select the arrow to display the drop down list box choices (1min, 5mins, 15mins, 1hour, 4hours).
4. The new display interval takes effect upon selection of the display interval.
5. The trends displayed contain the discreet values associated with the displayed time stamp.

### Clear Trends

Trends clear upon discharge of the monitor. The Clear button allows the clinician to manually erase the list trends stored in the patient monitor without performing a discharge.

To clear the list trends:

1. Select the Trends quick-action button on the right side of the main screen to display the Trends dialogue.
2. Locate the Clear button.
3. Selecting the Clear button displays a confirmation message.
  - a. Select OK to permanently delete the list trends.
  - b. Select Cancel to retain the list trends.

### Print Trends

Trends may be printed to the bedside recorder and print what is displayed on the monitor.

It is also possible to print all available trends based on the currently defined interval. In this case, this will print all available trend pages. This is helpful for documenting the patient conditions throughout an extended period, such as in the case of a surgical procedure.

The Print and Print All button will only print trends on the local recorder and NOT on the Central Station. Note that there is no means of stopping a print in progress. Take care in printing all of the trends when a long duration of trends is available and the interval is set too narrowly, say every minute, as this will consume paper and may take some time to complete.

To print list trends:

1. Select the Trends quick-action button on the right side of the main screen to display the Trends dialogue.
2. Select the Print button.
3. The trends displayed in the trend window are printed.
4. To print older trends:
  - a. Use the page arrows to display the desired trends for printing.
  - b. Select the Print button in the Trend dialogue.

To print all trends on the local recorder:

1. Select the Trends quick-action button on the right side of the main screen to display the Trends dialogue.
2. Confirm the interval setting.
3. Select the Print All button.
4. All trends are printed.

### Close Trends

To close the Trends dialogue, select either the Close button in the Trends dialogue or select the Home quick-action button on the main screen.



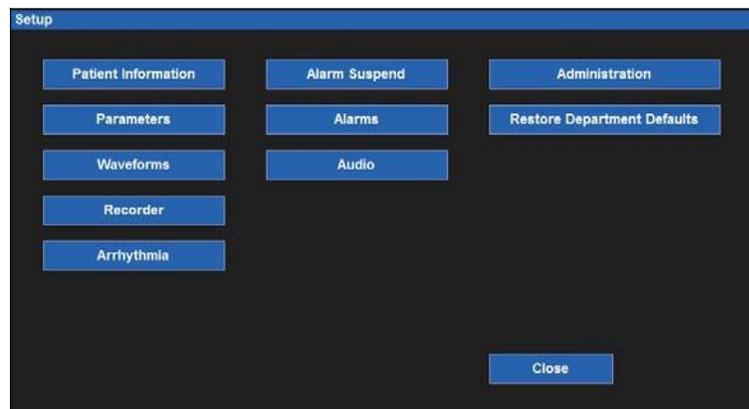
## 26. SETUP

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### Overview

The Setup quick-action key provides access to advanced functions such as arrhythmia settings, alarm settings, and other monitor configuration menus.

**Figure 76 Example Setup Dialogue**



### Patient Information

The Patient Information button provides access to the Patient Information dialogue. Access to this dialogue can also be obtained by selecting the black patient information area located above the system date and time.

Information that can be entered includes Last Name, Middle Initial, First Name, ID, Room number, Mode, Gender, Ethnicity, Date of Birth, Height and Weight.

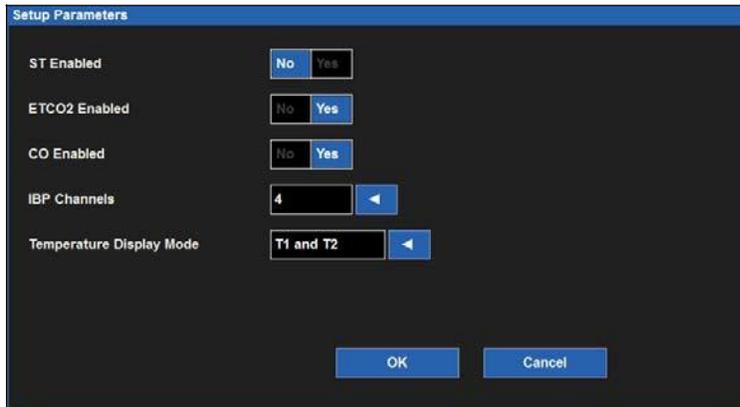
Refer to the Patient Information dialogue section in this manual for further details.

To access the Patient Information dialogue from the Setup dialogue:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Patient Information button to access the Patient Information dialogue.

### Parameters

The Setup Parameters dialogue is where the clinician can enable and disable the monitoring of certain parameters. Disabling a parameter removes that parameter from the patient monitor's main screen.

**Figure 77 Example Setup Parameters Dialogue**

To enable/disable a parameter:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Parameters button to access the Setup Parameters dialogue.
3. Locate the parameter label.
4. For ST Enabled, ETCO2 Enabled, and CO Enabled:
  - a. Select Yes to enable the parameter.
  - b. Select No to disable the parameter.
5. For IBP Channels, select the arrow to display the drop down list box:
  - a. Select 2 to enable P1 and P2.
  - b. Select 4 to enable P1, P2, P3, and P4.
  - c. Select None to disable all invasive pressure channels.
6. For Temperature Display Mode, select the arrow to display the drop down list box:
  - a. Select T1 only to display only T1 on the main screen.
  - b. Select T1 and T2 to display both temperatures on the main screen.
  - c. Select T1 and  $\Delta T$  to display T1 and  $\Delta T$  on the main screen.
7. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Waveforms

The Setup Waveform Area dialogue is where the clinician can choose which waveforms are displayed on the main screen, the size of those waveforms, and the sweep speed of those waveforms. This dialogue is also where the clinician can choose to overlap the invasive pressures on the main screen.

Figure 78 Example Setup Waveform Area Dialogue

1	II	Size	10 mm/mV
2	V	Size	10 mm/mV
3	RESP	Size	Auto
4	SpO2	Size	Auto
5	P1	Size	0 to 200 mmHg
6	P2	Size	0 to 200 mmHg

Sweep Speed: 25 mm/s

Show All Pressure Waveforms: No Yes

Overlap Pressure Waveforms: No Yes

OK Cancel

The number of waveform slots available depends on a number of factors. For instance, when ST monitoring is enabled an additional waveform slot is available. With ST monitoring disabled, this waveform slot is not available. The number of IBP channels and whether all channels are shown and overlapped or not will also affect the total number of waveform slots available. The maximum number of waveform slots is 8.

To select a waveform for display on the main screen:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Waveforms button to access the Setup Waveform Area dialogue.
3. The numbers 1-8 indicate waveform position on the main screen.
  - a. Waveform position #1 is always reserved for an ECG tracing.
  - b. Waveform positions #4-7 are reserved for an invasive pressure tracing when the “Show All Pressure Waveforms” is enabled. With this setting disabled, it is possible to use waveform slots 5 and 6 to display waveforms for ECG or invasive pressure waveforms.
  - c. The waveform selections are based on monitor options, ECG lead set, and the parameters that have been enabled/disabled in the Setup Parameters dialogue.
4. Choose the desired waveform position.
5. Select the arrow to display the drop down list box of available waveform choices.
6. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

To select a waveform size for display on the main screen:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Waveforms button to access the Setup Waveform Area dialogue.
3. Locate the Size label next to the parameter requiring adjustment.
4. Select the arrow to display the drop down list box of available waveform size choices.
  - a. The choices available are based on the specific waveform parameter.
  - b. Select the desired waveform size.
5. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

To select the sweep speed for waveforms displayed on the main screen:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Waveforms button to access the Setup Waveform Area dialogue.
3. Locate the Sweep Speed label.
4. Select the arrow to display the drop down list box (Choices include 6.25 mm/s, 12 mm/s, and 25 mm/s).
5. Select the sweep speed desired.
6. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

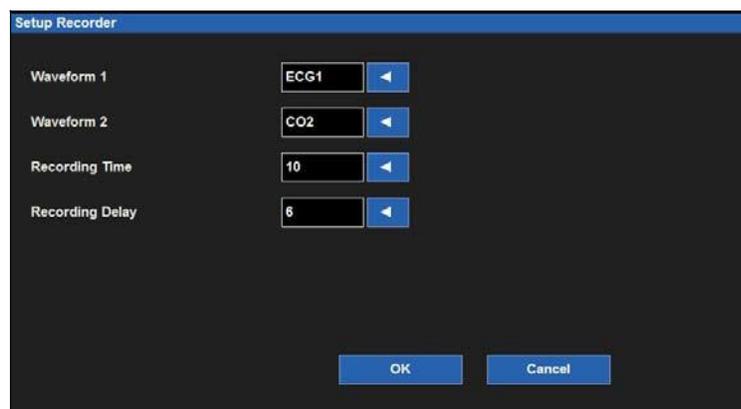
To enable/disable overlap invasive pressure waveforms:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Waveforms button to access the Setup Waveform Area dialogue.
3. Locate the Overlap Invasive Pressure label:
  - a. Select Yes to overlap all available invasive pressure.
  - b. The invasive pressures will occupy the space of four waveform slots.
  - c. The overlapped invasive pressure have independent waveform sizes.
  - d. Select No to keep the invasive pressure waveforms in separate waveform parameter tiles.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Recorder

The Surveyor S12 and S19 patient monitors may have a two-channel thermal bedside recorder as a purchasable option. The Recorder dialogue provides configuration for which two waveforms print, the length of the recording strip, and the recording delay.

**Figure 79 Example Setup Recorder Dialogue**



To select the two waveforms to print on the bedside recorder (optional):

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Recorder button to access the Setup Recorder dialogue.
3. Locate the Waveform 1 (prints in top waveform position of the thermal recorder printout) label.
4. Locate the Waveform 2 (prints in the bottom waveform position of the thermal recorder printout) label.
5. Select the arrow to display the drop down list box (Choices are dependent upon monitor configurations).
6. Select the waveform desired.
7. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

To select the recording length to print on the bedside recorder (optional):

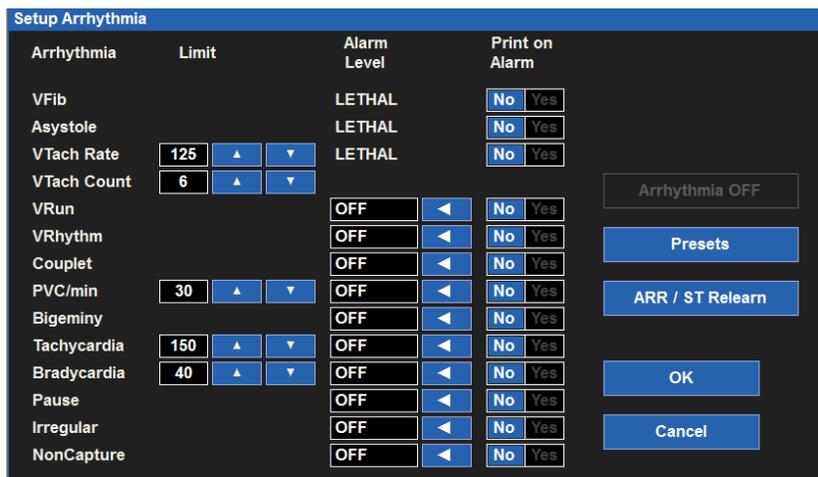
1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Recorder button to access the Setup Recorder dialogue.
3. Locate the Recording Time label.
4. Select the arrow to display the drop down list box (Choices are 5 seconds, 10 seconds, and 16 seconds).
5. Select the recording time desired.
6. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

To select the recording delay for the bedside recorder (optional):

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Recorder button to access the Setup Recorder dialogue.
3. Locate the Recording Delay label.
4. Select the arrow to display the drop down list box (Choices are 0 seconds, 6 seconds, and 10 seconds).
5. Select the recording delay desired.
6. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Arrhythmia

Figure 80 Setup Arrhythmia Dialogue



To adjust Arrhythmia alarm settings:

1. Select the Setup quick-action key on the main screen.
2. Select the Arrhythmia button in the Setup menu.
3. Adjust the Arrhythmia alarm settings as desired.
  - a. To adjust the Alarm Level:
    - Locate the Alarm Level button.
    - Select the arrow to display the drop down list box with choices.
    - Select the appropriate choice.
  - b. To adjust the Print on Alarm:
    - Locate the Print On Alarm button.
    - Select Yes to enable the Print On Alarm.
  - c. Select No to disable the Print On Alarm.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

VFib, Asystole and VTach may not be turned off in this dialogue, are only available as high level alarms, and are labeled as LETHAL.

To disable all the non-lethal arrhythmias with one action:

1. Select the Setup quick-action key on the main screen.
2. Select the Arrhythmia button in the Setup menu.
3. Select the Arrhythmia OFF button.
4. This action disables all the non-lethal arrhythmia alarms.
5. To re-enable a non-lethal arrhythmia, select the individual non-lethal arrhythmia and configure.

## Alarm Suspend

The ability to suspend all alarms is a configurable feature determined by the system administration and is protected behind a password in the Administration Setup Alarms dialogue. Contact the system administrator for further details.



