CAUTION: Federal law restricts this device to sale by or on the order of a physician.
1. NOTICES

Manufacturer’s Responsibility

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

- System installation and assembly operations, extensions, readjustments, modifications or repairs are carried out by personnel authorized by Welch Allyn, Inc. only.
- The device is used in accordance with the instructions for use.
- The device is correctly maintained according to the standards authorized by Welch Allyn, Inc. using original spare parts.
- The device is used with compatible accessories and supplies. Contact Welch Allyn or one of its affiliates for a current list of compatible accessories and supplies.
- The electrical installation of the relevant room complies with the requirements of appropriate regulations.

Responsibility of the Customer

The user of this device 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 Welch Allyn, Inc. authorized personnel must have access to this manual at any time.

The user of this device must periodically check the transmitters and monitors, their functionality and the integrity of their accessories.

Equipment Identification

Welch Allyn, Inc. equipment is identified by serial and part numbers on the side, back, or bottom of the device. Care should be taken so that these numbers are not defaced.

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Other Important Information

The information in this document is subject to change without notice.

Welch Allyn, Inc. makes no warranty of any kind with regard to this material including, but not limited to, implied warranties of merchantability and fitness for a particular purpose. Welch Allyn, Inc. assumes no responsibility for any errors or omissions that may appear in this document. Welch Allyn, Inc. makes no commitment to update or to keep current the information contained in this document.

Notice to EU Users and/or Patients:

Any serious incident that has occurred in relation to the device, should be reported to the manufacturer and the competent authority of the Member State in which the user and/or patient is established.

Disposal

This product and its accessories must be disposed of according to local laws and regulations. Do not dispose of this product as unsorted municipal waste. For more specific disposal information see www.welchallyn.com/weee.
2. WARRANTY INFORMATION

Your Welch Allyn Warranty

WELCH ALYN, INC (hereafter referred to as “Welch Allyn”) warrants that components within Welch Allyn 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 Welch Allyn, 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, TRANSUDER 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) Parts and/or accessories of the Product/s not obtained from or approved by Welch Allyn;
c) Misapplication, misuse, abuse, and/or failure to follow the Product/s instruction sheets and/or information guides;
d) Accident; a disaster affecting the Product/s;
e) Alterations and/or modifications to the Product/s not authorized by Welch Allyn;
f) Other events outside of Welch Allyn’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 WELCH ALYN TO HAVE BEEN DEFECTIVE. This remedy shall be conditioned upon receipt of notice by Welch Allyn of any alleged defects promptly after discovery thereof within the warranty period. Welch Allyn’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 Welch Allyn’s principal place or any other place as specifically designated by Welch Allyn or an authorized distributor or representative of Welch Allyn, and (ii) all risk of loss in transit. It is expressly agreed that the liability of Welch Allyn is limited and that Welch Allyn does not function as an insurer. A purchaser of a Product/s, by its acceptance and purchase thereof, acknowledges and agrees that Welch Allyn is not liable for loss, harm, or damage due directly or indirectly to an occurrence or consequence therefrom relating to the Product/s. If Welch Allyn should be found liable to anyone under any theory (except the expressed warranty set forth herein) for loss, harm, or damage, the liability of Welch Allyn 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 WELCH ALYN 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 WELCH ALYN IS NOTIFIED WITHIN THE WARRANTY PERIOD. IN NO EVENT, INCLUDING THE CLAIM FOR NEGLIGENCE, SHALL WELCH ALYN 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.
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3. SAFETY INFORMATION

[WARNING:]
Means there is the possibility of personal injury to you or others.

[Caution:]
Means there is the possibility of damage to the device.

[Note:]
Provides information to further assist in the use of the device.

Safety Regulations

Surveyor Central and Surveyor Central Repeater are medical devices labelled, according to European directive 93/42/EEC (MDD), as a class IIb and class I medical devices respectively. Telemetry transmitters are produced by Welch Allyn, and marked per the MDD directive. Various other accessories, like the monitor and printer are marked by the respective manufacturers according to the applicable European directives. See respective declarations of conformity for details.

Surveyor Central cannot be classified as Medical Electrical Equipment according to the definition of safety standard IEC 60601. The Surveyor Central, together with all accessories that have a physical or logical connection with it, forms part of a Medical Electrical System. The Surveyor Central complies with various safety and performance regulations as mentioned in Appendix E.

[Warnings]

- This manual gives important information about the use and safety of this system. Deviating from operating procedures, misuse or misapplication of the system, or ignoring specifications and recommendations could result in increased risk of harm to users, patients and bystanders, or damage to the system.

- Users are expected to be licensed clinical professionals knowledgeable about medical procedures and patient care, and adequately trained in the use of this system. Before attempting to use this system 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 system. Contact Welch Allyn service for additional training options.

- The Surveyor Central is not designed to be used in the environment where the patient is undergoing a medical procedure as defined in IEC 60601-1 (1.5 m from the patient). The use of an isolation transformer between mains and Surveyor Central is required but is not a sufficient safety measure for use in the patient environment because of data connections (data network) that might cause excessive leakage currents in some conditions. Additional separation devices may be required. Any equipment that has a physical connection between Surveyor Central and that is in the patient environment must have additional protection against electrical shock (e.g., a separation device between the equipment and Surveyor Central) in order to be in compliance with IEC 60601-1 or equivalent safety standards.

- The Surveyor Central is not battery operated. For uninterrupted use, an appropriate uninterruptible power supply (UPS) is required. The WiFi network (telemetry) as well as any active network components such as switch and firewall should also have the capability to remain operational in cases of general power outages. The Surveyor Central is designed to continue operation with the last stored settings after a power interruption, however, loss of stored data is possible if power is interrupted to the system that stores the data. When using a backup power source such as a UPS, periodically check it to ensure it is properly functioning per the manufacturer’s recommendations and specifications.
• In order to be safely used, all accessories (such as monitors, printers, data network, etc.) must be compatible, and comply with all safety and EMC regulations that apply to them according to their intended use; for use in Europe, these accessories should be CE marked.

• The various parts of a Surveyor Central monitoring system (Telemetry receiver computers, control and display computers, storage computers, printers, or bedside monitors) are all connected through a specific Ethernet data network. This network must be installed according to all applicable standards and may only be logically or physically connected to the outside world through a specific routing device available from Welch Allyn. Any other data path can lead to serious security risks and interruptions of monitoring. Other devices must not be connected to the Surveyor data network.

• Connection of the Surveyor Network along with its associated transmitters and monitors to the IT Network in a healthcare delivery organization may carry risks to patients, operators as well as 3rd parties. Such risks must be carefully assessed and mitigated. The IEC 80001-1:2010 standard provides guidance to the healthcare delivery organization for carrying out such risk assessment and mitigation. Changes to the IT Network can also introduce new risks which should be carefully assessed and planned.

• The Surveyor Central, 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.

• In the case of a Surveyor Central system with additional control stations for display and control of the same patient channels in multiple locations, silencing or suspending of alarms will cause the alarm to be silenced or suspended at all the locations. Be certain that alarms are silenced or suspended by the clinician having direct responsibility for care of the given patient.

• Cleaning must be performed with the system turned off. Let all parts dry well before turning the power back on.

• Install all computer equipment with adequate space around ventilation vents. Clean and remove accumulated dust on ventilation openings, and also remove dust regularly from the inside of the system. The last operation must be performed by adequately trained and authorized personnel, and with the system turned off.

• Install the computer that generates the alarm sounds in such a way that the sound can be heard adequately in the appropriate areas. The speaker is installed on the front panel of the computer.

• The Surveyor Central provides an alarm volume adjustment. Be sure to set the volume at a level that alarms can be heard above the ambient noise level in the environment of use. Setting alarm volumes too low can impede recognition of alarm signals.

• The hardware watchdog device is connected to the computer with a USB cable and has its own power supply. Mount it in such a way that the sound can be heard adequately in the appropriate areas. Test regularly by temporarily removing the USB plug while the central station power is turned on.

• The Surveyor Central must be connected to a properly grounded power terminal, and the electrical installation must comply with the local safety requirements for the environment where it is used.

• The Surveyor Central requires more than one mains outlet. Fix multi-socket outlets properly, do not leave them on the floor, and organize the cabling in such a way that normal work is not hampered and safety is not compromised.

• Regularly check all mains power cables for damage and proper connection. Do not use equipment with a damaged power cord.
The Surveyor Central components are not waterproof. Avoid spillage of liquids from penetrating the system or submersion of components and transmitters into a liquid. In case of accidental spillage, turn device off and let dry thoroughly.

The various manufacturers of accessories provide separate user manuals (e.g., monitor, laser printer, Surveyor S12/S19, Surveyor S4, patient cables, electrodes). Read these manuals well and refer to them for specific functions. It is recommended to keep all manuals together. Refer to these manuals for a list of approved accessories. When in doubt, contact Welch Allyn.

Every hardware or software modification has to be made by Welch Allyn authorized and trained technical personnel.

Do not disassemble the equipment as hazardous voltages may be present within. Contact Welch Allyn or an affiliated service representative for repairs.

Technical and service documents are available upon request.

Always turn the system off before connecting or disconnecting any cables.

Do not use the system in places that are susceptible to explosion hazard or in the presence of flammable gases.

Do not use the system in the presence of Magnetic Resonance Imaging (MRI) equipment and tomography equipment.

Do not insert a bootable CD/DVD on the Surveyor Central computers. Do not run any program from CD/DVD or USB memory sticks. These I/O devices should only be used for export and import of patient ID formats, profiles and protocols.

Surveyor Central computers contain a small lithium battery for maintaining clock and BIOS settings which should normally last the lifetime of the system. If the battery needs to be replaced, be sure that it is done by qualified personnel and with a battery of the same type.

Surveyor Central software has been extensively tested and clinically validated. Several protection mechanisms against software errors have been built into the Surveyor Central; however, in the unlikely event of a failure of the software or the computer processor, the electronic (hardware) “watchdog” of the Surveyor Central sounds a continuous loud beep and the Central station has to be power-cycled to remove this. Please inform Welch Allyn service personnel for further troubleshooting should this continuous loud beeping occur.

Surveyor Central hardware has been carefully selected for reliability; however, in mission critical situations, it might be advisable to have a backup system available at short notice. This also includes accessories such as patient transmitters and monitors which, by nature and way of use, can be more prone to failure.

Installation and connection to data networks must be performed by properly trained personnel, authorized by Welch Allyn, Inc.

To maintain designed operator and patient safety, use only parts and accessories supplied with the system and available through Welch Allyn, Inc.

The equipment described in this manual has an expected lifetime of five years from the date of manufacture. Operation beyond this expected life may not meet specifications. This lifetime is only valid if devices are used according to the instructions in this manual and associated manuals provided with the equipment.
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 optionally equipped with Welch Allyn’s VERITAS™ 12-lead resting ECG interpretation algorithm. When this option is enabled, the VERITAS ECG algorithm can provide an over-reading physician with a silent second opinion through diagnostic statements output on the ECG report. For additional information on the Welch Allyn VERITAS 12-lead resting ECG interpretation algorithm, please refer to the Physician’s Guide to ECG Interpretation.

12-lead ECGs acquired through Surveyor Central or attached monitors 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 Central 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 minimum amplitude for detecting QRS complexes is user selectable between 160, 300 and 500 µV. A low value of this limit has the risk of detecting P waves as QRS complexes in the case of atrio-ventricular block; however, a high value might lead to false cardiac arrest alarms if the QRS amplitude is low in all leads. Therefore, the user is encouraged to select detection leads with amplitude of at least 1 mV and set the minimum QRS amplitude at 300 µV.

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.

When the 40 Hz filter is used, the frequency response requirement for diagnostic ECG equipment cannot be met. The 40 Hz filter significantly reduces high-frequency components of the ECG and pacemaker spike amplitudes, and is recommended only if high-frequency noise cannot be reduced by proper procedures.

The quality of the signal produced by the system may be adversely affected by the use of other medical equipment connected to the patient including, but not limited to, defibrillators and ultrasound machines.

If the system or one of its subsystems become inoperable during monitoring, a medium or low priority type alarm sounds and a message is displayed on the screen. In case of hardware or software failure that causes the sound generator or display subsystem to fail, the hardware watchdog unit generates a continuous beep. Periodic checks of the monitoring screen are recommended to ensure proper functioning.

The LCD supplied with the Surveyor Central has a separate power switch and power-on indicator. If no image appears on the screen, check the LCD power indicator. Alarm sounds are not affected by the status of the LCD. Do not connect a sound-capable display monitor such as a LCD TV to the Surveyor Central.

The on/off switch of the Surveyor Central is deactivated and can only be used for emergency power down by depressing it for a period greater than 4 seconds. Normal shutdown of the Surveyor Central should be done by using the password-protected configuration window.

Do not use excessive force on any of the connection cables and handle all accessories with care.

Various alarm conditions require operator set limits that vary per patient. For telemetry monitoring, Surveyor Central supports the selection of appropriate alarm profiles when a patient is admitted. The operator should check these settings after each patient admission to ensure whether the chosen alarm limits are appropriate for the individual patient. Inappropriate alarm limits render the alarm system useless.
SAFETY INFORMATION

- Saved profiles are only applicable to the type of cable and detection leads in use when the profile was defined. If another type of cable is used with a saved profile, the default detection leads will be utilized.

- In any single environment such as an intensive care unit or cardiac operating theater, a potential hazard can exist if different alarm preset values are used for the same or similar equipment.

- Portable and mobile RF communications equipment can affect medical electrical equipment or systems as well as the Surveyor Central and its accessories.

- Surveyor Central 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 priority, 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.

- The Surveyor Central alarm system can be globally disabled or suspended for a period of time for a patient. The selection between disabling and suspending, as well as the suspension duration, can be set in the password-protected system configuration page. A clear visual indication of this condition is present in the patient window, and a reminder signal sounds every three minutes. Any technical alarms will be visually presented on the screen, regardless of the alarm disabled state. In this configuration the technical alarms will not be audible.

- The intended use of Surveyor Central Repeater is to repeat waveforms, parameters and system status of selected patients monitored by Surveyor Central in order to enhance workflow for medical personnel. Surveyor Central Repeater does not produce audible alarm signals and may not be used to substitute any alarm functions of Surveyor Central.

- This manual applies to the most recently manufactured system, with respect to software release and hardware configuration. Whenever used for software upgrades on previously installed equipment, some technical specifications or labels may not be respected, whereas functions and instructions for use of the system are always valid. This user manual reflects software version 5.1.0.

The following warnings concern telemetry monitoring:

- Electrostatic discharges may generate short interference on the ECG tracings.

- WiFi Telemetry: The Surveyor S4 utilizes standard WiFi telemetry per the IEEE 802.11g/n standard. The WiFi network supporting the Surveyor S4 and for use with the Surveyor Central must be installed and tested in accordance to Welch Allyn’s guidance and network requirements. Also refer to Welch Allyn’s Manufacturer Disclosure Statement for Medical Device Security (MDS2) documents for the Surveyor Central and Surveyor S4. Welch Allyn and/or 3rd party partners are available to perform network site surveys and audits to confirm the suitability of the facility’s WiFi network for use with the S4 mobile monitor and connection to the Surveyor Central and its Surveyor Network.

- The system was not designed to be used with high frequency (HF) surgical devices.

- Use of transmitters and monitors may be restricted in some countries; see the transmitter’s and monitor’s user manuals for details.

- Consult the Surveyor S12/S19 and Surveyor S4 user manuals for more information regarding the patient cable, electrode recommendations, cleaning, maintenance, channel frequencies, precautions to take during patient defibrillation, and other warnings.

The following warnings concern pulse oximetry (SpO₂) telemetry monitoring:

- Pulse oximetry sensors must be checked a minimum of every 4 hours and moved to a new site as necessary.
• Pulse oximetry sensors are susceptible to high ambient light interference including ambient photodynamic therapy. Shield the sensor area as necessary.

• SpO₂ measurement may be adversely affected by dyes (e.g., methylene blue, indocyanine green, indigo, carmine, fluorescein) introduced into the bloodstream.

• Any condition that restricts blood flow such as the use of a blood pressure cuff or extremes in systemic vascular resistance may cause inability to determine accurate SpO₂ readings.

• Certain conditions such as physical movement (patient and imposed motion); diagnostic testing; low perfusion; electromagnetic interference; electrosurgical units; 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 displayed on the LCD of the transmitter and by alarms generated at the Surveyor Central system for signals coming from the transmitter.

• The performance of the monitor may be compromised by excessive motion.

• Nail polish and/or artificial fingernails can affect the accuracy of pulse oximetry and should be removed.

• The pulse oximeter equipment is calibrated to display functional oxygen saturation.

• Functional SpO₂ testers (simulators) are useful to measure how accurately a particular monitor is reproducing the calibration curve but cannot be used to assess the accuracy of a type of probe or monitor. If there is independent demonstration that a particular calibration curve is accurate for the combination of a pulse oximeter monitor and a pulse oximeter probe, then a functional tester can measure the contribution of a monitor to the total error of a monitor/probe system. The functional tester can then measure how accurately a particular pulse oximeter monitor is reproducing that calibration curve.

• If no SpO₂ or pulse rate is present, alarm conditions are provided at the Surveyor Central system. There is no alarm condition provided at the transmitting device.

• For additional instructions and warnings, refer to the user manual of the transmitting device.

The following warnings concern heart rate for telemetry monitoring:

• Heart rate indication is usually not affected by ventricular or supraventricular arrhythmias or irregular heart rates. 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 IEC 60601-2-27.

• High heart rate and low heart rate alarms cannot be disabled.

• Tall and peaked T-waves may affect QRS detection resulting in doubled heart rates. Surveyor Central rejects tall T-Waves less than or equal to 230% of a 1 mV QRS measured according to IEC 60601-2-27.