**WARNING:** *IF this feature is enabled, suspending all alarms suspends ALL alarm conditions **including** the lethal arrhythmias (VFib, VTach, and Asystole). Use this feature with extreme caution as alarm checking is suspended for **all** alarm conditions **including** the lethal arrhythmias (VFib, VTach, and Asystole). Patients must be closely observed if all alarms are suspended.*

**NOTE:** *Follow hospital standard of care for the use of this feature. This feature is only intended to be used during end of life situations and only based on the hospital standard of care.*

**NOTE:** *This feature can be enabled/disable by the system administrator.*

When this feature is enabled, during an Alarm Suspend mode, an Alarm Suspend message appears in the messaging area of the main screen. Once the Alarm Suspend period ends the audio and visual alarm notifications automatically resume.

When this feature is enabled, to enter the All Alarms Suspended Mode and suspend **all** alarm notifications (**including VFib, Vtach, and Asystole**):

1. Select the Setup quick-action key on the main screen.
2. Select the Alarm Suspend button in the Setup menu.
  - This displays the “Alarms Suspended” message in the message area on the main screen.
  - **ALL** alarms are now suspended including the lethal arrhythmias (VFib, Vtach, and Asystole).
3. Select the Close button to close the Setup menu.

When this feature is enabled, to exit the All Alarms Suspended Mode and resume alarm notifications:

1. Select the Setup quick-action key on the main screen.
2. Select the Alarm Resume button in the Setup menu.
  - This removes the “Alarms Suspended” message in the message area on the main screen.
  - All configured alarms are now active.
3. Select the Close button to close the Setup menu.

## Alarms

The Setup Alarms dialogue is where the clinician can make changes to several parameters are one time as opposed to making changes through each individual numeric parameter’s tile.

Figure 81 Example Setup Alarms Dialogue

	Lower Limit	Upper Limit	Alarms On	Print on Alarm
HR	50 ▲ ▼	120 ▲ ▼	Auto	No Yes
ETCO2	25 ▲ ▼	60 ▲ ▼	Auto	No Yes
RR	5 ▲ ▼	30 ▲ ▼	Auto	No Yes
FICO2		5 ▲ ▼	Auto	No Yes
IPI	4 ▲ ▼		Auto	No Yes
SpO2	90 ▲ ▼	100 ▲ ▼	Auto	No Yes

Previous Page   Next Page   OK   Cancel

To adjust numeric parameter alarm settings:

1. Select the Setup quick-action key on the main screen.
2. Select the Alarms button in the Setup menu.
3. Locate the numeric parameter to adjust. Select the Next Page button to scroll to see more numeric parameters (based on monitor configuration).
4. Adjust the numeric alarm settings as desired.
  - a. To adjust the Lower and High alarm limits:
    - Adjust the Lower alarm limit by selecting the up/down arrows to move the lower alarm limit box until the desired value is reached.
    - Adjust the Upper alarm limit by selecting the up/down arrows to move the upper alarm limit box until the desired value is reached.
  - b. To Auto adjust the alarm limit values:
    - Select the Auto button.
  - c. To adjust the Alarm On/Off:
    - Select Yes to enable that parameters' alarms.
    - Select No to disable that parameters' alarms.
    - The Alarm Off icon displays in that numeric parameter tile.



**WARNING:** Disabling the parameters' alarm limits means that NO low or high alarm conditions for that parameter will produce alarm notifications. Use this feature with extreme caution.

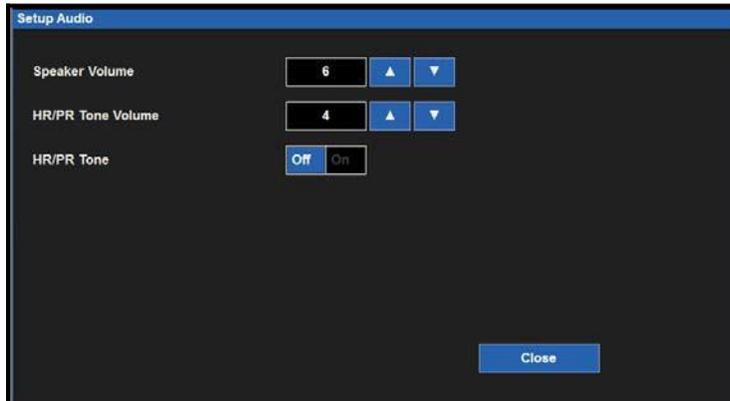
**NOTE:** The Lower Limit and Higher Limit windows in this dialogue may contain limit values but these alarms ARE disabled if that numeric parameters' Alarms on button is set to NO.

- d. To adjust the Print on Alarm:
  - Locate the Print On Alarm button.
  - Select Yes to enable the Print On Alarm.
  - Select No to disable the Print On Alarm.
5. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Audio

The Setup Audio dialogue is where the speaker volume and the HR/PR tone volume are configured. This area is also where the HR/PR systole beep tone can be enabled and disabled.

**Figure 82 Example Setup Audio Dialogue**



To adjust the speaker volume:

1. Select the Setup quick-action key on the main screen.
2. Select the Audio button in the Setup menu.
3. Locate the Speaker Volume label.
4. The Speaker Volume choices are 1 to 10 in increments of 1.
  - a. Select the Up arrow to increase the speaker volume.
  - b. Select the Down arrow to lower the speaker volume.
  - c. As the volume is adjusted, an audible tone is played to indicate the volume of the speaker.
5. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

To adjust the HR/PR systole beep tone volume:

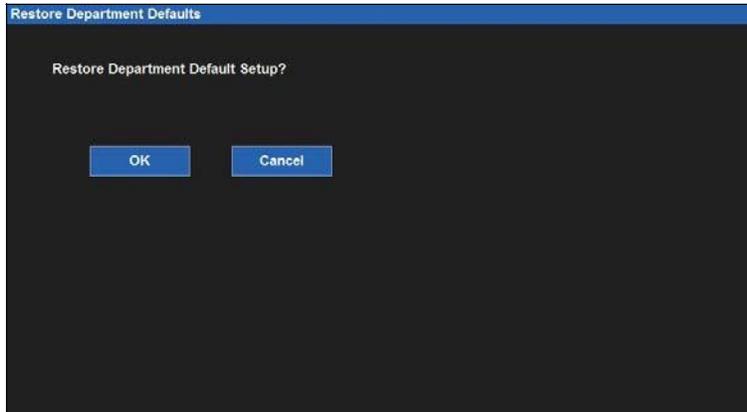
1. Select the Setup quick-action key on the main screen.
2. Select the Audio button in the Setup menu.
3. Locate the HR/PR Tone Volume label.
4. The HR/PR Tone Volume choices are 1 to 10 in increments of 1.
  - a. Select the Up arrow to increase the HR/PR systole beep volume.
  - b. Select the Down arrow to lower the HR/PR systole beep volume.
  - c. As the volume is adjusted, an audible tone is played to indicate the volume of the HR/PR systole beep.
5. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

To enable/disable the HR/PR systole beep tone:

1. Select the Setup quick-action key on the main screen.
2. Select the Audio button in the Setup menu.
3. Locate the HR/PR Tone label.
  - a. Select Yes to enable the HR/PR systole beep tone.
  - b. Select No to disable the HR/PR systole beep tone.
4. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

## Restore Departmental Defaults

Figure 83 Restore Departmental Defaults



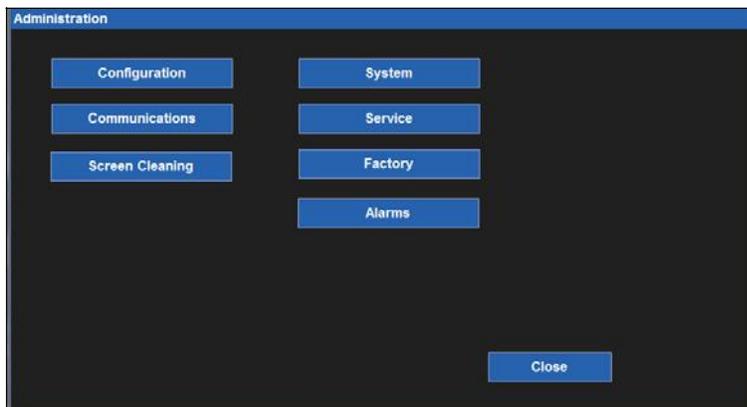
To restore the patient monitor back to the departmental default configuration:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Restore Departmental Defaults button.
3. Select the OK button to enter OR select the Cancel button to cancel the changes.

## Administration

The Administration dialogue contains service and configuration related functions. The functions located on the left of this dialogue do not require a password. The functions located on the right of this dialogue are password-protected. Contact the system administration for further details.

Figure 84 Example Administration Dialogue



## Configuration

Selecting this item displays the setup of this Surveyor including its serial number, Ethernet MAC address, internal software version as well as those of accessories and modules integrated with this system. There are no configuration options here but this information is helpful for service personnel when analyzing the system for issues.

**Figure 85 Example Setup Configuration Dialogue**

Field	Value
Serial number	PFD1010
Ethernet MAC	
MAIN	1.0.655 X Jul 11 2012
PRESS	---
ACQUIRE	---
ECGACQ	---
CF	---
ZAC	1.0
SpO2	
CO2	
Recorder	

## Communications

Use this dialogue to configure the communication parameters of the Surveyor including the Bed ID, Unit ID as well as the network parameters for both the Surveyor Central and this Surveyor patient monitor. Alternatively, if the patient monitor is interfaced to a 3<sup>rd</sup> party EMR application, this setting can also be defined here. This information is typically defined by authorized installation and service personnel.

Specific configuration parameters include:

- Bed ID and Unit ID for interfacing with Surveyor Central.
- TCP/IP network parameters including host name, IP address, and port number for Surveyor Central.
- Whether dynamic host control protocol (DHCP) is utilized by the Surveyor to obtain IP address information for the bedside monitor. If not, the user can define specific static IP addresses including IP address, subnet mask, gateway address and Domain Name System (DNS) address information.
- Define the Connect Type to “ZAC” for Surveyor Central.
- For interfacing to 3<sup>rd</sup> party EMR applications, define the Connect Type as “Serial”. All other settings in this screen will not matter and may be blank.

**Figure 86 Example Setup Communications Dialogue**

Setup Communications

Bed ID

Unit ID

Use DHCP  No  Yes

Central Host Name

Central IP Address

Central Port Number

IP Address

Subnet

Gateway

DNS

Connect Type

OK Cancel

**Connectivity**

When interfacing to 3<sup>rd</sup> party EMR applications, the connectivity type must be defined. The typical setting for most EMR applications is “1”.

*NOTE: Contact Mortara Technical Support for a list of approved and supported EMR applications.*

Setup Connectivity

EMR Interface Type

OK Cancel

## Screen Cleaning

Based on the clinician's discretion, the bedside monitor's touch screen may require occasional cleaning. The touch screen may be cleaned with a soft, lint-free cloth and a non-abrasive, gentle cleaner such as plain soap and water. Avoid spraying cleaning agents directly onto the monitor's touch screen. Spray the cleaning agent onto the lint-free cloth first and then wipe the touch screen. Do not use any cleaning agents that may leave a film.

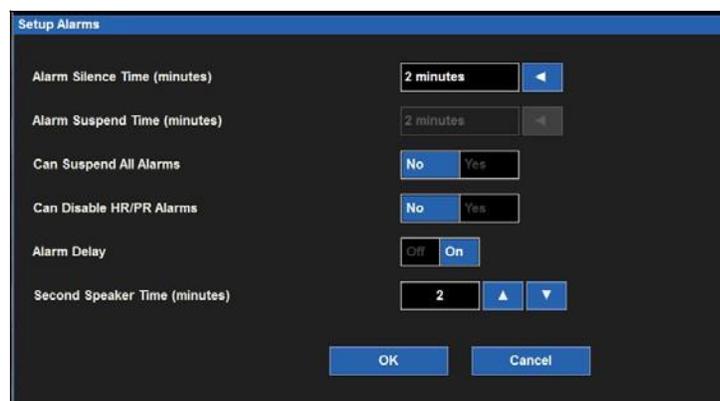
To clean the touch screen:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Administration button.
3. Select the Screen Cleaning button.
4. The "Screen Cleaning Mode" message displays in the alarm messaging area of the main screen.
5. During this 15 seconds, patient monitoring and alarm notifications continue.
6. After the 15 seconds has expired, the touch screen activates.

## Administration Setup Alarms Dialogue

The Administration Setup Alarms dialogue is a password protected feature. Contact the system administrator for further details.

**Figure 87 Administration Setup Alarms Dialogue**



### Alarm Silence Time

This setting controls the length of silence time for the Alarm Silence quick-action key on the main screen.

To select the Alarm Silence Time:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Administration button.
3. Select the Alarms button to access the Administration: Setup Alarms dialogue.
4. Locate the Alarm Silence Time label.
5. Select the arrow to display the drop down list box (Choices are 1 minute, 1.5 minutes, 2 minutes, 5 minutes and 10 minutes).
6. Select the alarm silence time desired.
7. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

**Alarm Suspend Time**

This setting controls the length of silence time for the Alarm Suspend function.

To select the Alarm Suspend Time:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Administration button.
3. Select the Alarms button to access the Administration: Setup Alarms dialogue.
4. Locate the Alarm Suspend Time label.
5. Select the arrow to display the drop down list box (Choices are 1 minute, 1.5 minutes, 2 minutes, 5 minutes and 10 minutes).
6. Select the alarm silence time desired.
7. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

**Can Suspend All Alarms**

This setting controls if the clinician has the ability to suspend all alarms including the lethal arrhythmias (Asystole, VTach, and VFib).

To configure:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Administration button.
3. Select the Alarms button to access the Administration: Setup Alarms dialogue.
4. Locate the Can Suspend All Alarms label.
  - a. Selecting Enabled means the clinician can suspend all alarms including the lethal arrhythmias.
  - b. Selecting Disabled means the clinician cannot disable all alarms. If this choice is selected, the Suspend All Alarms button will be hidden from the Setup dialogue.
5. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

**Can Disable HR/PR Alarms**

This setting controls if the clinician has the ability to disable the HR/PR alarms.

To configure:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Administration button.
3. Select the Alarms button to access the Administration: Setup Alarms dialogue.
4. Locate the Can Disable HR/PR Alarms label.
  - a. Selecting Enabled means the clinician can disable the HR/PR alarms.
  - b. Selecting Disabled means the clinician cannot disable the HR/PR alarms.
5. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

**Alarm Delay**

This setting determines if the monitor uses a delay before providing alarm notifications. This feature is intended to reduce erroneous alarm notifications.

To configure:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Administration button.
3. Select the Alarms button to access the Administration: Setup Alarms dialogue.
4. Locate the Alarm Delay label.
  - a. Select Yes to enable the alarm delay.
  - b. Select No to disable the alarm delay.
5. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

If enabled, the alarm delay values are based on the specific parameter and as follows:

Parameter	Lower limit violation delay	Upper limit violation delay
HR, PR (from SpO2), PR (from IBP)	3 seconds	3 seconds
RR	5 seconds	5 seconds
Mortara SpO2, Nellcor SpO2 (SatSeconds disabled)	10 seconds	10 seconds
IPI	10 seconds	0 seconds
Nellcor SpO2(SatSeconds enabled), all other parameters	0	0

**Second Speaker Time (Minutes)**

The Surveyor has a second speaker that provides additional audible notification when the initial audible alarm is not acknowledged and silenced. The second speaker begins sounding approximately 1 second after a pre-defined amount of time has passed if the initial alarm sound has not been silenced.

To configure the second speaker alarm time:

1. Select the Setup quick-action key on the main screen to access the Setup dialogue.
2. Select the Administration button.
3. Select the Alarms button to access the Administration: Setup Alarms dialogue.
4. Locate the Second Speaker Time (Minutes) label.
  - Select the Up/Down arrow to rotate through the choices (Choices include 0 minutes, 1 minute, 2 minutes, and 3 minutes).
5. Select the OK button to enter that change OR select the Cancel button to cancel the changes.

**Administration Setup System Dialogue**

The System dialogue is a password protected area intended for use by service and system administrative personnel only. The Setup System dialogue is where the units of measure are configured for height, weight, and temperature. This dialogue is also used to configure the print location, set the date and time, and to save departmental default settings. Contact service or system administrator for further details.

The following table lists specific reports and where they may be printed based on system configuration.

Recording type	Prints at
Strip chart (initiated by pressing the Print soft key on monitor)	Print location setting (Bedside, Central, or both)
12 lead report	Print location setting (Bedside, Central, or both)
Alarm report	Print location setting (Bedside, Central, or both)
Trend report	Bedside
ST averages	Bedside

### Administration Setup Service Dialogue

The Service dialogue is a password protected area intended for use by service and system administrative personnel only. The Setup Service dialogue is where the demonstration mode for simulated data on the patient monitor is enabled and disabled. This dialogue is also where the monitor settings can be transferred to and from a USB thumb stick when configuring multiple monitors. The monitor can be returned to the factory default configuration settings in this dialogue. Contact service or system administrator for further details.

### Administration Setup Factory Dialogue

The Factory dialogue is a password protected area intended for use by service and administrative personnel only. Contact service or system administrator for further details.



## 27. PRODUCT SPECIFICATIONS

### General Specifications

Dimensions	S12: 315 W x 203 H x 125 D mm (12.4 W x 8.0 H x 4.9 D inches) S19: 468 W x 289 H x 97 D mm (18.4 W x 11.4 H x 3.8 D inches)
Weight	S12: 3 Kg (6.6 lbs) Standard configuration; including battery and built-in recorder  S19: 5 Kg (11.2 lbs) Standard configuration, including battery; excluding recorder
Type of Protection (Electrical)	Class I
Degree of Protection (Electrical)	Type CF Applied Parts
Degree of Protection (Water)	Drip Proof (IPX1)
Disinfecting Method	Per the instructions in the General Care & Maintenance section
Degree of Safety (Flammable Anesthetic Mixture)	Not suitable for use in the presence of a Flammable Anesthetic Mixture including O <sub>2</sub> or N <sub>2</sub> O
Mode of Operation	Continuous
Languages	English, Italian, German, Spanish, Portuguese, French, Dutch, Hungarian, Polish and Croatian
Units of measure (each set independently)	English (inches, lbs, °F, mmHg) Metric (cm, kg, °C)
Network Interface	IEEE 802.3 100 Ethernet 10/100 RJ45 networking with static or dynamic IP for interface to Surveyor Central monitoring station.
Serial Interface	Support for interfacing with approved EMR applications using RS-232 connectivity
Patient Risk Current	Complies with IEC 60601-1 Leakage Current Requirements
Casing Material	PC-ABS

## Environmental Conditions

Temperature	Operating temperature: +0° to +40° C (+32° to +104° F) Storage temperature: -20° to +60° C (-4° to +140° F)
Humidity	Operating humidity: 15% to 90% RH, non-condensing Storage humidity: 15% to 95% RH, non-condensing
Altitude	Operating: 0 to 4572 m (0 to 15,000') Storage: 0 to 12192 m (0 to 40,000')
Cooling	Convection (no fan)
Shock	Per IEC 60068-2-27
Vibration	Per IEC 60068-2-64

## Power Requirements & Battery

Power Source	AC Power / Battery
AC Power Source	External AC Power Adapter (Mortara REF: 4101-012) 100 – 240 VAC; 1.2 A max; 50 – 60 Hz Class I, Continuous Use
Power Consumption	S12: 18W nominal, 29W (when charging battery) S19: 27W nominal, 29W (when charging battery)
Startup Time	Less than 46 seconds
Battery Type	Internal Lithium-Ion Rechargeable 8700 mAh (Mortara REF: 4800-017)
Battery Life	S12: 3 hours* S19: 2 hours*
Battery Charging Time	When off: 5 hours When On: S12: 7 hours S19: 20 hours

## Display Specifications

Type	High definition, antiglare 16:9 Color TFT-LCD with LED backlight and resistive touch panel controls
Size & Resolution	S12: 11.6 inches diagonal; 256mm x 144 mm active area; 1366 x 768 pixels S19: 18.5 inches diagonal; 410mm x 230 mm active area; 1366 x 768 pixels

## Recorder Specifications

Type	Thermal
Patient Monitors	S12: Optional, configured S19: Optional, modular
Print Width	48 mm
Paper Width	50 mm
Recording	Strip chart printing of two selectable waveforms
Recorder Speed	25 mm/sec
Recorder Resolution	200 dpi (v) x 400 (h) dpi
Waveform Recording	Any two of <ul style="list-style-type: none"> <li>• ECG (I, II, III, avR, avL, avF, or V)</li> <li>• SpO2</li> <li>• CO2</li> <li>• IBP (P1, P2, P3 or P4)</li> </ul>
Recording Time (Total duration of recording)	5, 10 & 15 seconds
Recording Delay (Recorded data prior to Alarm/Print condition)	0, 6 & 10 seconds

## Mounting Specifications

Per the Flat Display Mounting Interface (FDMI), also known as VESA Mounting Interface Standard (MIS), of the Video Electronics Standards Association.

Conforms to MIS-D 75 (75 mm × 75 mm) and MIS-D 100 (100 mm × 100 mm) standards for optional mounting on a rolling stand (max. height 100 cm or 43 inches), wall mount or articulating wall mount using Mortara specified accessories.

## Trending

Trending	Up to 72 hours of numeric parameter information
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## 28. PARAMETER SPECIFICATIONS

### Patient Population

Monitoring Capabilities	Adult or Pediatric
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### Waveforms

Waveform Slots	<p>8 total slots available</p> <p>Top waveform (Position #1) always reserved for an ECG tracing</p> <p>Bottom four waveforms (Position #5, 6, 7, and 8) always reserved for invasive pressures.</p> <p>Configurable based on available parameters</p> <ul style="list-style-type: none"> <li>• ECG any of I, II, III, V, aVL, aVR or aVF</li> <li>• SpO<sub>2</sub></li> <li>• CO<sub>2</sub> or impedance respiration</li> <li>• IBP P1, P2, P3 or P4</li> </ul>
Waveform Sweep Speed	6.25 ms, 12.5 ms, 25 ms & 50 ms
Waveform Delay	0.5 seconds on all parameters

### ECG

ECG	3/5 Lead Cable or Mortara AM12 12-Lead ECG Acquisition Module
ECG Interpretation	Available with AM12 only
ECG Modes	Adult / Pediatric
Simultaneous Leads Available	<p>3 Lead Cable: I, II, III</p> <p>5 Lead Cable: I, II, III, aVR, aVL, aVF, V</p> <p>AM12: I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6</p>
Acquisition Rate:	<p>3/5 Lead Cable: 250 samples/s</p> <p>AM12: 40,000 samples/s initially, reduced to 500 s/s for analysis</p>
Resolution:	<p>3/5 Lead Cable: 2.5<math>\mu</math>V</p> <p>AM12: 1.17<math>\mu</math>V reduced to 2.5<math>\mu</math>V for analysis</p>
Dynamic Range/Offset Tolerance:	$\pm$ 300mV
ECG Gain	2.5, 5, 10, or 20 mm/mV
CMRR:	According to AAMI EC13 and IEC60601-2-27
Max. Auxiliary Patient Current:	< 10 $\mu$ A
Frequency Response Filtering:	<p>3/5 Lead Cable: Diagnostic or ST Monitoring: 0.05 to 40 Hz</p> <p>Monitoring: 0.67 to 40 Hz</p> <p>AM12: Diagnostic: 0.05 to 150 Hz</p>
Input Impedance:	>2.5 MOhm at 10 Hz

Electrodes:	Must be compatible with EN 60601-2-27
Beat Detection:	Sensitivity 99.90%, positive predictivity 99.88% (AHA/MIT database)
Beat Recognition:	Normal, Ventricular, Paced, Unknown
HR Averaging	<p>The algorithm calculates the heart rate from its available source.</p> <p>If the heart rate from the last four R to R intervals is greater than 48 beats per minute, the average heart rate is determined by averaging the last 16 R to R intervals.</p> <p>If the heart rate from the last four R to R intervals is less than or equal to 48 beats per minute, then this rate is used.</p> <p>Paced beats and PVCs are included in the heart rate calculation.</p>
HR Range:	15 to 300 bpm Adult and Pediatric
HR Resolution	1 beat per minute
HR Availability:	Within 6 s after appearance of traces
HR Measurement Accuracy	Measurement error (RMS) as measured according to ANSI/AAMI EC57: 2.8% AHA database, 1.7% MIT database
HR Report Interval	1 second
Minimum QRS Amplitude:	300 $\mu$ V
Notch AC-Filter:	50, 60 Hz
Pacer Display/Analysis	Clinician selectable

## Arrhythmia Analysis

Arrhythmia Detection	VFib, Asystole, VTach, PVC Run, VRhythm, Couplet, Bigeminy, Sustained Tachycardia, Sustained Bradycardia, Irregular, PVC/m too high, Pause, Pacer Non-Capture
VFib Detection: ECG Leads Used	3 lead: Displayed ECG vector 5 lead and AM12: II, V1, and V5.
Beat Detection: ECG Leads Used	<p>3 lead: Displayed ECG vector</p> <p>5 lead:</p> <ul style="list-style-type: none"> <li>When configured to <b>Auto</b>, the ECG leads used for HR and ARR processing start with II and V for detection and III for confirmation while allowing the algorithm to switch to other available leads based on signal quality.</li> <li>When configured to <b>Single Lead</b>, the ECG lead used for HR and ARR processing is the one specified by the user from the set I, II, III, or V.</li> <li>When configured to <b>Multiple Leads</b>, the ECG leads used for HR and ARR processing are selected internally from the set II and V for detection, and III for confirmation.</li> </ul>

	<p>AM12:</p> <ul style="list-style-type: none"> <li>When configured to <b>Auto</b>, the ECG leads used for HR and ARR processing start with II and V5 for detection and V1 for confirmation while allowing the algorithm to switch to other available leads based on signal quality.</li> <li>When configured to <b>Single Lead</b>, the ECG lead used for HR and ARR processing is the one specified by the user from the set I, II, III, or V (V1).</li> <li>When configured to <b>Multiple Leads</b>, the ECG leads used for HR and ARR processing are selected internally from the set II and V5 for detection, and V1 for confirmation.</li> </ul>
Beat Typing: ECG Leads Used	<p>3 lead: Displayed ECG vector</p> <p>5 lead:</p> <ul style="list-style-type: none"> <li>When configured to <b>Auto</b>, the ECG leads used for HR and ARR processing start with II and V for detection and III for confirmation while allowing the algorithm to switch to other available leads based on signal quality.</li> <li>When configured to <b>Single Lead</b>, the ECG lead used for HR and ARR processing is the one specified by the user from the set I, II, III, or V.</li> <li>When configured to <b>Multiple Leads</b>, the ECG leads used for HR and ARR processing are selected internally from the set II and V for detection, and III for confirmation.</li> </ul> <p>AM12:</p> <ul style="list-style-type: none"> <li>When configured to <b>Auto</b>, the ECG leads used for HR and ARR processing start with II and V5 for detection and V1 for confirmation while allowing the algorithm to switch to other available leads based on signal quality.</li> <li>When configured to <b>Single Lead</b>, the ECG lead used for HR and ARR processing is the one specified by the user from the set I, II, III, or V (V1).</li> <li>When configured to <b>Multiple Leads</b>, the ECG leads used for HR and ARR processing are selected internally from the set II and V5 for detection, and V1 for confirmation.</li> </ul>
VTach Rate Threshold	Configurable from 100-200 beats per minute. For a VTach condition to be considered, the rate of the ventricular rate must be greater than the configured VTach rate.
VTach Count (PVC Run)	Configurable from 3-20 consecutive ventricular beats. For a VTach condition to be considered, the length of the ventricular waveform must be greater than the configured VTach length.