• The heart rate meter correctly detects all beats of the alternating beat type waveforms considered in 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 low heart rate, high heart rate and asystole, as measured according to IEC 60601-2-27, is less than 10 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:

<table>
<thead>
<tr>
<th>Performance Measures</th>
<th>MIT Database</th>
<th>AHA Database</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Welch Allyn</td>
<td>Welch Allyn</td>
</tr>
<tr>
<td>QRS Detection Sensitivity %</td>
<td>99.93</td>
<td>99.78</td>
</tr>
<tr>
<td>QRS Detection Positive Predictivity %</td>
<td>99.87</td>
<td>99.91</td>
</tr>
<tr>
<td>PVC Detection Sensitivity %</td>
<td>95.13</td>
<td>93.15</td>
</tr>
<tr>
<td>PVC Detection Positive Predictivity %</td>
<td>97.04</td>
<td>98.40</td>
</tr>
<tr>
<td>PVC Detection False Positive Rate %</td>
<td>0.220</td>
<td>0.154</td>
</tr>
</tbody>
</table>

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.

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 device.

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 square waves. A lead fail alarm is generated on the Surveyor Central.

The following warnings concern pacemaker patients for telemetry monitoring:

Rate meters may continue to count the pacemaker rate during occurrences of cardiac arrest or some arrhythmias. Do not rely entirely upon heart rate meter ALARM SIGNALS. Keep pacemaker PATIENTS under close surveillance. See this manual for disclosure of the pacemaker pulse rejection capability of this instrument.

With the Surveyor S4 when used with the 4-wire, 5-wire or 10-wire ECG cable, all pacemaker spikes are rejected per the IEC 60601-2-27 standard (0.1 - 2 ms duration, 2 - 700 mV amplitude). Signals are recognized as pacemaker spikes when they have a slew rate over 4 V/s, as measured according to the IEC 60601-2-27 standard. Abnormally high or wide pacemaker spikes might be recognized as QRS if their amplitude and pulse width exceed these values.

With the Surveyor S4 when used with the 3-wire ECG cable, pacemaker spikes are not rejected consistently. For this reason, do not rely upon heart rate meter ALARM SIGNALS, when using a 3-wire cable.

Welch Allyn does not claim, verify, or validate support for all available pacemakers.


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 standstill.
• 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.

Notes

• Surveyor Central contains electronic records including ECG’s which can be exported to other applications. The Surveyor Central system can be part of a system that is compliant with the electronic records requirements of part 11 of Title 21 of the Code of Federal Regulations; Electronic Records; Electronic Signatures (21 CFR Part 11) as stipulated by the US Food and Drug Administration's (FDA). The user of the Surveyor Central system must ensure full compliance to this as required.

• Compliance with applicable privacy and data protection guidelines, such as HIPAA in the United States and Directive 95/46/EC of the European Parliament and the Council, plus any other local regulations and policies are the ultimate responsibility of the entity deploying and using the Surveyor Central. The Surveyor Central system implements certain features such as username/passwords and audit trails. By-design, the system is accessible and available for use upon power-up. The facility deploying and using the system is responsible for ensuring appropriate safeguards are put in place to protect patient health information (PHI). This includes a mixture of physical and IT-based mechanisms to secure PHI from unauthorized access. The Surveyor Central Station including printers generating reports must be placed in a physical location that is secure (e.g., nurse’s station). Surveyor Review and Repeater stations may be placed in less secure locations but must implement proper username/password access policies as required.
4. EQUIPMENT SYMBOLS AND MARKINGS

WARNING The warning statements in this manual identify conditions or practices that could lead to illness, injury, or death. In addition, when used on a patient applied part, this symbol indicates defibrillation protection is in the cables. Warning symbols will appear with a grey background in a black and white document.

CAUTION The caution statements in this manual identify conditions or practices that could result in damage to the equipment or other property, or loss of data.

- Direct Current (DC) power input
- Indicates compliance to applicable European Union directives
- Universal Serial Bus (USB) port
- Do not dispose as unsorted municipal waste. Per European Union Directive 2002/96, requires separate handling for waste disposal according to national requirements
- Output terminal
- Network connection
- Mouse Connection
- Serial Port Connection
- ON (Power)
- Keyboard Connection
- Parallel Port Connection
- Reorder Number
- Medical Device
- Model Identifier

Product Lifetime

Welch Allyn intends to support the Surveyor Central Processing Unit, monitors, transmitters and proprietary antenna network components most current version, for not less than three (3) years beyond the date of the last unit produced of that revision, or for as long as parts, accessories and expertise are available from our vendors, subject to last time buys and technology obsolescence.
5. ELECTROMAGNETIC COMPATIBILITY

Electromagnetic compatibility (EMC) with surrounding devices should be assessed when using Surveyor Central. An electronic device can either generate or receive electromagnetic interference. Testing for electromagnetic compatibility (EMC) has been performed on a representative Surveyor Central configuration, which included an Uninterruptable Power Supply (UPS) and was executed according to the international standard for EMC for medical devices (IEC 60601-1-2). This IEC standard has been adopted in Europe as the European Norm (EN 60601-1-2).

**WARNING:** Surveyor Central should not be used adjacent to, or stacked on top of other equipment. If Surveyor Central must be used adjacent to or stacked on top of other equipment, verify that Surveyor Central operates in an acceptable manner in the configuration in which it will be used.

Fixed, portable, and mobile radio frequency communications equipment can affect the performance of medical equipment. See table for recommended separation distances between the radio equipment and Surveyor Central.

**WARNING:** The use of accessories and cables other than those recommended by Welch Allyn may result in increased emissions or decreased immunity of the transmitter.

Please note the emissions and immunity declaration tables that follow.
Guidance and Manufacturer’s Declaration: Electromagnetic Emissions

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

<table>
<thead>
<tr>
<th>Emissions Test</th>
<th>Compliance</th>
<th>Electromagnetic Environment: Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Emissions CISPR 11</td>
<td>Group 1</td>
<td>The system 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.</td>
</tr>
<tr>
<td>RF Emissions CISPR 11</td>
<td>Class A</td>
<td>The system 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.</td>
</tr>
<tr>
<td>Harmonic Emissions IEC 61000-3-2</td>
<td>Not Applicable</td>
<td></td>
</tr>
<tr>
<td>Voltage Fluctuations/ Flicker Emissions IEC 61000-3-3</td>
<td>Not Applicable</td>
<td></td>
</tr>
</tbody>
</table>

Guidance and Manufacturer’s Declaration: Electromagnetic Immunity

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

<table>
<thead>
<tr>
<th>Emissions Test</th>
<th>Compliance</th>
<th>Compliance Level</th>
<th>Electromagnetic Environment: Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrostatic discharge (ESD) IEC61000-4-2</td>
<td>+/- 6 kV contact +/- 8 kV air</td>
<td>+/- 6 kV contact +/- 8 kV air</td>
<td>Floors should be wood, concrete, or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.</td>
</tr>
<tr>
<td>Electrical fast transient/burst IEC 61000-4-4</td>
<td>+/- 2 kV for power supply lines +/- 1 kV for input/output lines</td>
<td>+/- 2 kV for power supply lines +/- 1 kV for input/output lines</td>
<td>Mains power quality should be that of a typical commercial or hospital environment.</td>
</tr>
<tr>
<td>Surge IEC 61000-4-5</td>
<td>+/- 1 kV line(s) to line(s) +/- 2 kV line(s) to earth</td>
<td>+/- 1 kV line(s) to line(s) +/- 2 kV line(s) to earth</td>
<td>Mains power quality should be that of a typical commercial or hospital environment.</td>
</tr>
<tr>
<td>Voltage fluctuations and interruptions</td>
<td>&lt;5% UT for 0.5 cycles 40% UT for 5 cycles 70% UT for 25 cycles &lt; 5% UT for 5s</td>
<td>&lt;5% UT for 0.5 cycles 40% UT for 5 cycles 70% UT for 25 cycles &lt; 5% UT for 5s</td>
<td>Note that monitoring is interrupted at the level “&lt; 5% UT for 5s&quot;if a UPS is not used.</td>
</tr>
<tr>
<td>Power frequency (50/60 Hz) magnetic field IEC 61000-4-8</td>
<td>3 A/m</td>
<td>3 A/m</td>
<td>Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.</td>
</tr>
</tbody>
</table>

**NOTE:** UT is the AC Mains voltage prior to application of the test level.
Guidance and Manufacturer’s Declaration: Electromagnetic Immunity

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

<table>
<thead>
<tr>
<th>Emissions Test</th>
<th>IEC 60601 Test Level</th>
<th>Compliance Level</th>
<th>Electromagnetic Environment: Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conducted RF IEC 61000-4-6</td>
<td>3 Vrms 150 kHz to 80 MHz</td>
<td>3 Vrms 150 kHz to 80 MHz</td>
<td>Portable and mobile RF communications equipment should be used no closer to any part of the system, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.</td>
</tr>
<tr>
<td>Radiated RF IEC 61000-4-3</td>
<td>3 V/m 80 MHz to 2.5 GHz</td>
<td>3 V/m 80 MHz to 2.5 GHz</td>
<td>Where ( P ) is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and ( d ) is the recommended separation distance in meters (m).</td>
</tr>
</tbody>
</table>

Interference may occur in the vicinity of equipment marked with the following symbol:

---

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 active components.

b. Over the frequency range 150 kHz to 80 MHz, field strengths should be less than [3] V/m.
Recommended Separation Distances Between Portable and Mobile RF Communications Equipment and the System

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

<table>
<thead>
<tr>
<th>Rated Maximum Output Power of Transmitter (W)</th>
<th>Separation Distance According to Frequency of Transmitter (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>150 KHz to 80 MHz</td>
</tr>
<tr>
<td></td>
<td>( d = 1.2\sqrt{P} )</td>
</tr>
<tr>
<td>0.01</td>
<td>0.1 m</td>
</tr>
<tr>
<td>0.1</td>
<td>0.4 m</td>
</tr>
<tr>
<td>1</td>
<td>1.2 m</td>
</tr>
<tr>
<td>10</td>
<td>4.0 m</td>
</tr>
<tr>
<td>100</td>
<td>12.0 m</td>
</tr>
</tbody>
</table>

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.

**NOTE:** For RF transmitters that radiate around the working band of the telemetry transmitters interference can occur also at shorter distances.

**NOTE:** For EMC assessment, essential performance was absence of disruption of the operation of the SC System, and, in particular, maintaining HR accuracy to no more than ±10% deviation, and continued function of alarms during and after the test.
6. INTRODUCTION

Purpose

This user manual explains how to:

- Use and understand Surveyor™ Central, Surveyor Central Repeater, and available options
- Enter, modify, and delete information
- Perform common operator tasks

NOTE: This manual may contain screen shots. Any screen shots 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.

Audience

This manual is written for clinical professionals who are expected to have a working knowledge of medical procedures and terminology as required for monitoring cardiac patients.

Intended Use

The Surveyor Central Station system is intended for monitoring of physiological signs, including cardiac and vital signs, for multiple patients within a medical facility. The system can receive, display and store data from up to a maximum of 64 multi-parameter patient monitors, mobile monitors, and/or telemetry systems. The system can support patient monitoring and telemetry monitoring modes simultaneously. Patient monitors can be Surveyor S12 or S19 patient monitoring systems. Ambulatory telemetry transmitter and mobile monitor sources can be Surveyor S4 systems.

In patient monitoring mode, the patient monitors provide primary monitoring functionality while the Surveyor Central Station system provides continuous secondary monitoring of patients including alarm reception and management, display and storage of parameters and waveforms including full-disclosure, automatic and on-demand generation of various printed reports using a network-attached printer.

In telemetry monitoring mode, the Surveyor Central Station provides primary monitoring of patients including display of values and waveforms, alarm generation and management, data storage, patient management and report printing functionality. Patients are monitored through telemetry, when moving in a defined area, of a variable size depending on layout and thickness of walls. In order to guarantee a proper signal transmission in each different situation, an antenna network can be installed according to customer needs.

The data and analysis provided by the Surveyor Central Station is reviewed, confirmed, and used by trained medical personnel in the diagnosis of patients with various conditions.

Indications for Use

The Welch Allyn Surveyor Central Station is indicated for use in adult and pediatric patient populations.

- In a clinical setting, by qualified medical professionals, properly trained for patient monitoring and use of the system. Continuous analysis is provided for all patients. The personnel must be experienced in cardiovascular problematic situations and emergency procedures or pathologies related to cardiac involvements.
- Centralized monitoring through a network of patients in Coronary Care Units, Intensive Care Units, Ambulatory Care Units (Telemetry Units), Step-Down Units, Operating Rooms, Emergency Departments and Surgical
Centers. Evaluation of adult and pediatric patients with symptoms suggesting arrhythmia. Detected arrhythmias create an audiovisual alarm according to the alarm profile.

- Chest Pain Evaluation.
- Evaluation of patients with pacemakers.
- Evaluation of a patient’s response after resuming occupational or recreational activities (e.g., after M.I. or cardiac surgery.)
- Evaluation of monitored parameters documenting therapeutic interventions in individual patients or groups of patients.
- Clinical and epidemiological research studies.

**System Description**

The Surveyor Central can perform telemetry monitoring using the Surveyor S4 integrated with the healthcare delivery organization’s WiFi network infrastructure. The Surveyor Central is also designed to communicate with the Surveyor S12/S19 multi-parameter patient monitors. Its intended functions include:

- Real-time, 3-wire (1-lead), 5-wire (7-lead) and 10-wire (12-lead) diagnostic ECG signal display
- Real-time SpO₂ plethysmographic waveform display
- Automatic monitoring of arrhythmias, SpO₂ values, and ST changes including one or more displayed waveform channels for each patient
- Visual and audible alarms of events, arrhythmias, and set parameters with adjustable priorities
- Averaged and reference QRS complexes
- Graphical trend review
- Single lead or any combination of leads up to 12 for ECG rhythm and report printing
- ECG signal and SpO₂ data storage with optional full-disclosure storage and review
- When the patient device is a Surveyor S12/S19 monitor, additional parameters may include non-invasive blood pressure (NIBP), impedance respiration, invasive pressures (P1-P4), Temperature (T1, T2), end-tidal and inspired CO₂, and cardiac output (CO).

Through telemetry, patients using ambulatory transmitters are monitored while moving in a designated area. To guarantee proper signal transmission in various situations, install an antenna network as per facility requirements.

The Surveyor Central Station communicates with the Surveyor S12/S19 patient monitors through a Local Area Network (LAN) interface. The Surveyor Central network can distribute patient data to one or more Surveyor Central control stations in a single or dual display mode.

Each Surveyor Central receiving workstation will acquire data. Connect multiple Surveyor workstations to the same Surveyor Central network to allow real-time patient monitoring in a variety of different system configurations (see following page).

Control, viewing, receiving signals, and data storage are all possible on a single Surveyor Central workstation. Control, viewing, receiving signals, and

*Figure 1 – An example of Surveyor Central configured with dual displays.*
data storage can also be achieved using separate workstations for each function—or a combination of functions—on the Surveyor Central network. Networked printers are used for automatic or manual printouts of 12-lead ECG, ECG rhythm, plethysmographic waveform with % SpO₂ and pulse rate, and reports.

An optional redundant storage server is available for increased storage capacity as well as storage to duplicate data disks when continuous and complete ECG capture is critical. This is valuable for institutions that collect ECG data for research purposes. This capability may also be important for other medical facilities.

The Surveyor Central system provides the means for users to manage patient records with associated patient demographics and assign each to a particular patient monitor or telemetry system for obtaining physiological information. Physiological data obtained from patient monitors and telemetry devices are viewable and stored continuously with a minimum storage timeframe of 72 hours. Alarm monitoring and management, including definition of alarm limits, as well as data trending and reporting are available. Full disclosure supports review of the data on a particular patient including review of 12-lead ECG waveforms and other data and waveforms for obtained parameters.

Surveyor Central with WiFi telemetry

![Surveyor Central with WiFi telemetry](image)

**Figure 2** - A Surveyor Central configuration with WiFi telemetry using Surveyor S4 mobile monitors.

**Surveyor Central with Multiple Control of Same Channels**

Additional control stations are available for display and control of the same patient channels in multiple locations. Channel allocation for multiple control stations is defined during installation and setup.

**Surveyor Central USB-WATCHDOG**

Surveyor Central is intended for continuous use. A Watchdog is externally connected to a USB port and emits a loud and continuous audible alarm in case of system failure. A Watchdog is a required and necessary part of every control workstation.
Optional System Components

- **Single color displays**: A single 24” LCD display optimally supports up to 16 or a maximum total of 32 telemetry and patient monitoring slots.

- **Dual color displays**: A 24” dual LCD display optimally supports up to 32 or a maximum total of 64 telemetry and patient monitoring slots.

- **Single, touch-enabled color display**: A single 24” LCD display optimally supports up to 16 or a maximum of 32 telemetry and patient monitoring slots; with touchscreen function.

- **Keyboard/mouse switch**: Allows one keyboard and mouse to control up to 4 nodes, with their displays configured to seamlessly produce one large virtual desktop.

- **Surveyor Central control station**: A workstation with single or dual display on the Surveyor Central network for purposes of controlling and viewing a set of monitored channels at a designated location within the facility.

- **Surveyor Central receiving station**: A workstation connected to the healthcare delivery organization’s WiFi network through a firewall router for the purposes of receiving transmitted signals from Surveyor S4. As required, the receiving station produces a set of channels for viewing or storage at another location on the Surveyor Central network.

- **Surveyor Central receiving and control station**: A workstation with single or dual display connected to the transmitters and monitors for purposes of receiving transmitted signals to produce, display, and control a set of monitoring channels. Data storage is accomplished at another location on the Surveyor Central network.

- **Redundant data storage**: Stores real-time data and simultaneously copies the data to a set of Redundant Array of Independent Disks (RAID) for increased storage capacity and data security in situations where complete data collection is critical. All system data storage for workstations on the Surveyor Central network is performed at this networked server when it is a component of the Surveyor Central.

- **Surveyor Central repeater station**: A display station where monitoring channels are repeated and can be displayed, printed, and reviewed. Alarms are visual only and are not audible or controlled at the repeater station.