## ST Analysis

ST Segment Analysis	Sensing leads: Any ECG lead available based on lead set used
ST Measurement Accuracy	Range: 2500 to +2500 $\mu$ V, Mean Error = 7 $\mu$ V (Std Dev = 63 $\mu$ V) per EC57 on ESC-ST database
Averaging	Over rolling 32 beats
Alarm Delay	60 seconds

## Non-Invasive Blood Pressure (NIBP)

Type:	Oscillometric
Input Connector	Single Lumen Hose (Quick-Disconnect fitting)
Cuffs	Child, Small Adult, Regular Adult, Large Adult, Thigh
Rated Cuff Pressure Range	0 to 270 mmHg
Derived Parameters	Systolic, Mean, Diastolic
Resolution	1 mmHg
Measurement Range	Systolic: 30 to 250 mmHg Mean: 20 to 230 mmHg Diastolic: 10 to 210 mmHg
Measurement Accuracy	Sys: $\pm 5$ mmHg ( <i>std. dev.</i> < 8mmHg) Mean: $\pm 5$ mmHg ( <i>std. dev.</i> < 8mmHg) Dia: $\pm 5$ mmHg ( <i>std. dev.</i> < 8mmHg)
Pulse Rate Range	30 to 240 bpm
Pulse Rate Accuracy	$\pm 5\%$ or $\pm 2$ bpm, whichever is greater
Update Interval	Upon measurement completion
Measurement Time	30 seconds (typical) < 135 seconds (maximum)
Initial Cuff Pressure	Adults: 160 mmHg (clinician-selectable) Pediatrics: 120 mmHg (clinician-selectable)
Repeated Cuff Pressure	Previous systolic + 40 mmHg
Static Cuff Pressure Accuracy	$\pm 3$ mmHg
Overpressure Cutoff	$290 \pm 3$ mmHg (normal means), $300 \pm 30$ mmHg (back-up)
Measurement Modes	Single Measurement or Auto (Interval) Measurement
Auto Measurement Settings	OFF, 2, 3, 5, 10, 15, 30, 60 minutes

## Pulse Oximetry (SpO<sub>2</sub>)

Module	Nellcor or Mortara
Application	Adult / Pediatric
Method	Absorption – Spectrophotometric (dual wavelength) (Functional oxygen saturation of arterial hemoglobin)
Parameters	Plethysmogram (trace), % SpO <sub>2</sub> , Pulse rate
Resolution	SpO <sub>2</sub> : 1% O <sub>2</sub> PR: 1 bpm (beat per minute)

Measurement Range	SpO <sub>2</sub> : 30 – 100 %, calibrated range 70-100% PR: 30 – 240 bpm (Mortara) PR: 25 – 250 bpm (Nellcor)
Measurement Accuracy	SpO <sub>2</sub> : from 70 to 100%: ±2% (O <sub>2</sub> ), < 70%: unspecified PR: ±3 bpm
Measurement Test Method	Per ISO9919 Clause 50 (Mortara SpO <sub>2</sub> A <sub>RMS</sub> = 1.73%) (Nellcor SpO <sub>2</sub> A <sub>RMS</sub> = 1.9%)
Report Interval	1 second. Numeric values held < 30 seconds
Pulse Tone	Yes (pulse tone pitch tied to SpO <sub>2</sub> parameter value)

## Temperature

Parameters	T1, T2 or ΔT; Direct-Mode
Compatibility	YSI 400-series probes
Input Connector	2-pin connector
Display Patient monitors	°F and °C (clinician-selectable)
Measurement Resolution	0.1 °C (0.1 °F)
Measurement Range	T1 & T2: 5.0 to 50.0 °C (41.0 to 122.0 °F) ΔT: 0.0 to 50.0 °C (32.0 to 122.0 °F)
Measurement Accuracy	±0.1 °C plus probe tolerance
Transient Response	Within 30 seconds from 25 to 27 °C

## Respirations: Via ECG Impedance

Method	Impedance Pneumography
Input Connector	Available via 3/5 ECG Cable only
Sensing Lead	II
RR Resolution	1 bpm (breaths per minute)
Measurement Range	2 to 120 bpm
Measurement Accuracy	±3 bpm
Measurement Sensitivity	0.25 ohms (minimum)
Report Interval	1 second
Bandwidth	0.17 to 3.3 Hz (-3dB)
Impedance Measuring Current	40 μA @ 28 kHz square wave across Lead II

## Capnography (CO<sub>2</sub>)

Method	Side-stream (Non-dispersive IR absorption)
Input Connector	Oridion Microstream FilterLine®. See Accessories chapter.
Displayed Parameters	End Tidal CO <sub>2</sub> , Respiration Rate, FiCO <sub>2</sub> and Integrated Pulmonary Index (IPI)
Displayable Waveform	Continuous CO <sub>2</sub>
Measurement Resolution	EtCO <sub>2</sub> + FiCO <sub>2</sub> : 1 mmHg Respiration: 1 bpm (breath per minute)
Measurement Range	etCO <sub>2</sub> : + FiCO <sub>2</sub> : 0 to 150 mmHg Respiration: 0 to 150 bpm
Measurement Accuracy (at sea level)	<p>EtCO<sub>2</sub>: + FiCO<sub>2</sub>:</p> <p>0 to 38 mmHg: ± 2 mmHg 38 to 150 mmHg: ± (5% of reading + 0.08% for every 1 mmHg &gt; 38 mmHg)</p> <p>Accuracy applies for breath rates of up to 80 bpm. For breath rates above 80 bpm, accuracy is 4 mmHg or ±12 % of reading whichever is greater, for EtCO<sub>2</sub> values exceeding 18 mmHg. This is tested according to and is compliant with ISO 21647. To achieve the specified accuracies for breath rates above 60 breaths/minute, the Microstream FilterLine H Set for Infant/Neonatal (p/n 006324) must be used. Above 55°C module temperature, ± 1mmHg or ± 2.5% (whichever is greater) has to be added to the tolerance of the accuracy specs.</p> <p>Respiration:</p> <p>0 to 70 bpm: ± 1 bpm 71 to 120 bpm: ± 2 bpm 121 to 150 bpm: ± 3 bpm</p> <p>ETCO<sub>2</sub>, FICO<sub>2</sub> and Respiration accuracy tested according to ISO21647 using a mixture of gases (5% CO<sub>2</sub>, 21% O<sub>2</sub>, N<sub>2</sub> balance) supplied via function generator and breath simulator application. Respiration rates from 10-60 bpm for adults/pediatrics and 60-110 bpm for infants as measured in 10 bpm discrete steps were tested for 1 minute before moving forward to the next value and at the end of this one minute period modules readings were taken.</p>
Report Interval	1 second
Flow Rate	50 ml / min (-7.5 to +15 ml / min), flow measured by volume
Warm-up Time required to meet accuracy specifications	Typical: 30 seconds Max: 180 seconds (Readings are not reported until warm-up has completed)
Barometric Pressure Range	430 to 795 mmHg
Automatic Barometric Compensation	Yes
Total System Response Time	3.5 seconds (typical) using standard Microstream FilterLine®
Drift of measurement Accuracy	Meets accuracy specifications when the calibration schedule is followed in the General Care & Maintenance section.

Measurement Accuracy for Gas Mixture	Meets ISO 21647 Clause 51.101.3 (Tables 101 and 103): ± (volume fraction of 0.43% + 8% of gas level)
Measurement Accuracy in the Presence of Interfering Gases	Meets ISO 21647 Clause 101.1 (Tables 101 and 105): ± (volume fraction of 0.43% + 8% of gas level)

## Invasive Pressures

Number of channels	P1, P2 (standard) and P3 or P4 (optional)
Sensitivity:	5 $\mu$ V/V/mmHg
Transducer Excitation Voltage	5V DC
Resolution:	1 mmHg
Measurement Range	-50 to 300 mmHg
Measurement Accuracy	±1 mmHg or ±1%, whichever is greater
Report Interval	Every 3 seconds
PR Range	30 – 250 bpm
PR Accuracy	±2 bpm or ±2%, whichever is greater
PR Resolution	1 bpm
Frequency Response:	0 – 12 Hz
Linearity Error:	< 1% or 1 mmHg
Measurement Patient monitors:	mmHg
Parameters:	Diastolic, Systolic, Mean for all types except Mean-only for CVP, RA, LA & ICP
Defibrillator Protection:	Requires transducers that withstand defibrillation as required by ANSI/AAMI BP 22
Zero Setting:	At connection of transducer, over complete pressure range, within 0.1 mmHg Manual

## Cardiac Output

Method	Thermodilution
CO Resolution	0.1 liters per minute
CO Measurement Range	0.3 to 20.0 liters per minute
CO Measurement Accuracy	±5% at 0 °C injectate
Update Interval	After each measurement
Measurement Start	Automatic, Manual
CO Averaging Support	Yes
Blood Temperature Probe Compatibility	3 pin thermistor (Edwards)
Blood Temperature Patient monitors	°C, °F
Blood Temperature Resolution	0.01 °C
Blood Temperature Measurement Range	33.0 to 40.0 °C
Injectate Temperature Probe Compatibility	In-line (Edwards), Bath (YSI)
Injectate Temperature Units of Measure	°C, °F
Injectate Temperature Resolution	0.1 °C
Injectate Temperature Measurement Range	0.0 to 40.0 °C
Computation Constant Resolution	0.001
Computation Constant Range	0.000 to 0.999
Hemodynamic Calculations:	CO, CI, BSA, SV, SVI, SVR, SVRI, PVR, PVRI, LVSW, LVSWI, RCW, RCWI, RVSW, RVSWI, PAWP

## 29. PARAMETER ALARM LIMIT RANGES

The high and low alarm limit ranges are as per the tables below.

### Adult Patient Mode

Parameter	Lower Limit Range (Factory Default)	Upper Limit Range (Factory Default)	Alarm Level (Factory Default)	Alarms On Choices (Factory Default)	Print on Alarm Choices
Heart Rate	Off, 20 – 269 <b>(50)</b>	50 – 270, Off <b>(120)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> Yes
Bradycardia	10 – 90 <b>(40)</b>		<b>Off*</b> , High	(Non Applicable)	<b>No*</b> Yes
Tachycardia	80 – 280 <b>(150)</b>		<b>Off*</b> , High	(Non Applicable)	<b>No*</b> Yes
ST Increase	(Non Applicable)		<b>Off*</b> , Low, Med,	(Non Applicable)	<b>No*</b> Yes
ST Decrease	(Non Applicable)		<b>Off*</b> , Low, Med,	(Non Applicable)	<b>No*</b> Yes
ST Change	1.0 – 9.0 <b>(2.0)</b>		(Non Applicable)	(Non Applicable)	(Non Applicable)
NIBP Systolic	Off, 30 – 258 <b>(75)</b>	32 – 260, Off <b>(220)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> Yes
NIBP Mean	Off, 20 – 253 <b>(50)</b>	22 – 255, Off <b>(120)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> Yes
NIBP Diastolic	Off, 10 – 233 <b>(35)</b>	12 – 235, Off <b>(110)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> Yes
SpO2	Off, 50 – 98 <b>(90)</b>	52 – 100, Off <b>(100)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> Yes
T1	°C : Off, 15.0– 44.9 <b>(35.0)</b> °F : Off, 59.0 – 112.8 <b>(95.0)</b>	°C : 15.1 – 45, Off <b>(37.8)</b> °F : 59.2 – 113.0, Off <b>(100.0)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> Yes
T2	°C : Off, 15.0– 44.9 <b>(35.0)</b> °F : Off, 59.0 – 112.8 <b>(95.0)</b>	°C : 15.1 – 45, Off <b>(37.8)</b> °F : 59.2 – 113.0, Off <b>(100.0)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> Yes
ΔT	°C: Off, 0.0 – 29.9 <b>(0.0)</b> °F : Off, 0.0 – 53.8 <b>(0.0)</b>	°C : Off, 0.1 – 30.0 <b>(2.8)</b> °F : 0.2 – 54, Off <b>(5.0)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> Yes
Resp Rate	Off, 2 – 118 <b>(5)</b>	4 – 120, Off <b>(30)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> Yes )
ETCO2	Off, 0 – 97 <b>(25)</b>	2 – 99, Off <b>(60)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> Yes
FICO2	(Non Applicable)	1 – 25, OFF <b>(5)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> Yes
IPI	Off, 1 – 9 <b>(4)</b>	(Non Applicable)	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> Yes

\*Factory Default Settings

## PARAMATER ALARM LIMIT RANGES

Parameter	Lower Limit Range	Upper Limit Range	Alarm Level	Alarms On Choices	Print on Alarm Choices
P1 Systolic	Off, -30 – 298 (*75)	-28 – 300, Off (*220)	*Med	No, *Yes	No* , Yes
P1 Mean	Off, -30 – 298 (*50)	-28 – 300, Off (*120)	*Med	No, *Yes	No* , Yes
P1 Diastolic	Off, -30 – 298 (*35)	-28 – 300, Off (*110)	*Med	No, *Yes	No* , Yes
P2 Systolic	Off, -30 – 298 (*15)	-28 – 300, Off (*50)	*Med	No, *Yes	No* , Yes
P2 Mean	Off, -30 – 298 (*10)	-28 – 300, Off (*25)	*Med	No, *Yes	No* , Yes
P2 Diastolic	Off, -30 – 298 (*5)	-28 – 300, Off (*20)	*Med	No, *Yes	No* , Yes
P3 Systolic	Off, -30 – 298 (*35)	-28 – 300, Off (*110)	*Med	No, *Yes	No* , Yes
P3 Mean	Off, -30 – 298 (*15)	-28 – 300, Off (*50)	*Med	No, *Yes	No* , Yes
P3 Diastolic	Off, -30 – 298 (*10)	-28 – 300, Off (*25)	*Med	No, *Yes	No* , Yes
P4 Systolic	Off, -30 – 298 (*35)	-28 – 300, Off (*110)	*Med	No, *Yes	No* , Yes
P4 Mean	Off, -30 – 298 (*15)	-28 – 300, Off (*50)	*Med	No, *Yes	No* , Yes
P4 Diastolic	Off, -30 – 298 (*10)	-28 – 300, Off (*25)	*Med	No, *Yes	No* , Yes

\*Factory Default Settings

## Pediatric Patient Mode

Parameter	Lower Limit Range	Upper Limit Range	Alarm Level	Alarms On Choices	Print on Alarm Choices
Heart Rate	Off, 20 – 100 <b>(50)</b>	50 – 250, Off <b>(150)</b>	<b>*Med</b>	No, <b>*Yes</b> )	<b>No*</b> , Yes
Bradycardia	10 – 90 <b>(40)</b>		Off, High <b>(Off)</b>		No, Yes <b>(No)</b>
Tachycardia	80 – 280 <b>(180)</b>		Off, High <b>(Off)</b>		No, Yes <b>(No)</b>
ST Increase	(Non Applicable)		Off, Low, Med <b>(Med)</b>	(Non Applicable)	No, Yes <b>(No)</b>
ST Decrease	(Non Applicable)		Off, Low, Med <b>(Med)</b>	(Non Applicable)	No, Yes <b>(No)</b>
ST Change	1.0 – 9.0 <b>(2.0)</b>		(Non Applicable)	(Non Applicable)	(Non Applicable)
NIBP Systolic	Off, 30 – 158 <b>(75)</b>	32 – 160, Off <b>(145)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
NIBP Mean	Off, 15 – 138 <b>(50)</b>	17 – 140, Off <b>(110)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
NIBP Diastolic	Off, 10 – 128 <b>(35)</b>	12 – 130, Off <b>(100)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
SpO2	Off, 50 – 98 <b>(90)</b>	52 – 100, Off <b>(100)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
T1	°C : Off, 15.0– 44.9 <b>(35.0)</b> °F: Off, 59.0 – 112.8 <b>(95.0)</b>	°C : 15.1 – 45, Off <b>(37.8)</b> °F : 59.2 – 113.0, Off <b>(100.0)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
T2	°C : Off, 15.0– 44.9 <b>(35.0)</b> °F : Off, 59.0 – 112.8 <b>(95.0)</b>	°C: 15.1 – 45, Off <b>(37.8)</b> °F : 59.2 – 113.0, Off <b>(100.0)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
ΔT	°C: Off, 0.0 – 29.9 <b>(0.0)</b> °F : Off, 0.0 – 53.8 <b>(0.0)</b>	°C : Off, 0.1 – 30.0 <b>(2.8)</b> °F : 0.2 – 54, Off <b>(5.0)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
Resp Rate	Off, 2 – 118 <b>(10)</b>	4 – 120, Off <b>(45)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
ETCO2	Off, 0 – 97 <b>(25)</b>	2 – 99, Off <b>(60)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
FICO2	(Non Applicable)	1 – 25, OFF <b>(5)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
IPI	Off, 1 – 9 <b>(4)</b>	(Non Applicable)	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes

\*Factory Default Settings

## PARAMETER ALARM LIMIT RANGES

Parameter	Lower Limit Range	Upper Limit Range	Alarm Level	Alarms On Choices	Print on Alarm Choices
P1 Systolic	Off, -30 – 298 <b>(75)</b>	-28 – 300, Off <b>(145)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
P1 Mean	Off, -30 – 298 <b>(50)</b>	-28 – 300, Off <b>(110)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
P1 Diastolic	Off, -30 – 298 <b>(35)</b>	-28 – 300, Off <b>(100)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
P2 Systolic	Off, -30 – 298 <b>(15)</b>	-28 – 300, Off <b>(50)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
P2 Mean	Off, -30 – 298 <b>(10)</b>	-28 – 300, Off <b>(25)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
P2 Diastolic	Off, -30 – 298 <b>(5)</b>	-28 – 300, Off <b>(20)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
P3 Systolic	Off, -30 – 298 <b>(35)</b>	-28 – 300, Off <b>(110)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
P3 Mean	Off, -30 – 298 <b>(15)</b>	-28 – 300, Off <b>(50)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
P3 Diastolic	Off, -30 – 298 <b>(10)</b>	-28 – 300, Off <b>(25)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
P4 Systolic	Off, -30 – 298 <b>(35)</b>	-28 – 300, Off <b>(110)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
P4 Mean	Off, -30 – 298 <b>(15)</b>	-28 – 300, Off <b>(50)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes
P4 Diastolic	Off, -30 – 298 <b>(10)</b>	-28 – 300, Off <b>(25)</b>	<b>*Med</b>	No, <b>*Yes</b>	<b>No*</b> , Yes

\*Factory Default Settings

## 30. ALARM SPECIFICATIONS

### General Alarms

Alarms	Audible & visible alarm indication + external nurse call interface Alarm levels: High, Medium & Low Alarm Volume: 45 - 85 dB(A)
Visual Alarm Light	Color coded: Red, Yellow, Cyan Complies with IEC60601-1-8
Audible:	High, medium, low level, no sound Clinician adjustable volume control from 1 to 10 (45 – 85 dB) Complies with IEC60601-1-8
Alarm Silence / Suspend Times	Configurable: 1, 1.5 or 2 minutes

### ECG and HR Messages

Message	Parameter Value	Possible Causes	Suggested Actions
HR asystole	ASY	No QRS detected for last 4 seconds	<p>Check the patient and provide any necessary clinical care.</p> <p>Check the ECG lead being used to calculate the heart rate (the top displayed lead) -- make sure that the QRS amplitude on this lead is at least 0.5 mV.</p> <p>Change to another ECG lead to get adequate QRS amplitude.</p> <p>Reposition or change electrodes if no lead gives adequate QRS amplitudes. Remember the importance of good skin preparation techniques.</p>
HR ventricular fibrillation	VF	No organized ventricular rhythm detected	<p>Check the patient and provide any necessary clinical care.</p> <p>Check the ECG lead being used to calculate the heart rate (the top displayed lead) -- make sure that the QRS amplitude on this lead is at least 0.5 mV.</p> <p>Change to another ECG lead to get adequate QRS amplitude.</p> <p>Reposition or change electrodes if no lead gives adequate QRS amplitudes. Remember the importance of good skin preparation techniques.</p>

Message	Parameter Value	Possible Causes	Suggested Actions
HR lead off	[blank]	Unplugged cable Broken cable Loose lead wire Faulty lead wire Dried out electrode Inoperable ECG circuit	Check to make sure electrodes are still securely attached to the patient, and reattach if necessary. Remember the importance of good skin preparation techniques. Check to make sure all the lead wires are still connected to the electrodes. Check to make sure the lead wires are securely connected to the Surveyor patient monitor. Check to make sure there are no broken lead wires. Turn monitor off, then back on If message persists, contact Mortara technical support.
HR artifact	---	Patient movement Electrical noise from auxiliary equipment Bad electrode contact	Calm the patient. Isolate the patient from auxiliary equipment, if possible. Check to make sure electrodes are still securely attached to the patient, and reattach if necessary. Remember the importance of good skin preparation techniques.
HR < [lower limit]	[number]	The patient's heart rate has fallen below the current lower alarm limit.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.
HR > [upper limit]	[number]	The patient's heart rate has risen above the current upper alarm limit.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.
ECG Unable to Calibration		The AM12 12-Lead ECG Acquisition Module has failed its calibration	Disconnect and reconnect the AM12, while making sure that there are no spurious contacts between electrodes and earth ground.

## Non-Invasive Blood Pressure (NIBP) Messages

Message	Parameter Value	Possible Causes	Suggested Actions
NIBP weak signal	---	Poor limb perfusion Improper cuff placement Cuff size too large for the patient	Check the patient and provide any necessary clinical care Check to make sure the cuff is wrapped properly, with the "artery" mark lined up over the brachial artery Check the limb circumference against the recommended range as printed on the cuff, to insure the cuff is not too big

Message	Parameter Value	Possible Causes	Suggested Actions
NIBP artifact	---	Persistent patient movement or coughing  Hemodynamic interference (varying pulse amplitudes due to breathing or cardiac valve defects)  Hose is clogged or leaking	Check the patient and provide any necessary clinical care  Calm the patient  Move the cuff to another limb with less movement  If no obvious patient motion, switching to the other limb may still help in the case of hemodynamic interference  Check the cuff and hose for signs of damage
NIBP cuff leak	---	Leaky cuff or hose  Cuff not applied to patient	Check for leaks in the cuff or hose and replace if necessary  Check that cuff and hose are connected to the monitor  Check that cuff is applied to patient
NIBP blocked hose -- check patient	---	Pinched Hose	Check the patient and insure that the cuff is deflated  Check for kinks or obstructions in the hose  Replace hose if necessary
NIBP measurement time exceeded	---	The measurement time limit (2¼ minutes) was exceeded, usually due to motion artifact	See suggestions for “NIBP artifact”  Repeat the measurement
NIBP needs service	---	Monitor has detected a hardware problem	Check the patient and insure that the cuff is deflated  Turn the monitor off, then on.  If message persists, contact Mortara technical support.
NIBP cannot measure	---	Initial inflation pressure may not have been high enough (if patient’s systolic pressure is above 200 mmHg)  Patient movement	Repeat the measurement (monitor will automatically adjust to using a higher initial inflation pressure if needed)
NIBPs < [lower limit]	[number]	The patient's systolic pressure has fallen below the current lower alarm limit.	Check the patient and provide any necessary clinical care.  Change the alarm limit if it is no longer clinically appropriate.

Message	Parameter Value	Possible Causes	Suggested Actions
NIBPs > [upper limit]	[number]	The patient's systolic pressure has risen above the current upper alarm limit.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.
NIBPd < [lower limit]	[number]	The patient's diastolic pressure has fallen below the current lower alarm limit.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.
NIBPd > [upper limit]	[number]	The patient's diastolic pressure has risen above the current upper alarm limit.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.
NIBPm < [lower limit]	[number]	The patient's mean pressure has fallen below the current lower alarm limit.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.
NIBPm > [upper limit]	[number]	The patient's mean pressure has risen above the current upper alarm limit.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.