- **Network printer (print server)**: The printer must be plugged into the AC power outlet through the appropriate power cord that is in compliance with local regulations. Please refer to the printer manufacturer’s user manual for information, warnings, commands, and intended use.
System Software Options

- **Full disclosure for continuous data storage**: All patient monitoring data is available for review when this option is enabled. The storage amount is dynamic and relies on the number of channels utilized in relation to the size of the storage space. Each day of a patient’s data is equal to approximately 0.5 GB. Divide number of storage days by number of monitored patients to calculate number of days for each monitored patient (i.e., 600 days of storage ÷ 10 monitored patients = 60 days per patient). This option also allows off-line archive to a network directory or DVD media. Data can be acquired by Welch Allyn’s HSCRIBE™ Holter analysis system for further review, rhythm quantification, Holter reporting, and/or 12-lead ECG collection which can then be exported in XML or Unipro format. When this option is not enabled, one minute of ECG data surrounding each event or alarm is stored for review, ECG printing, and export.

- **Protocol manager**: Only available for Telemetry channels. Allows the clinician to design automatically-timed reminder events, automatically generate printed ECGs, and/or export resting 12-lead ECGs. This is particularly useful to clinicians that perform ECG data collection and must remember to execute certain functions at specific times. The application allows the clinician to program the times for such events to automatically occur. Several different protocols can be designed and the desired protocol can be selected during the patient monitoring sessions. Protocols can also be programmed in phases started by the Surveyor Central station user or by pressing the call button on the transmitter.

- **Extended arrhythmia and 12-lead ST monitoring**: In addition to standard lethal arrhythmia events and alarms, this option allows the clinician to automatically print and capture ventricular ectopy, rhythm patterns, and QRS changes as well as pacemaker failure events. This feature also allows averaged 12-lead ECG display for comparison of the reference ECG superimposed on the current ECG. The reference ECG is used for ST change alarms. Note that not all extended arrhythmias are available with S12/S19 patient monitors.

- **Resting ECG interpretation**: Enables global ECG measurement including QT/QTc calculation and 12-lead ECG interpretation utilizing Welch Allyn’s VERITAS algorithm. 12-lead ECGs can be exported in Unipro format to a network directory or directly to Welch Allyn’s E-Scribe™ data management system. This option is required to enable the ability to use and define E-Scribe custom ID formats. This feature is optional with telemetry only monitoring channels. This feature is always included with Surveyor S12/S19 patient monitoring or a mix of telemetry and S12/S19 patient monitoring.

- **Review station**: Enables patient data review in the Surveyor Central from the online database, as well as patient monitoring data archived from the database to external media. The (separate) Resting ECG Interpretation option is required to enable global measurement and 12-lead ECG interpretation on archived records.

The Surveyor Central review station screen layout is similar to the Surveyor Central review screen in dual-display modality and has the same functionality as the Surveyor Central review features including printouts and export. When networked to the Surveyor Central database, it is possible to initiate archive of patient monitoring data. Please refer to the Surveyor Central Review Station user manual (PN 9515-169-75-ENG) for more detail.
Surveyor S12 and S19 Patient Monitors

The Surveyor S12/S19 patient monitors are multiparameter patient monitors designed to acquire physiological waveforms and parameters, and to transmit this data to the Surveyor Central monitoring station.

Please refer to the Surveyor S12/S19 patient monitor user manual (PN 9515-183-51-ENG) for details.

Surveyor S4 Mobile Monitor

The Surveyor S4 is a small, lightweight mobile monitor with a touchscreen designed to acquire ECG and SpO₂, and to transmit this data to the Surveyor Central monitoring station via an 802.11g/n wireless network.

Please refer to the Surveyor S4 User Manual (PN 9515-190-50-ENG) for details.

Surveyor Central with Wireless Access Points

Transmission from and to the Surveyor S4 is via the healthcare delivery organization’s WiFi wireless network used for patient data transmission and other system-level communications. When configured with optional 10-wire ECG, the S4 provides continuous 12-lead ECG transmission. Refer to the diagram in this section.

Surveyor Central Network

The network for the Surveyor Central allows for the connection and exchange of data between the system components. Ethernet cable is used to connect all devices to the multi-port switch through an internal or external wall connection. All devices are outside of the patient area.

WARNING: Do not connect the Surveyor Central Network to computers, devices other than those specified by Welch Allyn, or the Internet, as system operation may be impaired. Consult Welch Allyn or one if its affiliates for information on devices that are approved for use on the Surveyor Central Network.

Surveyor Central’s security router is used to isolate the system from the institution network. A secure firewall router is used for any repeater stations or review stations that are located outside of the Surveyor network. Other applications that access Surveyor Central such as Surveyor Import for Holter analysis and remote service support are networked in this way.
The Surveyor Central repeater station is available as either a dedicated model or standalone software application.

- The dedicated model is installed within the Surveyor network and does not allow user access to any other Microsoft® Windows® programs. It will automatically start when the Surveyor Central is started, the same as any other dedicated node on the system.

- The repeater standalone application contains the same software and can be safely used on a computer on the institution network that meets the minimum specifications listed below and where there is access to the Surveyor security router through LAN or WLAN connection.
  
  - Microsoft Windows 7 OS or Windows 10 (64-bit only)
  - Intel® 2nd Generation Core™ i3 Processor
  - 4 GB RAM
  - 250 GB Hard Disk Drive
  - DVD/CD Drive (for software installation)
  - Fast Ethernet NIC
  - 1920 x 1080 Graphics Resolution

In addition, the repeater standalone application can be safely used on a suitable tablet PC’s that meets the minimum specifications listed below and where there is access to the Surveyor security router.

- Microsoft Windows 7 OS or Windows 10 (64 bit only).
- Intel® Core i3 (7 gen) 7130U
- 4 GB RAM
- 128 GB SSD
- 10.1"
- 1440 × 900 Graphics Resolution

**NOTE:** In order to meet the declared Repeater standalone application performances, no more than two Repeater standalone applications, with eight patients under monitoring, must be connected to the same access point.

**NOTE:** In order to meet the declared Repeater standalone application performances, no more than nine Repeater standalone applications must be used at the same time.

**NOTE:** When connected to Surveyor Central through WLAN connection, the Repeater standalone application performances depend on the customer WLAN connection and its traffic.

The Surveyor Central review station can be networked to the institution network with connection to the Surveyor security router when access to Surveyor Central’s patient database is desired for remote review. The review station can also be installed as a stand-alone and used for review of archived patient monitoring records from media external to the Surveyor Central. Please refer to the Surveyor Central Review Station user manual (PN 9515-169-75-ENG) for more detail.

### Surveyor Central Connections

**Peripheral Workstation Component Interconnect**

**NOTE:** Hardware and connections shown below are subject to change.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Network printer connection</td>
</tr>
<tr>
<td>2</td>
<td>Ethernet network connection</td>
</tr>
<tr>
<td>3</td>
<td>not used</td>
</tr>
<tr>
<td>4</td>
<td>Speaker connection (not used)</td>
</tr>
<tr>
<td>5</td>
<td>Keyboard connector</td>
</tr>
<tr>
<td>6</td>
<td>Display connection (dual support)</td>
</tr>
<tr>
<td>7</td>
<td>Dual display cable connected</td>
</tr>
<tr>
<td>8</td>
<td>not used</td>
</tr>
<tr>
<td>9</td>
<td>USB ports</td>
</tr>
<tr>
<td>10</td>
<td>AC power</td>
</tr>
<tr>
<td>11</td>
<td>Mouse connector</td>
</tr>
<tr>
<td>12</td>
<td>Enlarged view</td>
</tr>
<tr>
<td>13</td>
<td>Parallel printer port (not used)</td>
</tr>
</tbody>
</table>
WARNING: Always make sure system is turned off before connecting or disconnecting any cable.

Installation and Connections

Installation must be carried out by a Welch Allyn, Inc. authorized service representative in possession of current service and installation manuals. Surveyor Central requires specific settings based on the number and configuration of transmitters and monitors, the network layout, the type of printer, etc., as well as user preferences. The network laser printer requires specific settings and an installation driver. A package of cables, adapters, wire wraps, and labels are included with the system. Ensure these are available to installation personnel who will connect all accessories safely and in compliance with EMC and local safety requirements.

Routine Maintenance and Cleaning Instructions

1. **With the system turned off**, clean all system components (computer, display, keyboard, mouse, printer, etc…), in accordance with their manufacturer’s instructions.

2. Inspection and preventive maintenance by authorized personnel is recommended every six months.

3. Internal cleaning is recommended by means of a vacuum cleaner or similar device. Cleaning frequency depends on the environment.

**WARNING:** 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 device. Improper cleaning products and processes can remove important symbols or markings and should not be used.

Disposal of Waste Materials

Surveyor Central does not contain waste products that require special care for their disposal.

Components that have been in intensive or invasive contact with patients (e.g., electrodes) that might have been infected by a transmittable disease should be treated as biological waste products.

The disposal of accessories such as electrodes should be carried out according to manufacturer’s recommendations.

The device, after its useful life, is considered to be “Waste Electric and Electronic Equipment (WEEE)” which may contain toxic substances. The accumulation of this waste in the environment poses serious risk for the environment and human health. Therefore, WEEE needs to be collected separately and disposed of or recycled in an environmentally-friendly way. Your local administration provides the means to do so, and sanctions are foreseen for unauthorized disposal. Please consult your local regulations on how to dispose of the equipment after its useful life. The producer of this equipment participates actively with the collection and recycling of this equipment. You may return this equipment to your distributor for recycling or disposal.

Surveyor Central contains a lithium battery and electronic circuit boards which should not be incinerated or exposed to extreme heat.

For your guidance, a list of waste materials is shown below that are related to or contained in the device, according to the EC commission regulation 2557/2001, Annex Part 2, European Waste Code 9 April 2002 directive. Please consult eventual national implementations and later modifications.
Waste codes marked with an asterisk are considered to be hazardous waste.

<table>
<thead>
<tr>
<th>Class UE</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 02 14</td>
<td>Discarded electronic equipment not containing hazardous components</td>
</tr>
<tr>
<td>20 01 36</td>
<td></td>
</tr>
<tr>
<td>16 06 05</td>
<td>Other batteries and accumulators</td>
</tr>
<tr>
<td>20 01 34</td>
<td></td>
</tr>
<tr>
<td>15 01 01</td>
<td>Paper and cardboard packaging</td>
</tr>
<tr>
<td>20 01 01</td>
<td></td>
</tr>
<tr>
<td>15 01 02</td>
<td>Plastic packaging</td>
</tr>
<tr>
<td>20 01 39</td>
<td></td>
</tr>
</tbody>
</table>

Contact your local waste disposal agency for guidance on the proper recycling or disposal of these components. Respect your local institution regulations in the disposal of any possibly infected accessories like electrodes (waste code 18 01 03*).

**Privacy Information**

The equipment described in this manual is compliant with European directives 95/46/EC and 2002/58/EC on the protection of personal data.

Welch Allyn, Inc. or its representatives cannot be considered the “data controller” in the sense of these directives, neither as responsible for processing this data. These functionalities will need to be assigned within the structure of the user organization. It is therefore the duty of the customer to provide the correct storage and handling of data, putting into service all measures foreseen in the mentioned directives or its national implementation.

In particular, it is the duty of said customer to regulate access to the parts of the equipment described in this manual that might disclose information concerning a specific identified patient, taking those measures that he considers most suitable to obtain what is mentioned in the directives, providing, for example, rooms with limited access and/or a system of identification for access to the information.

The following information is meant to help the user decide which measures to take, taking into account both patient safety and the protection of personal information.

Surveyor Central allows the possibility to enter patient name as part of the demographic data. This name can be displayed on the screen of the system, depending on the configuration settings. The name is always displayed on all printouts.

Surveyor Central contains a temporary storage area of patient data (including patient name, if entered) meant for review in the context of immediate care, to which access is possible only through Surveyor Central components through the Surveyor data network. It is also possible to copy the data from a monitoring session (including patient name, if entered) to an off-line storage location or device. This data can only be read through specific Welch Allyn software for the purpose of reviewing this data, e.g., on a Holter analysis system or a Surveyor Central review station. It is the responsibility of the user organization to regulate access to these systems and software in compliance with local regulations.
7. USING THE SYSTEM

Turning on the Surveyor Central Workstation

The ON/OFF switch is located on the front side of the CPU. When switch is depressed, the workstation will power on. To turn on LCD screen, locate the main switch (usually on the bottom border of the screen).

**NOTE:** The power-up sequence takes about 2 minutes and then the main display appears.

**NOTE:** Always keep the monitor ON/OFF switch in the ON position. If the monitor’s indicator light is not illuminated, press the monitor ON/OFF switch. If the monitor indicator light is illuminated orange, red, or blinking and the monitor is still blank, check the cable connections between the monitor and the base. If an issue persists, contact Welch Allyn, Inc. technical support personnel.

Display Screen

The Surveyor Central screen is divided into sub-screens, each showing a single patient. The number of traces that are shown depends on how the system is configured. This screen is called the “multi-patient display”. An example is shown in Figure 7. In the multi-patient display, the entire screen displays real-time status of all connected patients including waveforms sent from monitors and/or telemetry transmitters.

**NOTE:** Normally, the waveform traces are drawn smoothly and continuously. Occasionally, you may observe a brief halt followed by the waveform catching up. This is usually due to momentary communication delays through the network between the Surveyor Central and the monitors/transmitters. The system is designed to work through such delays without data loss. However, if this occurs frequently, contact your network administrator or Welch Allyn to check the condition of the network.

![Figure 7 - The Surveyor Central multi-patient display screen.](image)
**Moving the Cursor**

The on-screen arrow is the mouse cursor used to activate all functions. For example, if you want to acknowledge and silence an alarm, move the cursor with the mouse over the Event/Alarm button (only visible if there is an alarm present) and left click the mouse button. It is not possible to acknowledge and silence alarms from a Surveyor Central repeater station, with the exception of protocol alarms.

**Multi-patient Display Buttons**

Buttons in the lower right area of the multi-patient display are active and can be selected by a left mouse click.

- **Show 10 mm/s** is used to toggle all monitored ECG waveforms between 25 mm/s and 10 mm/s speed for all patients.

- **Patients** will open a window that allows pre-admission entry of patient demographics. This window also shows the status of the current monitored patients. **Patients** is not active for the Surveyor Central repeater station.

- When using a Surveyor S12/S19 patient monitor, patient demographic information is communicated bidirectionally between the patient monitor and the Surveyor Central station — demographic information entered at the Surveyor Central station is sent to the patient monitor; demographic information entered at the patient monitor is sent to the Surveyor Central station.

  Patient data in the patients list can be added or edited allowing pre-admission by selecting **New** or **Modify** at the bottom of the display.

  The appropriate **ID Format** is also selected from the drop-down list in this window. When finished, select **OK** to save or **Cancel** to undo your changes.

- **Review** will open a multi-patient view of all of the current session events for all monitored patients. This allows you to filter, review, and edit all Events/Alarms. More detail will be explained later in this manual. Review is not available at the repeater station.

- **Config** will open a window that requires a password and will then present system configuration menus.

The number of available monitoring days in the database memory and current date and time are displayed in the area to the far right.

Feedback messages, when present, will appear in the lower left corner on the same status line. An informational message, such as a successful archive, will appear on a blue background. Error messages such as a print or archive failure will appear on a red background.
Multi-patient display sub-screen fields

Figure 8 - Detail view of a sub-screen within the multi-patient display.

A right click on the print icon shows a sub menu:
- Rhythm
- ST-Report
- Trends

A left click on the print icon will generate a printout according to the user-defined default print setting

A red-crossed circle on the print icon indicates that alarm printouts have been disabled in the Alarm settings tab.

SpO$_2$ display

When SpO$_2$ data is available, the sub-screen may also be configured to display the plethysmogram and/or a SpO$_2$ information block, as shown in the following example:

Figure 9 - Detail view of a sub-screen showing telemetry from a Surveyor S4 with SpO$_2$.

The plethysmogram is derived from the SpO$_2$ sensor placed on the patient, via the transmitting device. Its pulsatile characteristic reflects the flow of blood at the measurement site, but it is not a representation of arterial pressure. The plethysmogram is normalized so that its amplitude is continuously and automatically adjusted to fill the available display space. Consequently, the plethysmogram cannot be used to assess the strength of the signal; however, it is useful to visualize the impact of noise on the SpO$_2$ signal.

Within the SpO$_2$ parameter block, the following items are displayed:
- functional oxygen saturation in units of % SpO$_2$,
- pulse rate in units of beats/minute, and
- a Signal Quality Indicator (SQI) appearing as a colored square.
SpO₂ Signal Quality Indicator (SQI)

When used with a Surveyor S4, the SQI gives information about the condition of the signal being received by the sensor, as described in the table below. The S12/S19 and T12S do not support the SQI feature, and the SQI displays only a gray square.

<table>
<thead>
<tr>
<th>SQI color</th>
<th>Description</th>
<th>S12/S19</th>
<th>T12S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Good signal</td>
<td>Not applicable.</td>
<td>Not applicable.</td>
</tr>
<tr>
<td>Yellow</td>
<td>Signal is weak and/or degraded by noise such as motion artifact. Percent SpO₂ and PR value displayed may potentially be inaccurate.</td>
<td>Feature not available.</td>
<td>Feature not available.</td>
</tr>
<tr>
<td>Red</td>
<td>The signal is missing or inadequate for SpO₂ to be calculated.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gray</td>
<td>The SpO₂ is initializing.</td>
<td>No SQI information available.</td>
<td>No SQI information available.</td>
</tr>
</tbody>
</table>

Refer to the Surveyor S4 User Manual, p/n 9515-190-51, for information on how to address signal quality issues. Additionally, technical alarm messages from the S4 may be displayed indicating certain conditions.
**Single-patient Display**

A left click anywhere on a patient's sub-screen changes the background color, reduces the multi-patient display to half width, and opens the selected patient-related information on the right half of the screen in the Traces view. Patient-related functions will be explained later in this manual. Click on **Close** to return to the multi-patient display screen.