## Pulse Oximetry (SpO<sub>2</sub>) Messages

Message	Parameter Value	Possible Causes	Suggested Actions
SpO <sub>2</sub> replace sensor	---	Bad SpO <sub>2</sub> sensor Incorrect set-up within the Surveyor patient monitor.	Replace the SpO <sub>2</sub> sensor. Contact Mortara Technical Support.
SpO <sub>2</sub> check sensor placement	---	Sensor has become detached from patient Sensor not fully inserted on patient's finger Excessive ambient light Bad sensor (no red light coming from sensor)	Check to make sure the sensor is attached fully and securely to the patient Cover the sensor with opaque material, such as a towel, to reduce ambient light Reattach the sensor, possibly on a smaller or larger finger Replace sensor if there is no red light coming from it.
SpO <sub>2</sub> weak signal	---	Poor perfusion Large tissue mass Nail polish Bad SpO <sub>2</sub> sensor	Check the patient and provide any necessary clinical care Warm the patient's extremities if needed Reattach the sensor on a smaller finger Remove any nail polish that may be interfering with the red light Replace the SpO <sub>2</sub> sensor
SpO <sub>2</sub> unplugged	[blank]	SpO <sub>2</sub> sensor not connected to SpO <sub>2</sub> cable	Check to make sure the SpO <sub>2</sub> sensor is securely connected to the SpO <sub>2</sub> cable on the monitor
SpO <sub>2</sub> artifact	---	Patient movement or coughing Hemodynamic interference	Calm the patient Reattach the sensor on another finger with less movement Reattach the sensor on a larger finger
SpO <sub>2</sub> < [lower limit]	[number]	The patient's oxygen saturation has fallen below the current lower alarm limit.	Check the patient and provide any necessary clinical care Change the alarm limit if it is no longer clinically appropriate
SpO <sub>2</sub> > [upper limit]	[number]	The patient's oxygen saturation has risen above the current upper alarm limit.	Check the patient and provide any necessary clinical care Change the alarm limit if it is no longer clinically appropriate

Message	Parameter Value	Possible Causes	Suggested Actions
PR < [lower limit]	[number]	The patient's pulse rate has fallen below the current lower alarm limit.	Check the patient and provide any necessary clinical care Change the alarm limit if it is no longer clinically appropriate
PR > [upper limit]	[number]	The patient's pulse rate has risen above the current upper alarm limit.	Check the patient and provide any necessary clinical care Change the alarm limit if it is no longer clinically appropriate

## Temperature Messages

Message	Parameter Value	Possible Causes	Suggested Actions
T1 < [lower limit] T2 < [lower limit] $\Delta T$ < [lower limit]	[number]	The patient's temperature or different between the two temperature probes has fallen below the current lower alarm limit.	Check the patient and provide any necessary clinical care. Verify that the values are not due to artifact by checking the position of the patient and cables as well as the placement of the probe. Change the alarm limit if it is no longer clinically appropriate.
T1 > [higher limit] T2 > [higher limit] $\Delta T$ > [higher limit]	[number]	The patient's temperature or different between the two temperature probes has risen above the current higher alarm limit.	Check the patient and provide any necessary clinical care. Verify that the values are not due to artifact by checking the position of the patient and cables as well as placement of the probe. Change the alarm limit if it is no longer clinically appropriate.
T1 probe disconnected T2 probe disconnected	--	Probe is not connected to the Surveyor patient monitor	Connect the probe to the Surveyor patient monitor and the patient per clinical guidelines.

## Respiration Messages

Message	Parameter Value	Possible Causes	Suggested Actions
RR out of range (too high)	---	<p>The patient's respiration rate has risen above the maximum value the monitor can accurately detect.</p> <p>Electrical noise from auxiliary equipment</p> <p>Monitor confused by signal artifact</p>	<p>Check the patient and provide any necessary clinical care.</p> <p>Isolate the patient from auxiliary equipment, if possible.</p> <p>Check to make sure electrodes are still securely attached to the patient, and reattach if necessary. Remember the importance of good skin preparation techniques.</p>
RR lead off	[blank]	<p>Unplugged cable</p> <p>Broken cable</p> <p>Loose lead wire</p> <p>Faulty lead wire</p> <p>Dried out electrode</p> <p>Inoperable respiration detection circuit</p>	<p>Check to make sure electrodes are still securely attached to the patient, and reattach if necessary. Remember the importance of good skin preparation techniques.</p> <p>Check to make sure all the lead wires are still connected to the electrodes.</p> <p>Check to make sure the lead wires are securely connected to the Surveyor patient monitor.</p> <p>Check to make sure there are no broken lead wires.</p> <p>Turn monitor off, then back on</p> <p>If message persists, contact Mortara technical support.</p>
RR artifact	---	<p>Patient movement</p> <p>Electrical noise from auxiliary equipment</p> <p>Bad electrode contact</p>	<p>Calm the patient.</p> <p>Isolate the patient from auxiliary equipment, if possible.</p> <p>Check to make sure electrodes are still securely attached to the patient, and reattach if necessary. Remember the importance of good skin preparation techniques.</p>
RR < [lower limit]	[number]	<p>The patient's respiration rate has fallen below the current lower alarm limit.</p> <p>No breath has been detected for 30 seconds.</p>	<p>Check the patient and provide any necessary clinical care.</p> <p>Change the alarm limit if it is no longer clinically appropriate.</p>
RR > [upper limit]	[number]	<p>The patient's respiration rate has risen above the current upper alarm limit.</p>	<p>Check the patient and provide any necessary clinical care.</p> <p>Change the alarm limit if it is no longer clinically appropriate.</p>

## Capnography (CO<sub>2</sub>) Messages

Message	Parameter Value	Possible Causes	Suggested Actions
ETCO <sub>2</sub> < [lower limit]	[number]	The patient's ETCO <sub>2</sub> parameter value has fallen below the current lower alarm limit.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.
ETCO <sub>2</sub> > [upper limit]	[number]	The patient's ETCO <sub>2</sub> parameter value has risen above the current upper alarm limit.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.
FICO <sub>2</sub> > [upper limit]	[number]	The patient's FICO <sub>2</sub> parameter value has risen above the current upper alarm limit.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.
IPI < [lower limit]	[number]	The patient's IPI parameter value has fallen below the current lower alarm limit.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.
RR out of range (too high)	---	The patient's respiration rate has risen above the maximum value the monitor can accurately detect. Electrical noise from auxiliary equipment Monitor confused by signal artifact	Check the patient and provide any necessary clinical care. Isolate the patient from auxiliary equipment, if possible. Check to make sure electrodes are still securely attached to the patient, and reattach if necessary. Remember the importance of good skin preparation techniques.
RR < [lower limit]	[number]	The patient's respiration rate has fallen below the current lower alarm limit. No breath has been detected for 30 seconds.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.
RR > [upper limit]	[number]	The patient's respiration rate has risen above the current upper alarm limit.	Check the patient and provide any necessary clinical care. Change the alarm limit if it is no longer clinically appropriate.

Message	Parameter Value	Possible Causes	Suggested Actions
Note: Changing patient mode will change current setting values to saved default values.	--	The patient mode has changed. The patient age has changed.	Verify that the correct patient mode (Adult/Pediatrics) is being applied. Save or Purge patient data as appropriate, or cancel selection. Verify that the patient age is correctly entered. Clear IPI trend data and continue, or cancel selection.
Note: Changing patient mode will clear IPI trend data, even if other patient data is saved.	--	The patient mode has changed. The patient age has changed.	Verify that the correct patient mode (Adult/Pediatrics) is being applied. Save or Purge patient monitoring data as appropriate, or cancel selection. Verify that the patient age is correctly entered. Clear IPI trend data and continue, or cancel selection.
IPI age range not set	--	For pediatric patients, the age range must be set to correctly determine IPI.	Set the age range in the CO2 setup screen.
CO2 Occluded Line	--	CO2 sampling line cannot be cleared due to moisture or other obstruction.	Replace the sampling line. If connected to scavenging system, remove to see if the message disappears.
CO2 Warming Up	--	CO2 module is preparing to acquire data.	Allow more time.
Probe Unplugged	--	CO2 interface is not connected.	Connect the CO2 sample line to the monitor and patient.
CO2 Problem Detected	-	CO2 interface has encountered a problem	Check the CO2 subsystem including sampling line and exhaust port. Verify that the exhaust port is not blocked.

## Invasive Pressure Messages

Message	Parameter Value	Possible Causes	Suggested Actions
IBPs < [lower limit] IBPm < [lower limit] IBPd < [lower limit]	[number]	The patient's invasive systolic/diastolic/mean pressure has fallen below the current lower alarm limit.	Check the patient and provide any necessary clinical care. Verify that the values are not due to artifact by checking the position of the patient, cables and transducer. Zero set the pressure if necessary. Change the alarm limit if it is no longer clinically appropriate.
IBPs > [higher limit] IBPm > [higher limit] IBPd > [higher limit]	[number]	The patient's invasive systolic/diastolic/mean pressure has risen above the current higher alarm limit.	Check the patient and provide any necessary clinical care. Verify that the values are not due to artifact by checking the position of the patient, cables and transducer. Zero set the pressure if necessary. Change the alarm limit if it is no longer clinically appropriate.
IBP signal out of range [low] IBP signal out of range [high]	--	The invasive signal is out of range.	Verify the position of the patient, cables and transducer. Zero set the pressure if necessary.
IBP unplugged	--	IBP cable or transducer not plugged	Verify that the cable and transducer are properly connected.
Unable to zero	--	Stopcock is not open	Open the stopcock and check tubing and cables.
Zero required	--	IBP channel not zeroed	Zero the IBP channel
Zero required and 60 seconds has expired	--	IBP channel not zeroed	Zero the IBP channel
Calibration required	--	IBP channel requires calibration	Arrange for calibration service of the IBP channel
Calibration in progress	--	IBP channel calibration is in progress	Wait until the calibration process is completed
Cannot calibrate	--	Calibration failed	Contact Mortara Technical Support
ART: Check Transducer	--	ART IBP pressure below 10mmHg	Check ART catheter to ensure that it is properly positioned and connected.

## Cardiac Output Messages

Message	Parameter Value	Possible Causes	Suggested Actions
BT signal out of range (high)	N/A	BT out of range (too high)	Check the BT transducer
BT signal out of range (low)	N/A	BT out of range (too low)	Check BT transducer
IT signal out of range (high)	N/A	IT out of range (too high)	Check IT transducer
IT signal out of range (low)	N/A	IT out of range (too low)	Check IT transducer
No BT change in manual mode	N/A	CO measurement timeout	Restart the CO
BT transducer unplugged	N/A	BT unplugged	Plug in the BT transducer
IT transducer unplugged	N/A	IT unplugged	Plug in the IT transducer



## 31. TROUBLESHOOTING

The following table provides guidance for investigating issues that may occur during operation of the Surveyor patient monitors. Contact Mortara Technical Service for further assistance.

### Power and Battery

Symptom	Possible Causes	Suggested Resolution
The Surveyor patient monitor is not working and displays an error message.	Internal system failure	Power cycle the Surveyor patient monitor and try again. If problems persist, stop using the Surveyor patient monitor and contact Mortara Technical Support.
The patient monitor is plugged in but does not start up.	No AC power from outlet	Verify that the power outlet is working; verify the green LED on the front panel is illuminated.
	The monitor is powered off	Press the power switch to power on the patient monitor.
	Internal system error	Power cycle the Surveyor patient monitor. If problem persists, stop using the Surveyor patient monitor and contact Mortara Technical Support.
The patient monitor will not run once on battery power.	Battery needs charging	Connect the Surveyor patient monitor to AC power. Verify that the green LED is illuminated and the Surveyor patient monitor powers up.
	Battery will not hold charge	Replace the battery according to instructions in the General Care & Maintenance section.

### Display and Touch Screen

Symptom	Possible Causes	Suggested Resolution
The touch screen is not working properly.	Touch screen failure	Power cycle the Surveyor patient monitor and try again. If problems persist, stop using the Surveyor patient monitor and contact Mortara Technical Support.
The display is not working properly.	Display failure	Power cycle the Surveyor patient monitor and try again. If problems persist, stop using the Surveyor patient monitor and contact Mortara Technical Support.

## ECG, Arrhythmia, and ST

Symptom	Possible Causes	Suggested Resolution
ECG signal is noisy.	Notch filter selection may not be appropriate for local settings.	Change the notch filter setting in the Service menu based on local power frequency (50 or 60 Hz). Check the proximity of the ECG lead cables to power cable or high frequency noise sources.
	Patient movement Electrical noise from auxiliary equipment Bad electrode contact	Confirm electrode site preparation; confirm correct ECG placement; instruct the patient to not move. Calm the patient. Isolate the patient from auxiliary equipment, if possible. Check to make sure electrodes are still securely attached to the patient, and reattach if necessary. Remember the importance of good skin preparation techniques.
No ST numeric values displayed	ST is not enabled in the Setup HR dialogue AND/OR ST is not enabled in the Setup>Parameters dialogue	Enable ST in the Setup HR dialogue AND/OR Enable ST in the Setup>Parameters dialogue
No ECG traces are displayed	Electrodes for display lead not connected	Touch “all ECG” button, check which leads are displayed without connection. Correct the displayed lead per the attached electrodes.
	Bad ECG cable	Touch “all ECG” button, short lead wires together and observe which lead appear on the screen after circa 10 seconds. Change cable.
	Bad electrode contact (high skin-electrode impedance)	Touch “all ECG” button, check electrode contact, check electrodes not being dry, re-prep skin.
AM12 connected but no ECG traces are displayed	12-lead is not enabled in the Setup HR dialogue AND/OR AM12 encountered an error during power-up auto calibration	Enable 12-lead in the Setup HR dialogue AND/OR Unplug the AM12 from the device and plug it back in.

## Non-Invasive Blood Pressure (NIBP)

Symptom	Possible Causes	Suggested Resolution
NIBP measurement fails or inaccurate.	Cuff selection or placement, or patient movement	Confirm the selection and placement of the NIBP cuff; instruct the patient to not move during the measurement cycle; confirm appropriate initial inflation pressure settings. Re-attempt the measurement. If problems persist, contact Mortara Technical Support.
Audible beep heard	Successful completion of NIBP measurement	No action. This is as per design. The NIBP End Tone signifies to the clinician that the NIBP measurement has completed.
Cannot obtain BP measurement	Patient moving during BP acquisition Improper cuff size Cuff or tubing not properly connected BP out of range Improperly configured NIBP inflation pressure	Use comfort measures to encourage patient to keep NIBP limb still Ensure proper BP cuff size Check all NIBP connections Use a manual or alternative BP acquisition mode Adjust the NIBP inflation pressure based on the patient's systolic BP
BP values higher or lower than clinically anticipated	Improper cuff size or placement Patient moving during BP acquisition	Ensure proper BP cuff size and placement Use comfort measures to encourage patient to keep NIBP limb still

## Pulse Oximetry (SpO2)

Symptom	Possible Causes	Suggested Resolution
Pulse oximetry measurement fails or inaccurate	Sensor placement or patient movement	Confirm the selection and placement of the pulse oximetry sensor; instruct the patient to not move the SpO2 sensor extremity; remove dark finger nail polish.
Cannot obtain SpO2	SpO2 sensor not connected to patient Sensor/cable not properly connected Patient moving Overhead lighting interference Patient has poor perfusion, slow HR, low BP	Connect SpO2 sensor to patient Check all SpO2 connections Use comfort measures to encourage patient to keep SpO2 limb still Place SpO2 limb under the top sheet or blanket, for example Switch SpO2 to another limb
SpO2 waveform is erratic, low amplitude	Patient moving SpO2 sensor on same limb as NIBP cuff	Use comfort measures to encourage patient to keep SpO2 limb still Move SpO2 and NIBP to different patient limbs
No waveform/parameter	SpO2 sensor not connected to patient Sensor/cable not properly connected Patient moving	Connect SpO2 sensor to patient Check all SpO2 connections Use comfort measures to encourage patient to keep SpO2 limb still

## Temperature

Symptom	Possible Causes	Suggested Resolution
No T1, T2, or $\Delta T$ numeric values displayed	Incorrect display format	Select the temperature parameters to display via the Setup Temperature dialogue
No parameter	Temperature sensor not properly placed/connected	Check temperature sensor placement and connection

## Respirations: Via ECG Thoracic Impedance

Symptom	Possible Causes	Suggested Resolution
No respiration waveform displayed	3 or 5 lead cable: Cable not connected Electrodes not connected  AM12 in use  Resp disabled	Check that the ECG cable is properly connected into the patient monitor. Ensure ECG electrodes have good connection with the patient's skin.  The AM12 12-Lead ECG Acquisition Module does not support respirations. Alternative: Use 3 or 5 lead cable, capnography.  Enable Respirations via Setup Resp dialogue

## Capnography (CO<sub>2</sub>)

Symptom	Possible Causes	Suggested Resolution
No CO <sub>2</sub> waveform and numeric values displayed	CO <sub>2</sub> is not enabled in the Setup>Parameters dialogue	Enable CO <sub>2</sub> in the Setup>Parameters dialogue

## Invasive Pressures

Symptom	Possible Causes	Suggested Resolution
No Invasive pressure waveform and numerics displayed	Improper manifold setup Loose pressure tubing connections Pressure cable not connected into monitor Stopcock not in correct position Transducer requires zeroing  Invasive pressure are not enabled in the Setup>Parameters dialogue	Ensure the pressure manifold is properly connected, the invasive cable is inserted into the correct invasive pressure channel of the patient monitor, and the transducer is intact. Zero the invasive pressure  Enable invasive pressures in the Setup>Parameters dialogue
Invasive pressure waveform is dampened	Air in invasive pressure tubing Kinked or occluded patient catheter	Check patient Check invasive pressure tubing for patency Follow hospital standard of care
Cannot zero the invasive pressure	Stopcock not in correct position	Open stopcock to atmosphere Check pressure manifold patency
Invasive pressure numerics higher or lower than clinically anticipated	Improperly leveled transducer- either too high or too low	Re-level the transducer as per hospital standard of care
The PAWP dialogue is hidden	Invasive pressure not labeled as PA	Label the appropriate invasive pressure as PA

## Cardiac Output

Symptom	Possible Causes	Suggested Resolution
No CO tile displayed	CO is not enabled in the Setup>Parameters dialogue	Enable CO in the Setup>Parameters dialogue
No CO numerics displayed	CO curves not yet performed CO average not saved  CO is not enabled in the Setup>Parameters dialogue	Perform CO measurements Save CO average  Enable CO in the Setup>Parameters dialogue
CO numerics higher or lower than clinically anticipated	Computation constant incorrect for catheter and injectate volume	Enter computation constant as per PA catheter manufacturers recommendation
Irregular CO curve	Improper CO injection technique Patient movement during CO injection	Reattempt CO bolus as per hospital standard of care Use comfort measures to encourage patient to keep still during CO procedure
CO curves not drawn	Monitor is in Manual CO mode	When in Manual CO mode, select START when injecting the CO bolus to begin the CO curve drawing Switch to Auto CO mode



## 32. ACCESSORIES

Use the following Mortara part numbers to obtain spare parts or to reorder accessories:

MORTARA PART #	DESCRIPTION
<b>Blood Pressure</b>	
6901-021-02	CUFF BLOOD PRESSURE REUSABLE S12/S19 CHILD
6901-021-03	CUFF BLOOD PRESSURE REUSABLE S12/S19 SM ADULT
6901-021-04	CUFF BLOOD PRESSURE REUSABLE S12/S19 ADULT
6901-021-05	CUFF BLOOD PRESSURE REUSABLE S12/S19 ADULT LONG
6901-021-06	CUFF BLOOD PRESSURE REUSABLE S12/S19 LARGE ADULT
6901-021-07	CUFF BLOOD PRESSURE REUSABLE S12/S19 LARGE ADULT LONG
6901-021-08	CUFF BLOOD PRESSURE REUSABLE S12/S19 THIGH
6901-020-02	CUFF BLOOD PRESSURE DISPOSABLE S12/S19 CHILD - CASE 20
6901-020-03	CUFF BLOOD PRESSURE DISPOSABLE S12/S19 SM ADULT - CASE 20
6901-020-04	CUFF BLOOD PRESSURE DISPOSABLE S12/S19 ADULT- CASE 20
6901-020-05	CUFF BLOOD PRESSURE DISPOSABLE S12/S19 ADULT LONG - CASE 20
6901-020-06	CUFF BLOOD PRESSURE DISPOSABLE S12/S19 LARGE ADULT - CASE 20
6901-020-07	CUFF BLOOD PRESSURE DISPOSABLE S12/S19 LARGE ADULT LONG - CASE 20
6901-020-08	CUFF BLOOD PRESSURE DISPOSABLE S12/S19 THIGH - CASE 20
6901-022-01	EXTENSION HOSE BLOOD PRESSURE CUFF 3 M
<b>ECG</b>	
41000-032-52	AM12 PATIENT CABLE AHA CLIP
41000-032-53	AM12 PATIENT CABLE IEC CLIP
9293-050-50	ECG CABLE 3 WIRE AHA CLIP
9293-050-51	ECG CABLE 3 WIRE IEC CLIP
9293-050-60	ECG CABLE 5 WIRE AHA CLIP
9293-050-61	ECG CABLE 5 WIRE IEC CLIP
9293-059-52	3 WIRE ECG LEAD SET, SNAP ENDS, AHA MARKINGS, GRAY
9293-059-53	3 WIRE ECG LEAD SET, SNAP ENDS, IEC MARKINGS, GRAY
9293-059-62	5 WIRE ECG LEAD SET, SNAP ENDS, AHA MARKINGS, GRAY
9293-059-63	5 WIRE ECG LEAD SET, SNAP ENDS, IEC MARKINGS, GRAY
9293-059-50	3 WIRE ECG LEAD SET, CLIP ENDS, AHA MARKINGS, GRAY
9293-059-51	3 WIRE ECG LEAD SET, CLIP ENDS, AHA MARKINGS, GRAY
9293-059-60	5 WIRE ECG LEAD SET, CLIP ENDS, AHA MARKINGS, GRAY

<b>ECG</b>	
9293-059-61	5 WIRE ECG LEAD SET, CLIP ENDS, IEC MARKINGS, GRAY
9293-059-70	ECG TRUNK CABLE 3/5 WIRE GRAY
<b>PULSE OXIMETRY</b>	
9293-057-50	CABLE SPO2 ADAPTER AND EXTENSION – MORTARA INTERFACE ONLY
9293-057-60	SENSOR SPO2 REUSABLE FINGER CLIP – MORTARA INTERFACE ONLY
9293-057-61	SENSOR SPO2 DISPOSABLE ADULT CASE 24 – MORTARA INTERFACE ONLY
9293-057-62	SENSOR SPO2 DISPOSABLE PEDIATRIC CASE 24 – MORTARA INTERFACE ONLY
<b>INVASIVE PRESSURE</b>	
9293-058-50	CABLE Y INVASIVE PRESSURE
9293-058-60	CABLE INVASIVE PRESSURE EDWARDS
9293-058-61	CABLE INVASIVE PRESSURE BECTON-DICKINSON
<b>CARDIAC OUTPUT</b>	
9293-051-50	CABLE INVASIVE CARDIAC OUTPUT EDWARDS
9293-051-51	PROBE TEMPERATURE IN-LINE EDWARDS
9293-051-52	PROBE TEMPERATURE BATH EDWARDS
<b>CO2</b>	
9293-052-50	STARTER KIT CO2 ADULT
9293-052-60	FILTERLINE H CO2 ADULT/PED - CASE 25
9293-052-61	FILTERLINE CO2 ADULT/PED - CASE 25
9293-052-62	CAPNOLINE CO2 +O2 ADULT - CASE 25
9293-052-63	CAPNOLINE CO2 +O2 PED - CASE 25
<b>TEMPERATURE</b>	
9293-056-50	PROBE TEMP INTERNAL GENERAL PURPOSE
9293-056-51	PROBE TEMP INTRNL GEN PURPOSE SINGLE-USE - BOX 20
9293-056-52	PROBE TEMPERATURE SKIN SINGLE-USE - BOX 20
9293-056-60	CABLE ADAPTER TEMPERATURE DISPOSABLE PROBES
<b>RECORDER</b>	
5450-007-50	THERMAL PRINTER 50 MM WITH HOUSING
9100-030-50	PAPER ROLL CASE SURVEYOR S12/S19
9100-030-01	PAPER ROLL PACK SURVEYOR S12/S19

MORTARA PART #	DESCRIPTION
<b>MOUNTING</b>	
8363-031-60	WALL MOUNT STANDARD S12/S19 GCX KIT; INCLUDES: 8363-031-50; WALL MOUNT STANDARD S12/S19 9920-001-50; CHANNEL WALL MOUNT 19 X 2.5 ID X 4W 9920-003-50; HANGER CABLE - GCX WALL CHANNEL XXXX; BRACKET POWER BRICK WALL CHANNEL
8363-031-61	WALL MOUNT STANDARD W/MTG PLATE S12 GCX KIT; INCLUDES: 8363-031-51; WALL MOUNT STANDARD W/MTG PLATE S12 8363-019-50 MOUNTING PLATE SURVEYOR S12 9920-001-50; CHANNEL WALL MOUNT 19 X 2.5 ID X 4W 9920-003-50; HANGER CABLE - GCX WALL CHANNEL XXXX; BRACKET POWER BRICK WALL CHANNEL 8363-021-50; SOCKET MOUNT ROLL STAND AND WALL S12
8363-032-60	WALL MOUNT ARTICULATING S12/S19 GCX KIT; INCLUDES: 8363-032-50; WALL MOUNT ARTICULATING S12/S19 GCX 9920-001-50; CHANNEL WALL MOUNT 19 X 2.5 ID X 4W XXXX; BRACKET POWER BRICK WALL CHANNEL
8363-020-50	BRACKET RECORDER MOUNTING SURVEYOR S19 EXTERNAL
9911-019-50	ROLLING STAND; INCLUDES MO-0006-60; CART ROLL STAND SURVEYOR S12 W/ BASKET 8363-019-50 MOUNTING PLATE SURVEYOR S12) XXXX; BRACKET POWER BRICK WALL CHANNEL 8363-021-50; SOCKET MOUNT ROLL STAND AND WALL S12
<b>POWER</b>	
4800-017	INTERNAL LITHIUM-ION BATTERY
4101-012	EXTERNAL AC POWER SUPPLY
3181-008	AC POWER CABLE FOR S12/S19 EXTERNAL POWER SUPPLY - US AND CANADA
3181-012-01	AC POWER CABLE FOR S12/S19 EXTERNAL POWER SUPPLY – AUSTRALIA
3181-015-01	AC POWER CABLE FOR S12/S19 EXTERNAL POWER SUPPLY – UK
3181-002	AC POWER CABLE FOR S12/S19 EXTERNAL POWER SUPPLY – ALL OTHERS
<b>OTHER</b>	
9960-067	SURVEYOR USB FLASH DRIVE
9960-074	ADAPTER, RJ45 FEMALE TO DB9 FEMALE (FOR RS-232 SERIAL COMMUNICATION WITH EMR SOFTWARE USING CAT5 CABLING)

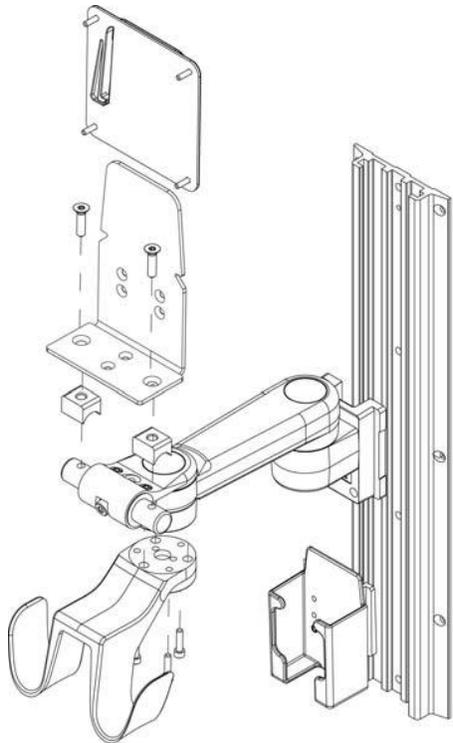
The following are compatible with the Nellcor pulse oximetry interface and can be purchased directly through Nellcor or authorized distributor.