**Selected telemetry patient sub-screen, Telemetry Traces view**

![Figure 10](image)

*Figure 10* - The multi-patient display has been reduced to fit on the left screen, while a detail patient view from telemetry is shown on the right.
S12/S19 patient traces view

Figure 11 - The multi-patient display has been reduced to fit on the left screen, while a detail patient view from a Surveyor S12/S19 is shown on the right.

Single-patient display tabs

When a patient is selected and opened, there are six tabs that can be used for review. All tabs contain information for the selected patient. If another patient is selected, the information in the tabs will change to that of the selected patient. Patient ID (or name) and ambulatory transmitter channel number (if available) are displayed above the tabs.

**NOTE:** The Patient Data tab is not available at the Surveyor Central repeater station.

<table>
<thead>
<tr>
<th>Patient ID: 849572, Channel: 38</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Data</td>
</tr>
</tbody>
</table>

Figure 12 - Tab controls available in the single-patient display.
Event/Alarm and Full-disclosure Review

A right click anywhere on a patient’s sub-screen or a left click on Review changes the background color, reduces the multi-patient display to half width, and opens the selected patient’s captured events/alarms and stored data on the right half of the screen. Review functions will be explained later in this manual. Click Close to return to the multi-patient display screen.

Figure 13 - Event/alarm and full-disclosure review screen.
Beginning a 12-lead ECG monitoring session

Correct electrode placement and skin preparation are important for acquiring a successful ECG and performing a reliable monitoring session. Low-amplitude signals may be the result of poor skin-to-electrode contact. To ensure electrode adherence, hair must be removed with a razor and the skin must be clean and dry. Gently abrade the skin where the gel will be in contact to ensure good ECG signal conduction. Avoid muscular and loose, flabby areas to minimize movement and muscular artifact. Good quality, long-term monitoring electrodes are recommended.

**WARNING:** Placement of the Left Leg (LL)* electrode in the original Mason-Likar position increases the similarity of the acquired ECG with a standard 12-lead ECG and is therefore recommended; however, clothing may interfere with this position and increase the amount of artifact. The modified position may decrease the sensitivity of inferior ECG leads and because axis shift with respect to the standard 12-lead ECG. Accurate skin preparation and suitable clothing are the most important factors in excessive artifact prevention.

**NOTE:** The Right Leg (RL) electrode may be positioned in any location least subject to motion artifact according to clinician preference and specific test requirements.

<table>
<thead>
<tr>
<th>AAMI</th>
<th>IEC</th>
</tr>
</thead>
<tbody>
<tr>
<td>RA</td>
<td>R</td>
</tr>
<tr>
<td>LA</td>
<td>L</td>
</tr>
<tr>
<td>RL</td>
<td>N</td>
</tr>
<tr>
<td>LL</td>
<td>F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Precordial electrodes</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1        C1</td>
</tr>
<tr>
<td>V2        C2</td>
</tr>
<tr>
<td>V3        C3</td>
</tr>
<tr>
<td>V4        C4</td>
</tr>
<tr>
<td>V5        C5</td>
</tr>
<tr>
<td>V6        C6</td>
</tr>
</tbody>
</table>

Figure 14 - Electrode placement.
To begin a 12-lead monitoring session:

1. Prep patient skin and attach monitoring electrodes and ECG cable to patient.

2. Ensure the Surveyor Central station is powered ON and displays patient monitoring slots.

   - When a Surveyor S12/S19 patient monitor is used:
     o Power ON the patient monitor or resume monitoring from a Standby mode.
     o Ensure the Network icon on the S12/S19 main display shows communication to the Surveyor Central station.
     o Refer to the Surveyor S12/S19 patient monitor user manual (PN 9515-183-51-ENG).

   - When a Surveyor S4 is used:
     o Apply the sensors to the patient and connect sensor cables to the S4. Refer to the S4 user manual (PN 9515-190-51-ENG) for specific instructions.
     o Secure the S4 to the patient’s body with the carrying pouch.
     o Turn the S4 ON by inserting batteries.
     o Ensure that the S4 establishes a connection to the Surveyor Central.
     o Check signal quality indicators on the S4, and re-prep electrode sites or reposition sensors as needed.
     o On the multi-patient display of Surveyor Central, locate the slot that matches the S4 and view the waveforms.

     **NOTE:** If you do not have a window set for the ambulatory transmitter, refer to the “System Configuration” section to setup receiver channels. Configurations for Surveyor S12/S19 and Surveyor S4 will be in place based on factory settings.

3. Click on window and the single-patient display will open with Patient Data tab active. Choose desired patient profile using the drop-down list box.

   **NOTE:** Creating and saving patient profiles will be explained in the Settings section of this user manual.

4. Click Start to start a new monitoring session. From this moment on, monitoring has started, data is stored, and the alarm system is activated.

The system will ask you to select the best ECG detection leads. If you click No the system will use default lead settings (V1, V5 and II). When Yes is selected, real-time, 12-lead ECG traces will be displayed allowing you to change detection leads if necessary. Select Learn to make any changes. Refer to the “Traces” section for more detail about the Learn button. After reviewing or changing the 12-lead display settings, click on the Patient Data tab to return to the window that allows you to enter patient demographics.

   **NOTE:** Refer to Appendix A to learn more about the importance of selecting the best detection leads.
5. Click **New** and type the patient information in the text entry fields.

![Image of patient data screen](image)

**Figure 15** - The patient data screen.

**NOTE**: *Age is calculated automatically when date of birth is entered (click on any other field to activate the calculation). Age can also be entered manually.*

6. When finished with all patient data operations, click **Confirm** in the lower portion of the display. A warning will ask if you are sure. Click **Yes**.

**NOTE**: *Confirmation of the patient data connects the stored data with patient demographics, and makes the data available for review.*

**ID Format**

When ID Format option is present on your system, you can select from a drop-down list of user-created IDs. ID Formats in the list were imported by use of the configuration menu using the Management selection. ID formats are created in conjunction with Welch Allyn’s E-Scribe system with the custom ID feature.

Patient data fields can be populated through the use of a bar code scanner. After scanning the bar code to populate the field, select **Confirm**. If the patient demographics were previously entered, all available data fields will be automatically filled. Note that the patient ID must be unique in order for this mechanism to work correctly. If there are more patients with the same patient ID registered, the data of the first found will be copied to these data fields. Patient data can be retrieved from the previously populated patients list by clicking **Import** and choosing from the list.
**WARNING:** For patients with pacemakers, the Pacemaker Present checkbox field should be enabled and the minimum rate of the pacemaker selected from the list.

![Figure 16 - Multi-patient display sub-screen for a pacemaker patient. PM indicates that pacemaker detection is enabled.](image)

The **Notes** field can be used to store information about the patient that will be available in the patient data display for other clinicians. Text in this field does not appear on printouts.

**WARNING:** Adjust the alarm thresholds to patient conditions after monitoring has started. Incorrect alarm threshold settings are a frequent cause of false alarms and lower the attention level to the genuinely important alarms.

**NOTE:** Alarm settings cannot be changed in a Surveyor Central repeater station and are presented for informational purposes only.

**NOTE:** The Surveyor S12/S19 patient monitors control the alarm activation, sound state and priority of each generated alarm, regardless of the limits and/or other settings configured on Surveyor Central (even if conflicting with Surveyor Central settings). The Surveyor Central station obtains these settings from the patient monitor.

**Reduced Lead-set Monitoring: Ambulatory Transmitter**

When using an ambulatory transmitter, patients can be monitored using a reduced lead set either by not connecting all the electrode wires or using a reduced lead-set cable. When a reduced lead set is used, select the **5 electrodes** cable radio button in the patient data display.

**NOTE:** When the selection in the window above is changed, ECG waveforms are flat-lined for 1 second, heart rate is reset, and any pending ECG alarms are cleared.

**NOTE:** If you change from 10 to 5 electrodes, it is recommended to select the best leads for QRS-detection (see Learn menu in the Traces tab).

**5-wire Monitoring**

Using R (RA), L (LA), F (LL), N (RL) and C1 (V1) electrodes will enable you to monitor leads I, II, III, aVR, aVL, aVF and V1. Select the **5 electrodes** radio button. The C1 (V1) electrode can be placed on any desired position on the thorax and will display and print as V1.

**NOTE:** When using an ambulatory transmitter, reduced lead monitoring or the selection of the 5 electrodes radio button will cause unused leads on the ECG printouts to be substituted by square waves.

**NOTE:** When using an ambulatory transmitter, reduced lead monitoring or the selection of the 5 electrodes radio button cannot be used when 12-lead ECG interpretation is required.
3-wire Monitoring

Using R (RA), L (LA), and F (LL), electrodes will enable you to monitor leads I, II, or III using the S4 mobile monitor or S12/S19 patient monitor when using it with a 3-wire cable.

**NOTE:** When using the S12/S19 patient monitor, the lead displayed on the Central Station is always indicated as Lead II regardless of the setting on the S12/S19 patient monitor.

Depending on the lead selected, the ECG waveform available will be displayed on the various panels as shown below with Lead II as an example here.

**Figure 17** - An example of 3-wire monitoring.
**Protocol Manager**

When Protocol Manager is included with your system, you are able to select from a list of user-created protocols. Protocols in the list were imported by use of the configuration menu using the Management selection. The protocols have been created from a separate application and are programmed to initiate automatic events and printouts once the protocol has been started. Select the protocol you wish to use for the current patient from the drop-down list located in the Patient Data tab. Protocols are saved with each individual profile and will be automatically selected by the profile. You can change to a different protocol at any time while monitoring a patient. Note that protocols are not available for use with the S12/S19 patient monitors.

**Using a Protocol**

A protocol will initiate automatic events, reminders, and printouts once it is started. A new protocol can be selected when there is no other protocol in progress. There are two ways to start the protocol:

1. After the monitoring session has started, select the **Patient Data** tab and then select **Start Protocol** to begin.

2. Change the date and time values to the right of the **Start Protocol** button as desired and then select **Schedule start**. The protocol will automatically start at the scheduled time.

Once the protocol has been started, Protocol buttons will appear as shown:

![Figure 18 - Protocol manager command buttons.](image)

**Stop Protocol** can be selected to stop the protocol at any time. Once this is done, a “Protocol Aborted” message will appear on the patient display.

The date and time values can be set to correct the protocol phase start. The protocol phase that is currently in progress will be reset to a 00:00 start time and will begin at the set time. Select **Correct phase start** after you have adjusted the date and time values.

Additionally, “Protocol Times” can be selected for display (chosen in the “Settings” tab under “Parameters”). The time on the left shows that the protocol phase has progressed for 42 seconds and the next protocol step (Prepare for baseline) will occur in 18 seconds as shown to the right. Protocol messages will appear in the alarm/event area of the display according to protocol definitions. Protocols can be defined with phases (or groups of steps) for automatic functions. The ambulatory transmitter calls button--when configured within the protocol--or acknowledgement of the last protocol step of the previous phase causes the next phase to begin. An example would be of sequential patient treatments requiring a new series or type of automatic events.

The last step of any phase of a protocol is infinite in duration and will continue until you select **Stop Protocol** or move to the next phase by acknowledging the protocol alarm or pressing the ambulatory transmitter button.
Ending a Monitoring Session: Telemetry

1. On the multi-patient display, click on desired patient window.
2. Select Patient Data tab.
3. Click on the Stop button.
4. A warning will ask if you are sure. Click Yes.
   
   NOTE: If the monitoring slot has not been assigned to any patient, recorded data will be deleted!!
5. This patient data will appear in the Patients list with a “Stopped” monitoring status.

Restarting a Monitoring Session: Telemetry

1. On the multi-patient display, click desired patient window and the patient data window will open with patient data grayed out. Select Same Patient to resume monitoring the same patient in the same monitoring window.
2. Selection of New Patient will remove the previous patient monitoring session from the patient slot allowing you to start monitoring a new patient. The previous patient’s monitoring session will be available for review and will be shown in the patients listing with a “Stopped” status.
3. Previous stopped patient monitoring sessions can be imported into any available monitoring window when starting a new monitoring session. This allows you to move the patient to a different ambulatory transmitter and display window as desired. This also allows you to combine multiple monitoring sessions for the same patient.
   
   NOTE: You can also start and stop monitoring sessions directly from the Surveyor S4 user interface.

Discharge: Surveyor S12/S19 Patient Monitor

The Discharge function at the Surveyor S12/S19 patient monitor is communicated to the Surveyor Central station. When the patient is discharged at the patient monitor, the monitoring slot at the Surveyor Central station closes and all patient information, trends, alarms, and other setting information are being cleared for that device.

Standby: Surveyor S12/S19 Patient Monitor

The Surveyor S12/S19 patient monitor has a Standby mode used to temporarily suspend patient monitoring (patient returning to same monitor) or permanently discharge the patient (patient not returning to monitor). This function is performed while standing at the patient’s bedside monitor. When the S12/S19 is placed in the Standby mode, the Surveyor Central station will discontinue monitoring. The Surveyor Central station displays a Standby message in that patient’s monitoring slot to note that monitoring is not active for that patient device. Once the patient monitor resumes monitoring, the Surveyor Central station will resume monitoring.

Resume Monitoring: Surveyor S12/S19 Patient Monitor

Once the Surveyor S12/S19 resumes monitoring after a Discharge or Standby mode, the Surveyor Central station will also resume monitoring.
8. SETTINGS

The Settings tab allows you to define:

- ECG and other waveform traces, gain settings, and parameters for single and multi-patient displays
- 12 lead ECG, rhythm, trend, and report printouts
- ID or name highlight color
- Signal settings
- Number of ECG leads, ECG filtering, and amplitude for optimal beat detection
- Protocol to be used for current patient
- Profiles to be saved for future use

Once all the settings under this tab, Alarm Settings, and Trends are defined, save your preferences as a Profile with a unique name that can be selected when starting future patient monitoring sessions.

**NOTE:** HR (heart rate) is always selected and cannot be deselected under Parameters.

**NOTE:** Some features (e.g., Protocols and Plethysmogram) are optional and may not be available as selections in this window.

**NOTE:** Print settings, Signals and Protocol settings cannot be changed in a repeater station and are presented for informational purposes only. Profiles cannot be saved from a repeater station.
**Display settings**

**Multi-patient**

View multi-patient display selections on the previous page. Selections will appear grayed when the maximum number of choices is reached, and is dependent on display window height.

Trace and parameter selections for single-patient display are shown below.

![Figure 20 - Trace and parameter selection screen.](image)

**Traces**

ECG and plethysmogram waveform tracings can be selected for both multi-patient and traces (single patient) display. Selection of at least one trace is required.

**Parameters**

Parameter labels and values can be selected for both multi-patient and traces (single patient) display. Parameters are displayed in the order that they appear in the Parameters column.
ID

In multi-patient display, select the color highlighting for the ID or patient name from the drop-down list to the right of ID: The configuration menu determines which value (ID or name) will be shown in the multi-patient display.

ECG Filter

In multi-patient display, choose a 0.05 – 40 Hz ECG filter or a 0.05 – 150 Hz ECG filter from a drop-down list after clicking on the value to the right of this selection. Filter setting has no effect on stored and exported data analyses.

**WARNING:** When the 40 Hz filter is used, the frequency response requirement for diagnostic ECG equipment cannot be met. The 40 Hz filter significantly reduces high-frequency components of the ECG and pacemaker spike amplitudes, and is recommended only if high-frequency noise cannot be reduced by proper procedures.

ECG Gain (mm/mV)

In multi-patient display, select 5 mV, 10 mV, 20 mV, or 40 mV of gain for all ECG traces from a drop-down list after clicking on the value to the right of this selection. This setting affects displayed traces as well as rhythm printouts.

Plethysmogram Gain

In multi-patient display, select 0.5 to decrease sensitivity by one half, 1 for normal sensitivity, or 2 to maximize the sensitivity for plethysmogram traces from a drop-down list after clicking on the value to the right of this selection. This setting affects displayed pleth traces as well as rhythm printouts.

Invasive Pressure Waveform Gain

The Surveyor Central Station can display up to four invasive pressure waveforms and numerics dependent upon the S12/S19 configuration. To adjust the invasive pressure waveform, gain, in the multi-patient display select 0.1, 0.25, 0.5, 1, or 2 mm/mmHg for the selected invasive pressure.

Capnography Waveform Gain

To adjust the Capnography waveform gain in the multi-patient display, select 0.1, 0.25, 0.5, 1, or 2 mm/mmHg

**Print settings**

Allows you to define and customize each type of printout as explained below. Click on type of printout you want to define under the PRINT selection. Printout examples are shown in Appendix C.

*NOTE:* Print settings cannot be modified on a Surveyor Repeater station.

Rhythm

Checked boxes under **Traces** define waveform to be included on a 10-second printout. Desired parameter labels and values can be checked under **Parameters**. Change rhythm printout speed by clicking on the value to the right of **Speed (mm/s)**. A drop-down list allows you to choose 5, 10, 25, or 50 mm/s paper speed. Click on checkbox area to the right of **Print Grid** selection to enable or disable grid. Note that the grid is not printed at 5 mm/s or when grid is disabled for the printer in the configuration menu.

The Surveyor S12/S19 patient monitors can be configured to print its rhythm strip to the central station’s printer. Refer to the Surveyor S12/S19 patient monitor user manual (PN 9515-183-51-ENG) for additional details.
Rhythm traces are printed with the timestamp centered in the middle of the page, as shown by a vertical dotted line.

**12-leads**

12-lead printout format is selected from the drop-down list to the right of **Format**. Choose from **6x2** (6 leads in 2 columns), **4x3+1** (3 leads in 4 columns with 1 rhythm channel [II]), **4x3+3** (3 leads in 4 columns with 3 channels of rhythm [II, V1 and V5]), or **4x3+1+P** (3 leads in 4 columns with 1 rhythm channel [II] and plethysmogram waveform). Rhythm channels cannot be changed. Click on **Print Grid** checkbox to enable or disable grid. 1 to 4 copies can be selected when each 12-lead printout is chosen. Click on **Print Interpretation** and **Print Reasons** checkboxes to enable or disable interpretive statements on the 12-lead printouts.

12-lead ECG’s are printed with the timestamp corresponding to the beginning of the acquisition of the ECG.

The Surveyor S12/S19 patient monitors will print its 12-lead report to the central station’s printer. Refer to the Surveyor S12/S19 patient monitor user manual (PN 9515-183-51-ENG) for additional details.

**ST Report**

Use the drop-down list to select trends to be printed on the report printout. The second trend in the rate-trend panel can be selected (the first trend is always HR), and both trends in the right panel can be selected from other parameters. Trend length (number of hours) can be defined in the **Trends** tab.

The Surveyor S12/S19 patient monitors can be configured to print a Trend report that includes the ST numerics to the central station’s printer. Refer to the Surveyor S12/S19 patient monitor user manual (PN 9515-183-51-ENG) for additional details.

**Trend**

Allows you to choose a single or two-page printout. The **ST Page** contains labels and trend values related to ST measurements in all leads; **Second Page** includes labels and trended values for all checked information in the lower portion of the display. Up to 14 trends can be selected.

The Surveyor S12/S19 patient monitors can be configured to print a Trend report to the central station’s printer. Refer to the Surveyor S12/S19 patient monitor user manual (PN 9515-183-51-ENG) for additional details.

**Summary report**

The Summary report provides a configurable report to tailor information to each specific patient’s needs. The report includes the following information:

- Patient demographics
- Patient overview information, which includes average and summary information of parameters.
- List of alarms.
- Graphical parameter trends (optional).
- Tabular parameter trends (optional).
- Alarm snapshots (optional) – shows one tracing of an alarm condition; also shows a timeline of alarm occurrences.
To configure the content of the summary report:

1. Select the patient by clicking on their slot in the **Multi-Patient display**.
2. Select the **Settings** tab.
3. Select the **Summary Report** page.
4. Select the **Report Duration** from the drop down list.
   The system supports reports covering 4, 8, 12, and 24 hours.
5. Select the reporting interval for tabular trends from the **Tabular Trends Interval** dropdown.
   The System supports intervals of 1, 5, 15, 30, and 60 minutes.
6. Select whether or not to include graphical trends in the report using the **Graphic Trends** checkbox.
7. Select whether or not to include tabular trends in the report using the **Tabular Trends** checkbox.
8. Select whether or not to include alarm snapshots in the report using the **Alarm Snapshots** checkbox.
9. Select the parameters to include in trends from the selections in the **Trends** box.
10. Based on your selections, the system estimates the length of the printed report in the **Report Pages Num.** indicator.
11. Select the **Confirm** button.

To print a summary report…

1. Right-click on the **Print Icon** in the **Multi-Patient display**.
2. Select **Summary Report** from the drop down menu.
Periodic print

The Periodic Print function is used to produce printed reports at predetermined time intervals.

![Figure 22 - Settings for the Periodic Print function.](image)

To enable periodic printing:

1. Select the patient by clicking on their slot in the Multi-Patient display.
2. Select the Settings tab.
3. Select the Periodic Print page.
4. Activate the periodic report function by checking the Enable control.
5. Select the reporting interval in the Period control. The system supports reporting intervals from 1 to 1,440 minutes (24 hours).
6. Select the type of report using the Format control.
7. Select Confirm.

To discontinue periodic printing:

1. Select the patient by clicking on their slot in the Multi-Patient display.
2. Select the Settings tab.
3. Select the Periodic Print page.
5. Select Confirm.
**Signal settings**

**Analyze Pacers**

The Surveyor S12/S19 patient monitors will send the pacemaker spikes to the central station if the Analyze Pacer setting is enabled at the patient monitor. Refer to the Surveyor S12/S19 patient monitor user manual (PN 9515-183-51-ENG) for additional details.

When the Analyze Pacer function is enabled on a Surveyor S12/S19 patient monitor and the patient possesses an active pacemaker, the Surveyor Central will display 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.

**WARNING**: Maintain proper clinical assessment and close surveillance for patients with pacemakers during continuous ECG monitoring. Do not rely entirely on rate meters for these patients.

**NOTE**: For the S12/S19 patient monitors, the only available setting is the **Pacemaker present** selection.

**NOTE**: Signal settings cannot be modified on a Surveyor Repeater station.

**ECG**

This screen provides adjustable settings related to the ECG.

![ECG settings screen used with the Surveyor S4 mobile monitor.](image)

**Figure 23** - ECG settings screen used with the Surveyor S4 mobile monitor.
When the monitored patient has a pacemaker, select **Pacemaker present** checkbox and select **Minimum pace rate** value from 40 to 100 beats per minute from the drop-down list. Note this selection is also present in the Patient Data tab.

**WARNING:** For patients with pacemakers, the Pacemaker Present checkbox field should be enabled and the minimum rate of the pacemaker selected from the list.

**NOTE:** When this selection is changed, ECG waveforms are flat-lined for one second, the HR is reset, and any pending ECG alarms are cleared.

**NOTE:** When changing from 10 to 5 electrodes, select the best leads for QRS-detection (see Learn menu in the Traces tab).

**NOTE:** 12-lead ECG interpretation may be affected by unattached lead wires, as with 5-electrode monitoring. Printing of 12-lead ECGs is not recommended.

**NOTE:** When using the S4 with LeadForm cable, a reduced lead set (5-wire) may also be selected on the device. Refer to the S4 User Manual. The S4 with shielded cable automatically detects the lead set used.

Detection Lead 1 and Detection Lead 2 are used for QRS beat detection. Choose leads that are of good quality and amplitude. **Confirmation Lead** is used to confirm the detected beat type. Choose a lead that is orthogonal or different than the detection leads.

Click on the value to the right of **Min. QRS Amp. (µV)** and adjust the Minimum QRS Amplitude in microvolts as 160, 300 or 500 µV using the drop-down list. Note that this selection is also present in the LEARN button of the Traces tab.

**WARNING:** A low minimum QRS amplitude setting may cause the system to detect P-waves as QRS complexes and thus fail to detect an atrioventricular block. A high value increases the probability of Asystole alarms when all leads have a low QRS amplitude. 300 µV is the factory default value.

Left click on **Confirm** to save all settings once your changes have been made.

**Protocol**

Change a protocol in this settings selection. Choose desired protocol from the drop-down list. Note that this selection is also present in the Patient Data Tab. Left click on **Confirm** to save your change once the Protocol has been selected.

**NOTE:** Protocol settings cannot be saved from a Surveyor Repeater station.

**SAVE as PROFILE**

**NOTE:** This feature applies to telemetry monitoring only and not the S12/S19 patient monitors.

Click on this selection to save all of your settings as a Profile that can be selected when you begin a new monitoring session. Saving your profile requires you to enter your system configuration password. After doing this, enter a name that will allow users to identify your defined settings. Note that the profile also contains all Alarm Settings and Trends settings. Make sure you check them before you save a profile, then left click on **Save**.

Prior to monitoring a new patient, you can choose your saved Profile from the drop-down list in the Patient Data tab.
9. ALARM SETTINGs

Alarms are generated for signals coming from the ambulatory transmitter and the Surveyor S12/S19 patient monitors. Alarm settings and other functions are managed through the Alarm Settings tab on the single-patient display. For a detailed description of alarm event criteria, refer to Appendix B.

NOTE: Alarm settings cannot be changed in a Surveyor Central repeater station and are presented for informational purposes only.

Patient Monitor-Specific Alarm Interactions

With the exclusion of Surveyor Central station-generated events (e.g. Link Lost alarm), the Surveyor S12/S19 patient monitors control the alarm activation, sound state and priority of each generated alarm, regardless of the limits and/or other settings configured on Surveyor Central (even if conflicting with Surveyor Central settings). The Surveyor Central station obtains these settings from the patient monitor. If the parameter alarm is disabled at the patient monitor, the alarm is also disabled at the Surveyor Central station. Refer to the Surveyor S12/S19 patient monitor user manual (PN 9515-183-51-ENG) for additional details. After startup, any subsequent changes to the alarm settings on the Surveyor Central or the Surveyor S12/S19 patient monitors assigned to a particular bed will be bidirectionally communicated.
Alarms and Events

Alarm Hierarchy

Alarms on the Surveyor Central are divided into four priority levels: high (red), medium (yellow), low (cyan), and informational events (white) according to alarm importance. High, medium, and low alarm events are both audible and visual with different messages for each. Informational alarms are visual messages only.

<table>
<thead>
<tr>
<th>COLOR</th>
<th>PRIORITY</th>
<th>VISUAL EXAMPLE</th>
<th>AUDIBLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>High</td>
<td>18:05:50 VTACH 5,120</td>
<td>3 acute beeps – short pause – 2 acute beeps – 5 second pause</td>
</tr>
<tr>
<td>Yellow</td>
<td>Medium</td>
<td>18:00:08 ST Increase 2.0 V4</td>
<td>3 medium-tone beeps – 14 second pause</td>
</tr>
<tr>
<td>Cyan</td>
<td>Low</td>
<td>17:59:15 Irregular Rhythm</td>
<td>2 low-tone beeps – 19 second pause</td>
</tr>
<tr>
<td>White</td>
<td>Informational</td>
<td>17:57:09 ST Relearn</td>
<td>None</td>
</tr>
</tbody>
</table>

*NOTE:* Alarm priority is defined according to IEC 60601-1-8. The priority of some alarms can be changed by the operator on the basis of clinical need.

Alarm Display

When an alarm is generated, a blinking message appears in the corresponding window showing the time alarm threshold was reached, the alarm message, and the alarm setting threshold. The time in front of the message is the time the alarm condition became true. When relevant, the alarm limit or ECG lead is also displayed. The message will continue to be displayed until the cause of the alarm disappears.

*NOTE:* The icon is displayed in front of the alarm message to identify the control to acknowledge and silence the alarm.

*NOTE:* Alarm event times can differ from alarm presentation times due to overlapping higher priority alarms, or built-in presentation delays to avoid false alarms on short, clinically non-relevant events (e.g., a 60-second delay is used with an ST-change).

*NOTE:* There are no audible alarms on a Surveyor Central repeater station.

How to Silence Alarms

Certain priority alarm events will also generate an audible signal along with the blinking message. Clicking on the message shows your acknowledgement and will silence the alarm though the message will stay on the screen to remind you that the cause of alarm is still present.

When a Surveyor S12/S19 patient monitor is used, the alarm silence is communicated bidirectionally between the patient monitor and the Surveyor Central station.
- Silencing an alarm at the Surveyor Central silences that alarm at the patient monitor.
- Silencing an alarm at the patient monitor silences that alarm at the Surveyor Central.

The alarm message and sound will remain for 20 seconds after the cause of an un-silenced clinical alarm disappears. This allows noticeable alarm presentation duration for conditions that last a short time. Technical and silenced alarm presentations disappear immediately after the cause goes away.
NOTE: Generic technical alarms (e.g., a printer paper-out condition) will appear on all patient windows involved. It is not necessary to silence all of these alarms separately. It is sufficient to left click on a single message to acknowledge the alarm on all patients.

NOTE: It is not possible to acknowledge and silence alarms from a Surveyor Central repeater station, with the exception of protocol alarms.

Permanent and Non-Permanent Alarms

Clinical alarms can be permanent (latched) or non-permanent (non-latched). Permanent means that the audible alarm will continue until the operator acknowledges the message and silences the alarm. Non-permanent means that the audible alarm will disappear automatically shortly after the clinical condition is resolved.

Permanent or non-permanent is a global configuration setting for all ambulatory telemetry patients and cannot be changed for individual patients. High-priority alarms are always permanent and low-priority alarms are always non-permanent. The user can also choose to have the high-priority alarms permanently enabled, even if all the alarms are disabled. This is defined in the configuration menu.

NOTE: Ventricular tachycardia (VTACH) alarms are NOT latched; the sustained Ventricular Tachycardia Alarm (>15 seconds) IS always latched.

When a Surveyor S12/S19 patient monitor is used, acknowledging a permanent (latched) alarm is communicated bidirectionally between the patient monitor and the Surveyor Central.

- Acknowledging a permanent (latched) alarm at the Surveyor Central acknowledges that permanent (latched) alarm at the patient monitor.
- Acknowledging a permanent (latched) alarm at the patient monitor acknowledges that permanent (latched) alarm at the Surveyor Central.

Overlapping Alarms

When several alarms occur within a short period of time and the system is busy displaying or printing a previous alarm printout, Surveyor Central will store the alarm events in memory and will automatically print them after the previous printout has finished. If more than one alarm is active, the auditory and visual indication of the highest priority alarm will be active. If more than one alarm with the same priority is active, the auditory and visual indication of the most recent alarm will be active.

For visual presentation, unacknowledged alarms have precedence over acknowledged alarms, depending on the priority. Note that up to three alarms are visualized simultaneously for a patient in the Traces tab.

Alarm and Event Messages

Due to available screen space, some alarm and event messages are abbreviated. Longer messages are displayed on the Review event list and on printouts. Refer to Appendix B for a list of all alarms, detailed alarm event criteria, and explanations.

Suspended Alarms

Alarms can be temporarily suspended if the signal quality does not provide reliable alarms or when both detection leads are noisy or detached. For example, if the transmitter is out of range, a low priority No Radio Signal message appears on the screen. If the situation persists for more than 10 seconds, a medium priority No ECG Monitoring message appears on the screen and an audible alarm is generated. Alarms will be re-enabled when the signal returns to normal or when other technical alarms occur.
When the patient device is a Surveyor S12/S19 patient monitor, suspending an alarm is communicated bidirectionally between the patient monitor and the Surveyor Central.

- Suspending an alarm at the Surveyor Central suspends that alarm at the patient monitor.
- Suspending an alarm at the patient monitor suspends that alarm at the Surveyor Central.

**Alarm Re-activation**

When an alarm is active, a new alarm of the same type will not register. For example, if a second Ventricular Tachycardia occurs while the first Ventricular Tachycardia alarm is still active, it will not register separately. This is specifically relevant when alarms are permanent or latching. Once the first alarm has ceased, the new same-type alarm will present itself immediately and will register as a separate event. In the case of alarms on numerical values (e.g., high HR), the parameter value has to go at least 5% below the threshold before the alarm cancels. Using high HR as an example, if the limit is set at 100 bpm, the alarm sounds at 100 bpm but will not cancel until HR returns to below 95 bpm. This mechanism is designed to prevent frequent alarm re-activation when parameter values are close to the limit.

**Disabling Alarms**

In the **Alarm Settings** tab, you can disable/enable most of the alarm events using the toggle button: “Disable Alarms” / “Enable Alarms”.

Left click **Disable Alarms** to disable all alarms except for technical alarms. (Technical alarms continue to be presented visually, but do not generate a sound.) The multi-patient display will show an **ALARMS OFF** message and the time alarms were disabled. An alarms disabled symbol will also display to the right of the upper trace lead. A technical event will store in **Review** showing the time and date that the alarms were disabled.

**WARNING:** When an “ALARMS OFF” message is present, no clinical alarm will be generated or stored in **Review**. Re-enable alarms as soon as possible; use this function only when necessary.

**NOTE:** If Red Alarms Always Enabled is selected in the configuration menu, all high-priority alarms will not be disabled.

**NOTE:** When alarms are disabled for any channel, the system sounds a brief 4-tone reminder signal every three minutes. Contact a Welch Allyn representative to disable this reminder signal in your system.

When the patient device is a Surveyor S12/S19 patient monitor, disabling an alarm is communicated bidirectionally between the patient monitor and the Surveyor Central.

- Disabling an alarm at the Surveyor Central disables that alarm at the patient monitor.
- Disabling an alarm at the patient monitor disables that alarm at the Surveyor Central.

If a minute duration for **All Alarms Paused Duration (min)** is defined in the configuration menu, alarms will automatically become enabled after duration has been reached. This is indicated by the label of the Enable/Disable button (Pause alarms xx minutes) and by a count-down timer near the alarms disabled symbol in the patient window.

When a Permanent duration is selected in the configuration Global Alarm Settings menu, there is no timer and the alarms will remain off until enabled.

The same functionality occurs when **Start with Alarms Paused** is enabled. Alarms will be paused according to the set paused duration. This setting is useful to prevent any unwanted alarm events during the start of monitoring.
Setting Alarm Event Automatic Printouts

Choose the layout of the automatic printout when an alarm event occurs, with or without export, in the Alarm Settings Tab. Left click on Printout to the right of the alarm label to open the drop-down list for rhythm, report, trends, and ECG format selections.

Choose desired printout and left click Confirm to save, or Cancel to undo your changes. Automatic printouts cannot be selected for technical alarms with the exception of the Patient call function of the transmitter. All automatic printouts for the patient can be disabled with the Disable Alarm Printouts or Enable Alarm Printouts toggle button, overriding the setting of the individual alarm. Automatic printouts can be set up at either the Surveyor Central or S12/S19 patient monitor.

When automatic alarm printouts are disabled on the Central Station for a given bed, the printer icon is displayed with a circle and crossed line on the lower right hand side of the multiscreen as shown below.

Changing Alarm Limits

When monitoring begins, alarm limits, priorities, and printouts are automatically assigned to the patient based on either the Profile chosen (new patient) or on the previous monitoring session (same patient). To change alarm limits, left click on the value to the right of the alarm limit you want to change. A drop-down list appears and related areas in the window are highlighted and become active. Click the desired limit and then left click Confirm to save, or Cancel to undo the change(s). Note that any limit that is changed remains highlighted until it is saved or cancelled.

New alarm limits become active after you have clicked on Confirm.

Use alarm group buttons (e.g., Electrocardiogram, etc.) in the lower portion of the Alarm Settings window to quickly move to related alarm settings.

**NOTE:** The alarm groups are the same as the alarm categories of the alarm event list in the Review tab. For a complete list of alarm group assignments, see Appendix B.

**WARNING:** Inappropriate limit settings may render an alarm ineffective and cause serious danger to the patient. Choose limits appropriately and based on the individual patient.

Changing Alarm Priority

To change an alarm priority, left click on the color value to the right of the alarm limit you want to change. A drop-down list appears and related areas in the window are highlighted and become active. Click on desired priority color (red, yellow, cyan or white) and then left click Confirm to save or Cancel to undo your change(s).