PART NUMBER	DESCRIPTION
DOC10	PULSE OXIMETRY EXTENSION CABLE – 10'
DOC8	PULSE OXIMETRY EXTENSION CABLE – 7'
DOC4	PULSE OXIMETRY EXTENSION CABLE – 4'
DS100A	OXIMAX DURASENSOR REUSABLE FINGER-CLIP OXIMETRY SENSOR
D-YS	OXIMAX DURA-Y REUSABLE MULTI-SITE OXIMETRY SENSOR
OXI-A/N	OXIMAX OXIBAND ADULT/NEONATAL REUSABLE SENSOR
OXI-P/I	OXIBAND® PEDIATRIC/INFANT REUSABLE SENSOR
MAX-A/N	OXIMAX SENSOR ADHESIVE ADULT/NEONATAL
MAX-P/I	OXIMAX SENSOR ADHESIVE PEDIATRIC/NEONATAL
MAX-PACI	SENSOR ASSORTMENT PACK
SRC-MAX	PULSE OXIMETRY TESTER, OXIMAX

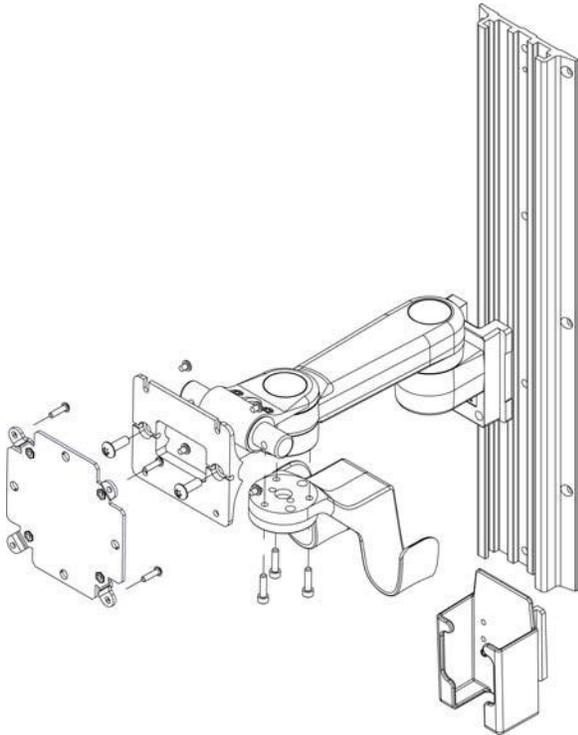
The Surveyor patient monitor's invasive pressure interface is compatible with transducers which have  $5\mu\text{V/V/mmHg}$  sensitivity and comply with the AAMI BP22 Standard including those available from Edwards Lifesciences and Becton, Dickinson & Company.

The Surveyor patient monitor's temperature interface is compatible with YSI 400 series temperature probes.

**Figure 88 Quick-Disconnect (M-Series) Wall Mounting Components**



**Figure 89 Value (Vesa M-Series) Wall Mounting Components**



**Figure 90 Premium (VHM-25) Wall Mount Components**

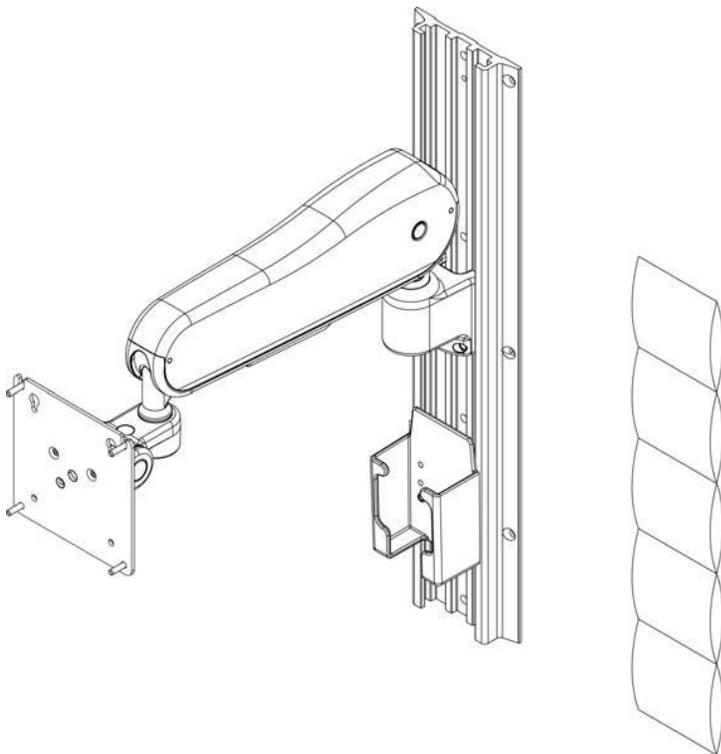
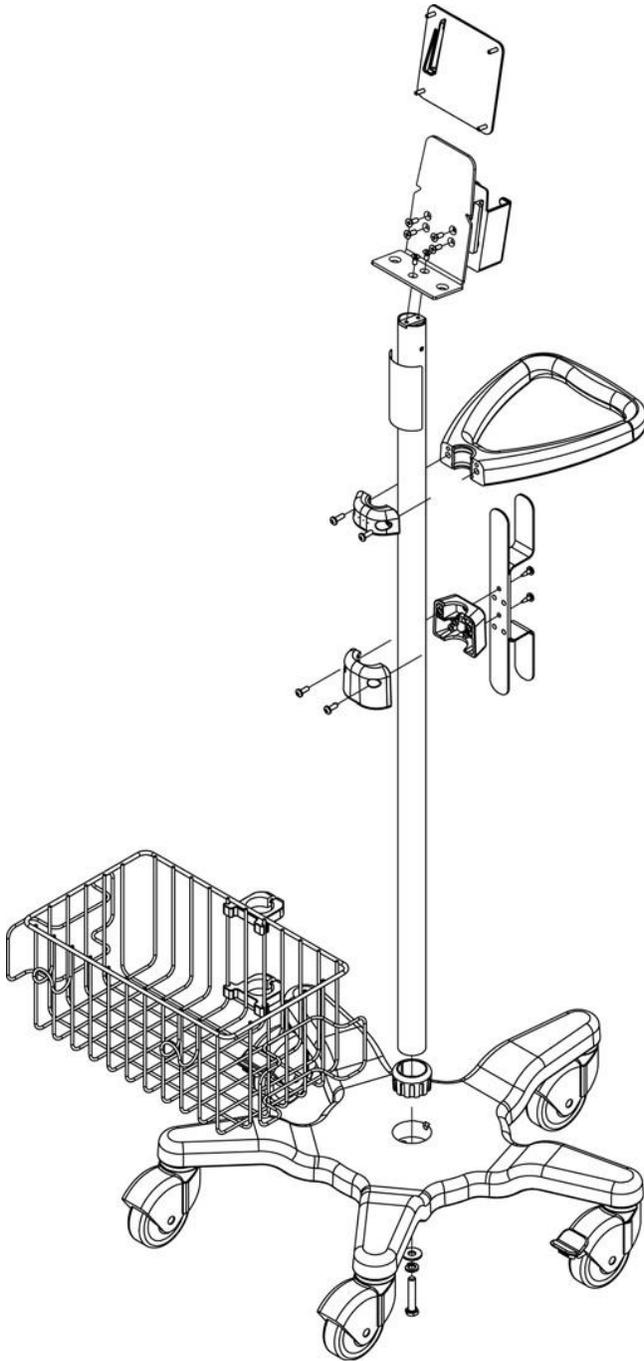


Figure 91 Surveyor S12 Roll Stand Components (not to be used with S19)



## 33. APPLIED STANDARDS

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- AAMI ES60601-1:2005 Medical electrical equipment Part 1: General Requirements for Basic Safety and Essential Performance
- CENELEC EN60601-1:2006 Medical Electrical Equipment Part 1: General Requirements for Basic Safety and Essential Performance
- CSA C22.2#601.1:1990 (R2005) Medical Electrical Equipment - Part 1: General Requirements for Safety-General Instruction No 1; Update No 2
- CSA C22.2#60601-1:2008 Ed:3 Medical Electrical Equipment - Part 1: General requirements for basic Safety and essential performance
- IEC 60601-1:1988 Ed:2 Medical Electrical Equipment Part 1: General Requirements for Safety; (Amd. 1-1991) (Amd. 2-1995) (Corrigendum-1995)
- EN 60601-1:1990, + A1:1993, + A2:1995, + A13:1996, Medical Electrical Equipment, General Requirements for Safety, Part 1
- IEC 60601-1:2005 Ed:3 Medical electrical equipment Part 1: General requirements for basic safety and essential performance
- IEC 60601-1-2:2007 Medical Electrical Equipment – Part 1-2: General requirements for safety – Collateral Standard: Electromagnetic Compatibility
- IEC 60601-1-4:2000 Ed:1.1 Medical Electrical Equipment - Part 1-4: General Requirements for Safety - Collateral Standard: Programmable Electrical Medical Systems; Edition 1:1996 Consolidated with Amendment 1:1999
- IEC 60601-1-6:2006 Ed:2 Medical electrical equipment - Part 1-6: General requirements for safety - Collateral Standard: Usability
- IEC 60601-1-8:2006 Medical Electrical Equipment -- Part 1-8: General requirements for basic safety and essential performance -- Collateral standard: General requirements, tests and guidance for alarm systems in medical electrical equipment and medical electrical systems
- IEC 60601-2-27:2005 Ed:2 Medical Electrical Equipment PT. 2: Particular Requirements for the Safety, including essential performance, of Electrocardiographic Monitoring Equipment
- ANSI/AAMI EC11:1991/(R)2007: Diagnostic Electrocardiograph Devices; for Electrocardiograms printed through Surveyor Central Station.
- IEC 60601-2-30: Second Edition Particular Requirements for the Safety, Including Essential Performance, of Automatic Cycling Non-Invasive Blood Pressure Monitoring Equipment
- IEC 60601-2-34:2000 Ed: 2 Medical Electrical Equipment - Part 2-34: Particular Requirements for the Safety, Including Essential Performance, of Invasive Blood Pressure Monitoring Equipment
- IEC 60601-2-49 Ed. 1.0 b:2006 Medical Electrical Equipment - Part 2-49: Particular requirements for the safety of multifunction patient monitoring equipment
- IEC 60601-2-51 Ed. 1.0 b:2005: Medical Electrical Equipment – Part 2-51: Particular Requirements for Safety, Including Essential performance, of Recording and Analyzing Single Channel and Multichannel Electrocardiographs, section 51 (Protection Against Hazardous Output) only; for Electrocardiograms printed through Surveyor Central Station.
- IEC 62366:2007 Medical equipment -- Application of usability engineering to medical equipment

- IEC 80601-2-30:2009 Ed:1 Medical Electrical Equipment- Part 2-30: Particular Requirements for the Basic Safety and Essential Performance of Automated Non-Invasive Sphygmomanometers
- ISO 80601-2-55:2010 Medical electrical equipment Particular requirements for the basic safety and essential performance of respiratory gas monitors
- ISO 80601-2-56:2009 - Medical electrical equipment - Part 2-56: Particular requirements for basic safety and essential performance of clinical thermometers for body temperature measurement
- ISO 80601-2-61:2011 - Medical electrical equipment -- Part 2-61: Particular requirements for basic safety and essential performance of pulse oximeter equipment
- ISO 9919 Issued:2005/03/15 Ed:2 Medical electrical equipment Particular requirements for the basic safety and essential performance of pulse oximeter equipment for medical use
- UL 60601-1:2003 Ed:1 UL Standard for Safety Medical Electrical Equipment, Part 1: General Requirements for Safety
- IEC 60601-2-51 Ed. 1.0 b:2005: Medical Electrical Equipment - Part 2-51: Particular Requirements for Safety, Including Essential performance, of Recording and Analyzing Single Channel and Multichannel Electrocardiographs – Section 51 Only