**NOTE:** Some alarm priorities cannot be changed by the operator, or only allow limited choices. This is by design and is intended to ensure patient safety.
When the patient device is a Surveyor S12/S19 patient monitor, the alarm priority settings are communicated bidirectionally between the patient monitor and the Surveyor Central.

- Adjusting an alarm priority at the central station adjusts that alarm priority at the patient monitor.
- Adjusting an alarm priority at the patient monitor adjusts that alarm priority at the Surveyor Central.

**Electrocardiogram Alarms: Heart Rate**

Left click on the High Heart Rate and Low Heart Rate limit drop-down lists to select and change the beat per minute alarm limit.

<table>
<thead>
<tr>
<th>Alarm type</th>
<th>Alarm trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Heart Rate</td>
<td>Alarm presents when HR bpm is lower than set limit</td>
</tr>
<tr>
<td>Bradycardia</td>
<td>Alarm presents when HR is 10 bpm below set Low HR limit</td>
</tr>
<tr>
<td>High Heart Rate</td>
<td>Alarm presents when HR bpm is higher than set limit</td>
</tr>
<tr>
<td>Tachycardia</td>
<td>Alarm presents when HR is 30 bpm above the High HR limit</td>
</tr>
</tbody>
</table>

**NOTE:** HR is calculated over an average of 16 beats when above 40 bpm and 4 beats when lower than 40 bpm.

**NOTE:** Low Heart Rate and High Heart Rate alarms cannot be disabled.

**Electrocardiogram Alarms: Heart Rate for S12/S19 Patient Monitoring**

Bradycardia and Tachycardia limits are defined at the S12/S19 patient monitor. Refer to the S12/S19 User Manual.

**Electrocardiogram Alarms: Cardiac Arrest**

To modify Cardiac Arrest limits for telemetry monitoring, locate the Arrest field and left click on the limit value to increase or decrease the number of seconds for the alarm limit. The set value reflects the number of seconds where no beats are detected before displaying a cardiac arrest alarm. There is no threshold limit for S12/S19 patient monitors.

**Ventricular Tachycardia Alarm**

To modify ventricular tachycardia thresholds, move the cursor onto the VTACH Length or VTACH Rate field and use the drop-down list to increase or decrease the threshold. This alarm is generated by two events: 1) number of ectopic ventricular beats and 2) ventricular ectopic beats with a rate higher than the set limit. Only a simultaneous occurrence of these two events will trigger the alarm.

<table>
<thead>
<tr>
<th>Limit type</th>
<th>Alarm setting criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>VTACH Length</td>
<td>Number of successive ventricular ectopic beats</td>
</tr>
<tr>
<td>VTACH Rate</td>
<td>Rate of successive ventricular ectopic beats</td>
</tr>
</tbody>
</table>

**NOTE:** Thresholds set too low may cause false alarms due to noisy signal, in particular when patients are ambulatory in the case of many false alarms, it is advisable to increase the limit. If it is required to evaluate shorter ventricular runs, you can activate the Ventricular Run alarm in the Extended Arrhythmias section as a lower priority alarm and review them periodically.

**NOTE:** Ventricular arrhythmias with a rate lower than the VTACH Rate limit may cause a ventricular rhythm alarm; arrhythmias shorter than the VTACH Length limit may cause a ventricular run alarm. Both alarms can be enabled or disabled in the Extended Arrhythmia group.
NOTE: Ventricular tachycardia (VTACH) alarms are NOT latched. The sustained Ventricular Tachycardia Alarm (>15 seconds) IS always latched.

**ST Alarms**

ST alarms can be disabled by individual lead check boxes in the ST Change group under the Alarm Settings tab.

**NOTE:** The alarm is initiated after a 1-minute duration of change that exceeds the threshold of the ST limit occurs.

**NOTE:** To redefine the reference level for ST alarm, press *New Ref* in the Averages tab or *Relearn + New ST Ref* in the Traces tab.

**NOTE:** 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.

**Extended Arrhythmia Alarms**

This optional group contains a number of extended, typically non-life threatening, arrhythmia events. In the default factory profile, all these alarms are disabled. Left click on the enable check box to enable each arrhythmia type individually. Some of these alarms may occur frequently; it is recommended that you do not set a priority that may obscure other, more serious alarms. Often an Informational (white) level alarm is enough to detect these types of arrhythmias in Review.

Pacemaker related alarms will not generate if the Pacemaker field in the Patient Data tab is not enabled. See Appendix B for a complete list of extended arrhythmia alarms.

**Resting ECG**

This optional group is available only when 12-lead ECG interpretation is present and allows the ability to have a low priority alarm signal when QTc values exceed the set millisecond limit, and are 70 seconds or more in duration. This group is not available for S12/S19 patient monitors.
**SpO₂ Alarms**

This optional alarm group is available when a transmitter with SpO₂ capability is used. Not all alarm types are supported on every transmitting device.

<table>
<thead>
<tr>
<th>Alarm type</th>
<th>Alarm trigger</th>
</tr>
</thead>
<tbody>
<tr>
<td>SpO₂ High</td>
<td>Medium-priority alarm presents when % SpO₂ is high than the set limit</td>
</tr>
<tr>
<td>SpO₂ Low</td>
<td>Medium-priority alarm presents when % SpO₂ is lower than set limit</td>
</tr>
<tr>
<td>Desaturation</td>
<td>High-priority alarm presents when % SpO₂ is 10% below set SpO₂ Low limit</td>
</tr>
<tr>
<td>Pulse rate low</td>
<td>Medium or low-priority alarm presents when SpO₂ pulse rate is below set limit</td>
</tr>
<tr>
<td>Pulse rate high</td>
<td>Medium or low-priority alarm presents when SpO₂ pulse rate is above set limit</td>
</tr>
</tbody>
</table>

*NOTE: There is a SpO₂ alarm presentation delay as a result of processing and averaging of the incoming signals. Please refer to Appendix B, Alarm Details Delays.*

**Technical Alarms**

Only technical alarms where the priority can be changed are in this list. For a complete list of alarms, refer to Appendix B.

ECG leads off, or ECG noise may lead to suspension of beat detection. If the condition persists for more than 10 seconds, a specific technical alarm will appear (e.g., HR Not Available or No ECG Monitoring) with a medium (yellow) priority.

Short transmission interruptions and brief noisy episodes are a normal part of ambulatory telemetry monitoring and may happen frequently. It is not recommended to increase the priority of these alarms above the Informational (white) level, unless a high signal quality is very important to you. Note that the Patient Call alarm event is considered to be a technical alarm as well; therefore, it will only be visually presented (but not audible) when all alarms are disabled.

**Protocol Events**

Protocol events are managed by the Protocol Manager. Alarm priorities and printout types are defined in separately generated protocol files. Any settings in this section will be ignored.
10. AVERAGES

Clicking on the Averages tab in the single-patient display opens the averages page. Display Reference and Markers measurement points can be enabled or disabled as desired by a left click on the buttons. ST measurements are displayed in millimeters (mm) or microvolts (µV); 1 mm corresponds to 100 µV.

This screen allows you to Print a report, trends, rhythm, or a 12-lead ECG. Change display gain by clicking on the respective buttons.

In the screen below, current averages are displayed against the reference averages in a different color with measurement points enabled.

Figure 26 - The Averages screen.
Reference

It is possible to display the reference average complex in yellow superimposed on the current complex in green together with the current ST values. This reference complex is used for ST change alarms and will be updated in the following cases:

- At the beginning of the monitoring session
- At a manual reset (New Ref button selected)

*NOTE: The “New Ref” button is disabled in a Surveyor Central repeater station.*

The display of the reference complex can be turned on and off by a left click on Reference. The time of the reference complexes is shown at the top center of the display and to the right of the ST (mm) measurement values highlighted in yellow. The lead of the enlarged complex can be chosen by pressing Lead. Choose between a fixed lead or choose Dynamic and let the system dynamically choose the lead with the biggest ST change with respect to the reference. The large complex is enlarged four times with respect to the normal ECG display; at 10 mm/mV gain this corresponds to 8 grid squares per mV. The display speed is 100 mm/s, so a grid square is 50 ms.

Markers

The points in the QRS complex where measurements are made by the system can be displayed by clicking on Markers. Vertical bars of 1 mV height indicate the QRS onset (beginning) and offset (end) that were detected by the system. A vertical dotted line indicates the ST measurement point. This point is always relative to the QRS offset with a user-defined delay (typically 60 ms). The delay can be adjusted in the configuration menu.

*NOTE: The segments of the vertical dashed lines where the ST measurements are taken have a length of 100 microvolts (1 mm with a normal gain of 10 mm/mV).*

ST Values

Each averaged QRS complex will show the current ST measurement value highlighted in green. If reference is enabled, the reference ST measurement value is displayed highlighted in yellow. Additionally, ST values are displayed to the right of each lead label highlighted in white. These values are continually updated and show the current ST segment value as negative or positive to the isoelectric line highlighted in green. The second set of values, highlighted in red, reflect the amount of ST change as compared to the reference ST value.

Other Displayed Information

The information shown to the right of the averaged waveform is shown in the Traces display.
11. TRENDS

The Trends page will show a resolution of 3, 6, 12, or 24 hours of user-selected trend values and HR. Left click on the **Hours** drop-down list to choose your desired resolution; trend scale is calculated by the system automatically.

**Trend Select**

**Trend Select** will open a drop-down list allowing you to choose the desired trends with up to three choices for Dual Trends display. HR trend will always be selected as a default for the Dual Trends view. Left click on **Trend Select** and then move the mouse cursor over the trend parameter selection you wish to edit. A drop-down list will appear allowing you to choose the desired parameter.

**Dual Trends**

The Dual Trends example for telemetry patient monitoring shown below has a set resolution of 3 hours where ectopic rate, ST II, and QTc Welch Allyn display selections were chosen. A trend duration of 3, 6, 12, or 24 hours can be selected from the drop-down list to the right of the Hours label.

**Upper Trend**

HR and ventricular ectopic (ECT) beat per minute labels are shown in white.

HR trending is shown in green with green trend values on the left side. The ECT trending is shown in red with the scale values in red on the right.

**Lower Trend**

ST lead II measurement and QTc ms labels are shown in white.

ST trending is shown in green with green scale values on the left side. QTc trending is shown in red with the scale values in red on the right.

**Minimum/Average/Maximum**

Minimum, average, and maximum values for each selected trend parameter are shown for each 30-minute period over the last 3 hours in the lower portion of the display.

---

**Figure 27** - The Trends screen.
The Dual Trends example for an S12/S19 patient monitoring slot shown below has a set resolution of 6 hours where respiration rate, P1 high and low mmHg values, and Temperature 1 display selections were chosen. The General Trend, parameter 2 list is displayed showing available selections.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Trend</strong></td>
<td><strong>Parameter 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00:00</td>
<td>01:00</td>
<td>02:00</td>
<td>03:00</td>
</tr>
<tr>
<td>HR (bpm)</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>RESP (rpm)</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>P1 (mmHg)</td>
<td>120</td>
<td>120</td>
<td>120</td>
</tr>
<tr>
<td>T1 (°C)</td>
<td>37.0</td>
<td>37.0</td>
<td>37.0</td>
</tr>
</tbody>
</table>

**Figure 28** - Example of the Dual Trends screen.
All ST Trends

In All ST Trends view, change trend resolution by clicking on the **Hours** drop-down list. Trend scale is calculated automatically by the system.

The time of the last trend value is highlighted in white at the top of the display. Trends are calculated every minute.

All 12-lead labels are displayed on the left side with their respective trend graph to the right.

HR trending is shown in green with white trend scale values on the left side.

Ventricular ectopic trending is shown in yellow on the same scale.

**Minimum/Average/Maximum**

Minimum, average, and maximum values for each selected trend parameter are shown for each 30-minute period over the last 3 hours in the lower portion of this display.

**NOTE**: When monitoring is interrupted for a period of time, trend values are not present and appear as a break in the trend.

![Figure 29 - All ST Trends screen.](image)
12. TRACES

The Traces tab displays the real-time 12-lead ECG and plethysmogram when an ambulatory transmitter or mobile monitor is used. When a Surveyor S12/S19 patient monitor is used, the Traces tab displays the waveforms that are in use at the patient monitor. As in the multi-patient display, active alarm event messages are displayed and can be acknowledged in the Traces display. Up to three overlapping alarm events can be displayed simultaneously.

Parameter values and other information are displayed in the upper right area of the window. Displayed waveforms and parameters can be changed in the Settings tab. **Print** can be selected to choose the type of printout from a list of choices.

![The Traces screen.](image)

**Figure 30 - The Traces screen.**
The following displays 3-wire, single-lead monitoring with Lead III.

![Figure 31 - The Trace screen showing a single lead trace.](image)

### Protocol Timers

When a protocol is in progress, the minutes and seconds (mm: ss) from the start of the protocol is displayed on the left; minutes and seconds before the next step is displayed to the right. An upcoming protocol message is also displayed so the clinician will know what is going to occur next.

### Access Point

For Surveyor S4, the following items are displayed, and can be used for troubleshooting:

- MAC address or name of the WiFi Access Point through which the S4 is communicating

  **NOTE:** Descriptive names can be defined within the Surveyor Central system for each of the WiFi access points. Contact Welch Allyn Customer Service for assistance in setting up this feature.

- MAC address of the S4 device
- Signal to noise ratio in dB.
- WiFi channel occupied

### ST Values

ST values are displayed to the right of each lead label highlighted in white. These values are continually updated and show the current ST segment value as negative or positive to the isoelectric line highlighted in green. The second set of values, highlighted in red, reflect the amount of ST change as compared to the reference ST value.
**QT/c Values**

Welch Allyn QT and QTc values are presented below ST values with HR (QT) and QTc calculations for Bazett and Fridericia when this option is available for telemetry monitoring. Note that the current HR value in the upper right corner and the QT HR value may differ slightly because the QT values are periodically calculated over 10 seconds of data.

**Arrhythmia Values**

Ventricular premature beats (VPB), R-On-T, couplet, pause, pacemaker non-capture (NC), and failure to output (OF) values per minute are shown below the QT/c values. VPB is the only value available for S12/S19 patient monitoring at the Surveyor Central station.

**SpO2 Values**

SpO2 percent and pulse rate (PR) values are displayed and continually updated when the T12S transmitter or S12/S19 monitors are used. Dashes (---) will be displayed in place of values when there is no valid signal.

**S12/S19 Numeric Parameter Values**

The numeric parameter values are displayed according to checked items in the Traces Parameters under the Settings tab.

**Learn**

In a case where the system incorrectly identifies the patient’s normal beats, it may be necessary to relearn the rhythm. A Rhythm Relearn does not modify the reference for the ST change measurement.

**NOTE:** The Learn button is available for S12/S19 patient monitoring at the Surveyor Central station allowing the clinician to choose **Relearn + New ST Ref** only.

Although ST monitoring is always performed on all available leads, actual QRS detection is based on a reduced number of leads. If necessary, these leads can be changed in cases of low amplitude or poor signal quality. Use the Learn menu selections and choose the best leads from the drop-down list.

**Detection Lead 1** and **Detection Lead 2** are used for QRS beat detection. Choose leads that are of good quality and have the best amplitude.

**Confirmation Lead** is used to confirm the detected beat type. Choose a lead that is orthogonal or different than the detection leads.

A minimum peak-to-peak amplitude for QRS detection can be set as 160, 300, or 500 µV (1.6, 3, or 5 mm with standard gain).

**NOTE:** The Learn button is disabled in a Surveyor Central repeater station.
WARNING: Careful setting of the correct leads for QRS detection is very important for optimal functioning of the VERITAS algorithm and ST monitoring, the prevention of false alarms, and the detection of true alarms. Refer to Appendix A for details on the VERITAS algorithm and recommendations for choosing the best detection leads.

WARNING: A low minimum QRS amplitude setting may cause the system to detect P-waves as QRS complexes and thus fail to detect an atrioventricular block. A high value increases the probability of Asystole alarms when one or both detection leads has a low QRS amplitude. 300 μV is the factory default value.

NOTE: Lead amplitudes used by the detection algorithm may differ slightly from printouts for technical reasons. The algorithm uses R (RA) as a reference instead of the Wilson terminal reference.

Choose Relearn + New ST Ref when you wish to perform an ST measurement reference relearn in addition to a rhythm relearn.

NOTE: Always exit the menu by clicking on Rhythm Relearn or Relearn + New ST-Ref after changing the detection leads or minimum QRS amplitude values.

Choose Cancel when you wish to exit the Learn window without making any changes.

ECG Gains

Click Gains when you wish to change the displayed ECG gain in all leads to 5, 10, 20, or 40 mm/mV. This will change the gain in the single-patient display as well as the multi-patient display. This will also change the ECG gain in all printouts.
Waveform gains

Click Gains when you wish to change the displayed waveform gain for each channel. This will change the gain in the single-patient display as well as the multi-patient display. This will also change the waveform gain in all printouts.

Respiratory (RESP) and Plethysmogram gains can be set to 0.5, 1, or 2.

P1, P2, P3, P4, ART, PA, RA, LA, CVP, ICP, and CO2 gains can be set to 0.1, 0.25, 0.5, 1, or 2 mm/mmHg.

Show 10 mm/s

Show 10 mm/s is a toggle button that allows you to choose 25 mm/s display speed or 10 mm/s display speed in the Traces view. This selection will only affect the single-patient display and will not change the mm/s speed in the multi-patient display or on any printouts.
13. REVIEW

Surveyor Central allows you to review all stored alarm events and ECG for all patients. The review window is on the right half of the screen when using a single monitor, or on the right display when using a dual monitor. Alarm events for all monitored patients are listed; click on any of the events to display ECG.

Multi-patient Review

In the multi-patient display, left click on Review at the bottom right of the display. In the example shown, an episode of VTACH has been selected with a left click. The monitored patient’s ID precedes the time and date of the event. 30 seconds of ECG lead II is shown in the Multi view. Parameters such as HR, VPB count, QT/c measurement, and ST measurement for the displayed ECG are shown in the bottom portion of the Review display. ST values are not displayed in this example because they are not calculated for ventricular beats.

All events with priorities that have not been acknowledged are shown in the alarm event listing for all patients in reverse chronological order. This window allows you to review all event alarms that have occurred for all of the currently monitored patient sessions. Left click on any alarm event and the ECG will be displayed.

The scroll bar at the right of the event list can be used to move to alarm events that are not currently in view. Navigation through the ECG and reviewing events, filtering events, acknowledging events, cancellation of events, and display selections are explained on the following pages.
WARNING: Only events that occurred within the last 30 minutes and that have never been acknowledged are shown in this screen. Go to Single Patient Review, explained on the next page, for review of acknowledged events and the events that have occurred earlier or in previous monitoring sessions.

NOTE: Multi-patient review is not available in a Surveyor Central repeater station.

Single-patient Review

In single-patient display, left click on Review at the bottom right of the display or right click anywhere on the ECG of a patient’s sub-screen in multi-patient display. Alternatively, highlight the patient and left click on Review. In the waveform traces view shown below, an event in the event list was selected with a left click. A 12-lead ECG is displayed at 25 mm/s speed. Parameters for the ECG are shown in the bottom portion of the display.

All event priorities for this patient are shown in the alarm event listing in reverse chronological order. This window allows you to review all event alarms that have occurred for this single patient. Left click on any alarm event and the ECG will be displayed.

Event review

Figure 34 - The Event Review screen.
Trend Review

Left click on Trend to toggle between events review and trend review. The events listing is changed to a trend that allows you to navigate to any monitoring session. HR trending and values are shown in green and ECT (ectopy) is shown in red.

![Figure 35 - The Trend Review screen.](image)

The start and end times of all monitoring sessions are shown to the right and left of the slider bar allowing you to navigate to any session time point. When the slider bar cursor is left clicked, the displayed dates and times will be shown.

A red vertical cursor will move when you left click anywhere in the trend and the ECG waveform at that time is immediately displayed. Blank areas in the trend and slider bar indicate periods when the monitoring was stopped and then restarted.

Navigation to Day and Time

Displayed ECG waveform dates and times are shown in the upper left corner of the review display. Left click on the date and time values and change them to navigate to any point in the monitoring data. You can also have left click on the date drop-down list to open a calendar and choose a date.

To navigate to any time or day during the monitoring session(s), enter the time and date and then click GO.

Select Trend for Waveform Traces Display

Click on Select Trend to change the displayed trend to durations of 3, 6, 12, or 24 hours and select various trend parameters.
Navigation within the Review ECG

- Use **Home/End** keys to go to the beginning or end of the monitoring period.
- Use **Page Down/Page Up** keys to go to the next/previous page of ECG.
- Use the mouse wheel to zoom in/out the number of seconds in the display.
- Right/left arrow keys move the displayed ECG a second at a time forward or backward.
- Up/down arrow keys move the displayed ECG set of traces to the previous/next line of traces.
- Left click on any beat in the display to center within the 12-second dashed box with the center on the beat you selected.
- Move the mouse cursor within the context of the Review ECG window and time and date at the bottom of the display will change to reflect the location of the ECG. Field is blank when the cursor is outside the Review ECG field.

Gain

ECG gain can be adjusted in 5, 10, 20, or 40 mm/mV and will affect all ECG gain in review. Plethysmogram gain, when present, can be adjusted to 0.5, 1, or 2 times sensitivity and will affect all plethysmogram gain in review.

Multi (Traces), 12-Lead and Custom Display

The **Multi** button is an on/off toggle that allows multiple traces for each ECG lead display. When depressed, the **Leads** and number of seconds drop-down lists allow customization of the ECG display. The number of seconds and the number of traces for each lead automatically adjust according to the number of leads selected. Close the **Leads** drop-down list by a left click.

When the **Multi** button is toggled off with a left click, an alternate view of the ECG can be selected. This view gives you only one single trace for each lead. You can select this view by left clicking again on the **Multi** button, toggling it off, or by left clicking on **12-lead/Custom**. Select either all 12 leads for display by left clicking **12-Lead** or select a subset of leads by left clicking **Custom**.

**Multi** is automatically toggled off when you left click on **12-Lead/Custom**. In single-trace view, display speed is expressed in mm/s and can be changed with the drop-down list. The number of leads in the custom display can be selected with **Leads**. The number of seconds displayed in this view is 6, 12, 30, or 60 seconds with dual monitors (half with a single monitor).

Select 5 mm grid display in the configuration menu. Note that the grid is never present at 5 mm/s display speed.
Graphical Trends Review

With events displayed, you can switch between waveform traces, graphical trends, ST trends, and tabular trends using the drop-down list below date and time selections. In this view, Waveform Traces and Events Select Trend related buttons are not available.

This view allows you to choose durations of 3, 6, 12, or 24 hours and any combination of up to 8 trend parameters.

The first trend is HR only. This trend can be turned off by use of the None selection.

Figure 36 - The Graphical Trends Review screen.
ST Trends Review

With events displayed, you can switch to ST trends using the drop-down list below date and time selections. In this view, Waveform Traces and Events Select Trend related buttons are not available. This view allows you to choose durations of 3, 6, 12, or 24 hours using the Select Trends button.

An ST trend for each of the ECG leads is displayed with a blue background. The HR trend is displayed in green and Ectopy is displayed at the bottom in yellow.

Location of the red vertical cursor determines the ST values in parenthesis that are shown to the right of the ST lead labels.

The values in parenthesis below HR indicate HR/ectopic beats per minute in relation to the red cursor location.

The HR trend scale values are shown to the right of the HR values (e.g., 250, 188, 126, 64, and 0).

The date and time shown in the middle lower portion of the display indicate mouse cursor position when it is moved over the graph.

Figure 37 - The ST Trends Review screen.
**Tabular Trends Review**

With Events displayed, you can switch to tabular trends using the drop-down list below date and time selections. In this view, Waveform Traces and Events Select Trend related buttons are not available.

This view allows you to choose durations of 3, 6, 12, or 24 hours and any combination of up to 8 trend parameters.

Trend column times will adjust as the durations are changed. This trend is 3 hours in duration and values are shown every 30 minutes.

Minimum, average, and maximum values for each time period are shown for each parameter.

![Tabular Trends Review screen](image)

**Figure 38 - The Tabular Trends Review screen.**
Print

Left click on Print in the lower area of the review display to open the available selections. When a 12-lead ECG is selected, the ECG located within the dashed box will be printed. In the review function, you can also print the ECG and trends as they are displayed on the screen. Patient demographics, displayed leads, and ST measurement values will appear on the waveform traces printouts. Note that the amount of data that is printed on the screen format differs slightly from the amount displayed, because dimensions of the screen differ from that of standard paper.

To print a Summary Report:

1. Click the Print button at the bottom of the review screen. A list of available reports pop up.
2. Select the Summary Report item.

Settings

Settings allows you to change the printout defaults after monitoring has been stopped. When monitoring is in progress, you can change these settings through use of the Settings Tab. Settings can be changed for the 12-lead ECG, ST report, and Summary Report.

To configure the contents of a Summary report:

1. Click the Settings button at the bottom of the review screen. A list of report configuration settings pops up. The following items apply to the Summary report:

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary Report: Report Duration</td>
<td>Selects the coverage period for the report.</td>
<td>4 hours, 8 hours, 12 hours, 24 hours</td>
</tr>
<tr>
<td>Summary Report: Tabular trends interval</td>
<td>Selects the reporting interval used for the tabular trends section of the report.</td>
<td>1 minute, 5 minutes, 15 minutes, 30 minutes, 60 minutes</td>
</tr>
<tr>
<td>Summary Report: Graphical Trends</td>
<td>Selects whether or not to include a graphical trends displays in the report.</td>
<td>Enabled/disabled</td>
</tr>
<tr>
<td>Summary Report: Tabular Trends</td>
<td>Selects whether or not to include a tabular trend display in the report.</td>
<td>Enabled/disabled</td>
</tr>
<tr>
<td>Summary Report: Alarm Snapshots</td>
<td>Selects whether or not to include alarm snapshots in the report.</td>
<td>Enabled/disabled</td>
</tr>
</tbody>
</table>

2. Click on the desired configuration item.
3. Click on the desired setting for the configuration item.

4. Repeat the above steps for each configuration change to be made.

**Reload**

Left click on **Reload** at the bottom of the review display to update or refresh any alarm events or trends that occurred since you entered the review display. Neither the alarm events list nor trends will update or show new information until you select this button.

**Alarm Events List**

**Multi-patient Alarm Events List**

Only alarm events that occurred in the last 30 minutes and have not been acknowledged are displayed. To acknowledge an event, left click the checkbox preceding it. Once you **Reload** or **Close** and then reopen the multi-patient review, the acknowledged event will not be shown. To cancel an event, left click the event and press **Delete**. Before you close review, select **Show cancelled events** to display only deleted events. **Return** to go back to the event list.

To undo a deletion, left click the event and press the **Insert** key. This must be done before you close the review screen. Deleted events cannot be undone once the review screen is closed.

**Single-patient Alarm Events List**

In single-patient review display, all acknowledged and unacknowledged events are displayed and can be deleted the same as in multi-patient review display. Cancellation is possible for both acknowledged and unacknowledged alarm events.

**Alarm Events Filtering**

You can filter the alarm events list by selecting or deselecting the check boxes to the right of the listing. Additionally, you can filter to view related groups of alarm events for:

- Electrocardiogram
- Ventricular Tachycardia
- ST Change
- Protocol Events
- Extended Arrhythmias
- Resting ECG
- NIBP
- Technical Alarms
- External Events
- Temperatures
- SpO₂
- Invasive Pressures
- CO₂
- Respiration Rate
- Technical Alarms
- All Alarms Off

Any combination of alarm priority types and related groups can be selected.

**NOTE:** Selected alarm event types and groups remain selected each time the review window is closed and reopened.
14. PATIENTS

Use Patients to view the status of all monitoring sessions in progress and those that have been stopped. New patient demographics can be entered to allow quick and easy import for when the monitoring session is started. Monitoring sessions that have been archived will show in the Status column. The Patients button is disabled in the Surveyor Central repeater station.

Once selected, a window will open. Sort the list by any of the column headers such as Last Name, ID, Date of Birth, Start Time, Stop Time, ID Format, or Status. The sort field is indicated by a triangular symbol. To sort in reverse order, click the column header again. To sort by two headers, click on the first choice then press and hold the shift key and simultaneously click on the second sort column.

Using Bar code, you can automatically highlight a patient by scanning the bar code with your bar code reader. To do this, click on the bar code field, scan the code, and left click on Confirm.

You can click anywhere on a patient line to highlight and select it. Buttons at the bottom of the display window allow you to:

- Add New patient demographics to allow import of information when a monitoring session is started.
- Modify existing patients; add information or edit changes to the demographics. Double click on a patient and this modality will open automatically.
- Delete patient data or demographics from the Surveyor Central database.
- Archive monitoring sessions to a defined location on your network.

**NOTE:** Change column widths by dragging the header border left or right. If you size a column too small and it disappears, click on the edge and drag it over the border of the next column. This will reset all column widths to their default size.

**NOTE:** Delete is inactive when status is “Monitoring.”

New

Selecting New will open a window.

Select ID format from the drop-down list and enter the patient demographics. Left click OK to save your changes and return to the patient list. If Cancel is selected, you will return without any saved changes.

Modify

Modify can be used to open a patient’s demographics window to add to or change any of the demographic information. Left click OK to save your changes and return to the patient list. If Cancel is selected, you will return without any saved changes.

Delete

Delete will remove New patient information that has been added, as well as patient data with a “Stopped” or “Archived” status from the database. Once done, the data cannot be retrieved. Delete is inactive if you have highlighted a patient that currently has a status of “Monitoring”.

The system may be setup to require the configuration password in order to delete a patient. If you require this function, please ask a Welch Allyn representative.
Archive

Archive will send all closed monitoring sessions of a highlighted patient to the destination defined in your system. If you highlight a patient that is currently being monitored, only the stopped monitoring sessions will be archived.

To archive all data up to the current time, go to the Patient Data Tab. Select Stop and then select Same Patient to immediately restart a new monitoring session. Go back to the patients list and select Archive.

**WARNING:** Protection of archived information sent to an off-line storage location is the responsibility of the customer who will provide correct storage and handling of data including regulation of access to this information.

**NOTE:** Archived data cannot be restored to your Surveyor Central. Archived data is typically used for acquisition at a Welch Allyn Surveyor Central review station, or an H-Scribe analysis system that has the Surveyor data analysis option.

Session Management

Moving a Patient

Through the patients list you can move a monitoring session to any other monitoring window on your system (i.e., move a patient from slot #14 to slot #2 or to any other networked control station):

1. From Patient Data window select the Stop monitoring button.
2. Click on a patient slot that is not currently being used (patient data window opens).
3. If the slot had previously been used by another patient, click on New Patient.
4. Click on Start.
5. Click on Import (patients list opens).
6. Highlight patient with the “Stopped” status.
7. Click on OK.

The previous closed session data is moved together with the patient to the new telemetry channel window.

**WARNING:** Alarm settings in the new monitoring session will be those of the chosen profile. Previous alarm settings for the patient are lost.

**NOTE:** Each window has a specific device or telemetry channel associated with it. Don’t forget to exchange the device. If you don’t, you may display data from a different patient.

Multiple Sessions

In cases where the patient will return for multiple monitoring sessions, the same steps can be used for each session. This allows you to keep all the sessions together and you can review data and events in one location. Archive the data together as desired or when the last session has been completed.

Blind Monitoring Sessions

When a New monitoring session is started, a “blind” session is opened. The blind session has no patient data associated with it; therefore, when you stop the monitoring session the data is LOST and there is no way to review
it. For this reason, a warning message will prompt that “All data will be deleted. Are you sure?” when you choose the Stop monitoring button.

**NOTE:** Once a monitoring session has been assigned to a patient, it is not possible to assign it to another patient.

**Review**

To review stored events or full-disclosure data for a single patient from the Patients menu, highlight the desired patient row and left click on **Review**.
15. SYSTEM CONFIGURATION

Most system configuration parameters can be changed through the configuration screen. Some parameters can only be changed by Welch Allyn, Inc. authorized personnel. These parameters include number of patients visible on the screen, colors, text strings, storage configuration, control, data processing, maintenance services, IP addresses, configuration of networked nodes, etc.

System configuration is entered through **Config** in the bottom right portion of the display.

Your current system software version and the Surveyor Central serial number are displayed when the **Config** button is selected.

Further access into the configuration menu requires a password to ensure your system’s security.

**CAUTION:** User actions can interrupt monitoring, destroy data, or change alarm modality. Use **Config** only if properly instructed and authorized.

**NOTE:** The password to access the configuration screen will be assigned to you by a Welch Allyn, Inc. representative.

The configuration screen is divided into several groups of functions.

- Beds
- Printers
- Volumes
- Alarms
- Display
- Signal Processing
- Passwords
- Management
- Users Setup

These functions are explained on the following pages.

All modifications made within the configuration menu will become active when **Confirm** is selected. All modifications will be cancelled, and the configuration that was in effect when you entered the screen will be reloaded when **Cancel** is selected.

**NOTE:** Each configuration group must be confirmed individually prior to selection of the next group item. If this is not done, your changes will not be saved.

**NOTE:** Beds, Display and Signals are the only functions available in a Surveyor Central repeater station.

**Beds**

The **Default** column identifies factory set system configurations. The two numbers in parenthesis (1, 2) identify the receiver used and the unit ID number. This column is used by Welch Allyn maintenance personnel and cannot be changed.

This window allows you to define the **Name** of the telemetry transmitter displayed in the patient display window. Enter any name that will allow clinicians to identify the transmitter with the monitoring slot. It is recommended you clearly label all transmitters to prevent any mix up of patients and waveforms. Recorded data cannot be moved to another patient after monitoring has been started.
The **Type** column tells the system that all channels will receive data from a telemetry transmitter, or monitor. This column is factory defined and is not editable.

The last column has no function.

It is not possible to change channel numbers for monitor slots.

Once your changes have been made, left click **Confirm** to save your settings.

**Beds menu at a Surveyor Central Repeater Station**

It is not possible to change bed names and telemetry channels.

Using the **Show** column check boxes in this menu, select the channels that are repeated at the repeater station screen.

**Printers**

**Station List** was configured upon installation and reflects the computer names of your Surveyor Central. In the **First Printer** column, select the name of the network printer from the drop-down list where you want your 12-lead ECGs, rhythm strips, trends, etc. to print.

Define a **Second Printer** and all printouts will print to both devices simultaneously.

The **System Printer List** shows all printers defined for your system. Select **Paper Size** (A4 or letter) in the column to the right. To **Print Grid** on your printouts, select the check box. Note that grid is not printed on 5 mm/s rhythm strips.

In the lower portion, set the **Speed (mm/s)** you want for 12-lead ECG printouts to 25 mm/s or 50 mm/s. With 50 mm/s, the 12-lead ECG will print on two separate pages.

Once your changes have been made, left click **Confirm** to save your settings.

**Volumes**

**Day Alarms and Warnings**: It may be desirable to select higher volumes for alarms and warnings during the daytime hours.

**Night Alarms and Warnings**: It may be desirable to select lower volumes for alarms and warnings during the night time hours so resting patients are not disturbed.

Left click on the time in the **Start** column to change the time that begins your Daytime hours. Use the scroll arrows for hours, minutes, and seconds or use the keyboard to enter the desired military time. To change the time your Night time hours, begin, repeat these steps.

Choose the **Sound Level** for day and night. To hear an example of the volume, use the **Test Volume** drop-down list to hear each type of sound level.

In order to have low priority alarms sound, ensure that **Sound Low Priority Alarms** is checked. Uncheck this item to not have low priority alarms annunciate.

⚠️ **CAUTION**: Setting a low level for the volumes may cause an alarm to be missed. Ensure volumes are appropriate for your situation.

Once your changes have been made, left click **Confirm** to save your settings.
**Alarms**

Latch all yellow alarms by selecting the **All Yellow Alarms Latched** check box.

**Permanent (Latched) and Non-permanent (Non-latched) Alarms**

Permanent (latching) means the audible alarm continues until the operator clicks or acknowledges the message to silence the alarm. Non-permanent (non-latching) means the alarm sound will disappear automatically shortly after the clinical condition is resolved.

*NOTE: Yellow latched alarms will prevent yellow priority protocol steps from advancing without first acknowledging the yellow messages.*

Permanent or non-permanent is a global configuration setting for all telemetry patients and cannot be changed for any individual. High-priority alarms are always permanent, except the Ventricular Tachycardia alarm; low-priority alarms are always non-permanent. When the check box **Red Alarms Always Enabled** is selected, all of the alarms marked as high priority will not be disabled when a clinician chooses to “Disable all alarms” (ALARMS OFF message is displayed) for an individual patient in the Alarm Settings tab.

When a minute duration (from 1 to 30 minutes) for **All Alarms Paused Duration (min)** has been selected, disabled alarms (ALARMS OFF message is displayed) will automatically become enabled after duration has been reached. A countdown timer will also appear in the patient sub-screen.

*CAUTION: Transient alarm conditions may not be noticed if “Alarms Latched” is OFF especially if the automatic alarm printout is also disabled.*

Check **Start with Alarms Paused** to start each monitoring session with all alarms paused, and to manually enable the alarms. This prevents unwanted alarm events while the monitoring is being started and the ST and ECG learning process is in progress. This setting is not possible if the duration is set to “Permanent”.

Once your changes have been made, left click **Confirm** to save your settings.

**Display**

**Patient identified by** allows you to select the demographics that will show on the multi-patient and single-patient displays. Select either **ID** or **Name** from the drop-down list.

The default printout type for all monitored patients is defined by left clicking the print icon in the monitoring window. Choose Rhythm, Report, Trends, 12-lead, or 12-lead with Export depending on the available options in the **Default print type** drop-down list.

To show **Grid on MultiPatient screen**, left click the check box to the right of this selection.

To show **Grid on real time Traces screen**, left click the check box to the right of this selection.

To show **Grid on Review screen**, left click the check box to the right of this selection.

Once your changes have been made, left click **Confirm** to save your settings.

**Display menu at a Surveyor Central Repeater Station**

The first check box of this menu has a different meaning at the repeater station. When **Show Patient ID** has been selected, the repeater station will show the patient identifier (name or ID) in the patient windows same as Surveyor Central.
Signal Processing

ST delay (ms) is the time after the J-point (end QRS) where the ST measurement is made. It can be selected from the drop-down list and set anywhere from 10 ms to 200 ms, in 10 ms increments.

**NOTE:** Stop and restart patient monitoring to update the measurement point if ST delay is changed during the monitoring session.

Ensure that AC Power Frequency (Hz) is set to your local power frequency. To change setting, click on the drop-down list and select either 50 Hz or 60 Hz.

Once your changes have been made, left click Confirm to save your settings.

**NOTE:** The ST settings cannot be changed in a repeater station and are presented for informational purposes only.

Passwords

Password settings allows you to change the existing configuration access password. Left click within the blank Enter new password field and type any desired password.

Retype the new password in the blank Confirm new password field. If it does not match, you will be prompted to retype the new password in both fields again.

Note you will be asked for the same password if you want to save a monitoring profile or delete a patient (if your system is set up for password-protected delete).

Once your changes have been made, left click Confirm to save your settings.

Management

Management Functions will show buttons allowing you to Import and Export custom ID Formats from an E-Scribe system, and Protocols created through the Protocol Manager external application tools. The buttons are inactive if you do not have these options on your system.

Profiles that have been saved can also be exported to another networked Surveyor Central node.

Import/Export

To Import or Export ID Formats, Import or Export Protocols, or Export Profiles, left click any of the buttons shown.

A window will prompt you to browse for the source (Import) or destination (Export) folder or networked location. Left click on folder or drive letter, then click OK and the data will automatically be imported or exported to the proper location.
Delete Saved Profiles, ID Formats, and Protocols

Delete saved profiles, protocols, or ID formats through the Delete drop-down lists.

Left click in the field to the right of Delete Profile, Delete ID Format, or Delete Protocol and a drop-down list will appear. Select the item you wish to remove from your system.

Once your changes have been made, left click Confirm to save your settings.

User Setup

Settings in this window set up permissions for review station users that have online database access through the institution network and the Surveyor network security router.

Review Users

Selection of User setup opens a window.

To add a new review user, type the user and domain names setup on the network and then click Add.

You can select any user and click on Delete to remove access.

User-Authorized ID Formats

With user name highlighted, select ID Formats for the user from the drop-down list. User will only be allowed to access patient data with ID Formats chosen here.

You can also select ID Formats to remove access for the user.

User Permissions for the ID Format

Choose the permissions allowed for the selected user by a left click on the check box next to the features desired.

- Create/Modify
- Delete
- Archive
- Review

Once all of the review users are configured, left click on Save Changes to save the settings.

Please refer to the Surveyor Central Review Station user manual (PN 9515-169-75-ENG) for more details about using the Review Station.

Shutdown or Reboot Node

Surveyor Central workstations can be turned off or rebooted by selecting Shutdown Node or Reboot Node in the configuration window. Upon selection, you will be prompted for confirmation.

To cancel the shutdown or reboot, left click No.

To continue, left click Yes and the shutdown process will begin.

After a node reboot, workstations will automatically restart after the reset.

After a node shutdown, turn the Surveyor Central node back on by pressing the ON/OFF switch on the front side of the workstation. System will restart within a few minutes; any patient monitoring that was in progress will continue.
The following chart contains information to assist the clinician with troubleshooting by providing possible solutions. Whenever the suggested solutions do not resolve the issue, contact Welch Allyn technical support for assistance.

<table>
<thead>
<tr>
<th>Trouble</th>
<th>Possible cause and solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noisy ECG signal</td>
<td>• Check that patient is relaxed. Tension can cause muscular interference.</td>
</tr>
<tr>
<td></td>
<td>• Check that all electrodes are securely attached to the patient’s skin.</td>
</tr>
<tr>
<td></td>
<td>• Check that there is no clothing rubbing or pulling on the lead wires or electrodes.</td>
</tr>
<tr>
<td></td>
<td>•</td>
</tr>
<tr>
<td>No ECG is displayed</td>
<td>• Check that “New patient” or “Same Patient” is selected in the Patient Data tab to begin monitoring.</td>
</tr>
<tr>
<td></td>
<td>• Check that transmitter channel matches the window telemetry channel that has been set.</td>
</tr>
<tr>
<td></td>
<td>• Check the telemetry transmitters are not outside the range of the WiFi network</td>
</tr>
<tr>
<td>Parameter values show question marks (??, ??, ???) or dashes (---)</td>
<td>• Check that transmitter is not out of range and is functional.</td>
</tr>
<tr>
<td></td>
<td>• The parameter may be outside of a valid clinical range.</td>
</tr>
<tr>
<td></td>
<td>• The parameter is disabled by the generating process (e.g., monitoring stopped or cardiac arrest).</td>
</tr>
<tr>
<td></td>
<td>• The generating process is not able to generate the parameter because of technical problems.</td>
</tr>
<tr>
<td>Alarm: “Alarm Engine Error” and no ECG waveforms</td>
<td>• Waveform generating device has been turned off or disconnected from the network. Identify the faulty unit(s) and check whether they are functioning properly. Check to see that the network connection is present.</td>
</tr>
<tr>
<td>Faulty Alarms or Arrhythmias</td>
<td>• Check status of the patient.</td>
</tr>
<tr>
<td></td>
<td>• Check that all electrodes are attached.</td>
</tr>
<tr>
<td></td>
<td>• Check the QRS morphology to see if there is a change. If yes, select “Learn…” in the Traces tab and then select <strong>Rhythm Relearn</strong>. Note that selecting “<strong>Relearn + New ST Ref</strong>” will also reset the ST measurement reference.</td>
</tr>
<tr>
<td></td>
<td>• Select Traces to display all 12 ECG leads. Determine best leads for detection, and then select Learn. Change detection lead 1 and/or detection lead 2 to leads that display the best amplitude and then select <strong>Relearn Rhythm</strong>.</td>
</tr>
<tr>
<td></td>
<td>• Alarm thresholds may be set too low during periods of noisy signals.</td>
</tr>
<tr>
<td></td>
<td>• QRS detection can be set to 300 µV when all leads have very low amplitude resulting in frequent false cardiac arrest alarms.</td>
</tr>
</tbody>
</table>
The following table specifically applies to connectivity issues when using the Surveyor monitors:

<table>
<thead>
<tr>
<th>Trouble</th>
<th>Possible cause and solution</th>
</tr>
</thead>
</table>
| **Absent ST segment values**   | - System is in process of learning ST and requires at least 16 normal beats.  
<pre><code>                             | - The patient's rhythm is paced (P) or ventricular (V) or VFIB. ST analysis is not performed on these beats.                                             |
</code></pre>
<p>|                                | - ST analysis is in process of &quot;Relearn&quot;. The clinician has selected the Learn… button or the Relearn + New ST Ref button. An ST Relearn also occurs when there has been a change in the QRS morphology and a new dominant rhythm is learned. |
|                                | - A lead is in fail or both detection leads are in fail or there is radio signal interference. Check lead connections and any possible cause of RF interference.       |
| <strong>Square Waves are showing on the display</strong> | - Check to see if a reduced lead set is being used for monitoring the patient. Unused leads appear as square waves.                               |
|                                | - Lead wires are disconnected. Attach the lead wire to the electrode.                                                                                  |
|                                | - Check to see if the “5 electrode cable” has been selected in the Patient Data window.                                                                |
|                                | - Check to see if a transmitter lead check is in progress.                                                                                             |
|                                | - Check surrounding area for any possible cause of RF interference.                                                                                     |
|                                | - Check to see that the connections between the ECG cable and the transmitter are secure.                                                                |
| <strong>SpO₂ signal is inadequate</strong>  | - Check the SpO₂ sensor to ensure it is correctly positioned according to accompanying instructions.                                                      |
|                                | - SpO₂ sensors are susceptible to high ambient light. Shield the sensor when this could be the cause.                                                   |
|                                | - Excessive motion can affect the SpO₂ signal quality. Check the patient to see if this is the cause.                                                   |
|                                | - Check to see that the connections between the sensor cable and the transmitter are secure.                                                             |
|                                | - Check sensor and cables to ensure there are no cracks or breakage.                                                                               |
| <strong>Faulty SpO₂ Alarms</strong>         | - Check status of the patient.                                                                                                                        |
|                                | - Check that SpO₂ sensor is attached and correctly positioned according to accompanying instructions.                                                |
|                                | - Check that the transmitter is turned on and in range.                                                                                                |
|                                | - Display the plethysmogram waveform to check signal quality.                                                                                         |
|                                | - Compare the SpO₂ pulse rate to the ECG heart rate values. Similar values are a good indication of adequate signal quality.                        |
|                                | - Check SpO₂ alarm threshold settings. Increase or decrease the limits according to patient condition status.                                      |</p>
<table>
<thead>
<tr>
<th>Trouble</th>
<th>Possible cause and solution</th>
</tr>
</thead>
</table>
| **No Data from Monitor**        | • Confirm network connections on both the Surveyor monitor and Surveyor Central  
• Confirm Communication Settings on the Surveyor monitor including assigned network address information, central station name or address as well as port number.  
• Confirm that the proper bed and unit ID has been established  
• Confirm that the Surveyor monitor is actively monitoring a patient and not turned off or in standby mode.                                                                                      |
| **Missing Parameter or Waveforms** | • Confirm that the desired parameters and waveforms are available on the selected Surveyor monitor configuration  
• Confirm that patient cables and sensors are properly attached to the patient and monitor and that the parameter and waveforms are displayed on the Surveyor monitor display  
• Ensure that the Surveyor Central has been properly configured to display the parameters and traces                                                                                                                |
| **Missing ECG Traces**          | • Ensure that the proper ECG lead cable is utilized and enabled. The Surveyor monitor has options for 3 or 5 lead cable, as well as 10-lead ECG. When the 10-lead ECG cable is attached and enabled in the settings, this will be the default source for ECG signals. |
| **Drawing of waveforms sent from an S4 is jittery** | • This may occur when there is a slight difference (less than 1 s) between the time kept on the S4’s internal clock and that of the Surveyor Central. This condition is automatically corrected within 30 min of starting the S4, after which the waveforms should be drawn smoothly. |
Computerized arrhythmia monitoring is a valuable tool in many situations; however, it is important that the user understands its limits so as to optimize performance and minimize false alarms.

Performance can be improved significantly by understanding the limits of the algorithm and its correct use. The most important parameters that affect performance are:

1. Signal quality
2. QRS-amplitude and form
3. T-amplitude and form
4. P-amplitude and form
5. Alarm limits

Welch Allyn’s VERITAS algorithm uses 2 leads for QRS detection; a third lead is used for additional information to improve discrimination between ventricular and supraventricular morphology of the detected QRS. All available leads are used for the measurement of the ST level. Choosing the right detection leads is an important way of improving performance in difficult cases, and in particular for ambulatory patients.

How to Optimize Performance

1. **Optimize signal quality.**

   Poor signal quality is always the most important cause for poor arrhythmia detection and false alarms, in particular for high HR and ventricular runs. There are measures that can be taken to improve signal quality:
   - Skin preparation is very important. Degrease the skin and use skin-prep tools to remove resistive skin layers. Use the impedance measurement tool on the transmitter to check the electrode skin contact.
   - Use good quality electrodes. Store them well in their original closed package and in the specified environmental conditions. Change applied electrodes every 24 hours as applied electrodes will dry out resulting in ECG baseline wander.
   - Choose the right locations on the body to apply electrodes:
     - Do not apply them on muscles and areas that are often touched or handled. Refer to relevant figures in the user manual.
     - Pay particular attention to the LA/L and RA/R electrodes, which can pick up muscle noise from the shoulder or pelvic muscles. The LL/F electrode is also notorious: the best place is on the iliac crest, but sometimes the trouser or waist band can interfere and cause many artifacts. In that case, it may be best to move the position of the LL/F electrode to the lower rib case.
     - It is important to realize that the 12-lead ECG can be significantly altered when the LL/F electrode is applied higher. The inferior part of the heart is not represented well; important ST changes in the inferior leads might be completely missed.
   - Prevent pulling of the wires on the electrodes. Although the LeadForm ECG cable is ergonomically formed, pulling of electrodes can still occur. Position the transmitter properly and use a well-made pouch. When necessary, tape the electrodes or wires.
   - Regularly check the ECG cable and lead wires. Replace any cable that is visibly damaged or stiff. Gently tug on all electrode-wire connections to check any broken wire that might make intermittent contact.
   - If a lead remains particularly noisy, do not choose that lead as a detection lead (see below).

2. **Select the right detection leads.**

   Selecting the right leads for the detection algorithm is always important, but particularly so in patients with wide QRS complexes (bundle branch blocks, hypertrophic hearts, ventricular pacemakers). Wide QRS complexes are more difficult to detect by the algorithm, lower the threshold for false detections of P- and
T-waves, and increase the probability of false ventricular fibrillation calls. The following general rules should be applied when selecting detection leads (in order of decreasing importance):

- Do not choose leads that are very noisy due to poor electrode contact.

- Choose leads with adequate QRS amplitude (it is recommended 1 mV at least, although QRS complexes as low as 0.3 mV are detected). If all leads are of low amplitude causing false cardiac arrest calls, select the leads with the highest amplitude and set the QRS threshold to 0.16 mV.

- Choose leads with a tall R-wave, which is not biphasic or even more irregular. This is particularly important when the QRS complex is wide.

- Do not choose leads with a tall, pointed T-wave. Sometimes it is tempting to choose, for example, V2 or V3 as a detection lead because of the high QRS amplitude; however, these leads also often present a tall T-wave. This might cause double detections and false high HR alarms.

- Do not choose leads with a large or pointed P-wave. Similar to the tall T-waves, these can cause double detections.

- Select the appropriate setting for “Pacemaker present”.

**WARNING:** Always select “Pacemaker present” when the patient has a pacemaker. Failure to do so can result in false QRS detection of the pacemaker spike and prevents the detection of pacemaker malfunction.

- The third lead, or “Confirmation Lead”, is less important for QRS detection. Choose a lead that is anatomically different from the detection leads (for example, if V2 and V4 are chosen as detection leads, do not use V3 as confirmation lead, but choose lead III). The default detection leads are V1 and V5, with Lead II as confirmation lead.

3. **Adjust the alarm thresholds to patient conditions.**

Incorrect alarm threshold settings are a frequent cause of false alarms and lower the attention level to the genuinely important alarms. It is important to choose the right thresholds for a particular patient and condition.

Examples are:

- Increase ST change thresholds for patients with a wide QRS or a pacemaker rhythm. ST levels vary in those conditions and are more difficult to measure.

- Do not choose a high HR limit that is too close to the normal HR of the patient. In particular, for patients with an irregular heart rate (e.g., atrial fibrillation) and for mobile patients the addition of some noisy beats might cause the alarm to occur frequently.

- Increase the minimum run length for the ventricular tachycardia alarm for ambulatory patients with a noisy signal. Noisy beats are easily mistaken for ventricular beats especially when preceded by a false detection. For patients with known short runs, it may not be useful to alarm on all of them as the clinician may become desensitized to the alarms. If you want to review whether the patient has short runs, activate the “Ventricular Run” alarm instead, with a low priority (e.g. white), and use the Review tab to quickly scan through them periodically. This will greatly reduce the number of false high priority alarms and reduce “alarm fatigue”.

18. ALARM DETAILS

This appendix concerns alarm settings for telemetry monitored patients and provides further and more detailed information on system criteria regarding alarms. The table below lists all telemetry monitoring alarms and their principle characteristics. Column definitions are:

**Message**
- The alarm message displayed on the multi-patient screen, listed in alphabetical order

**Group**
- The group to which the alarm belongs as used in the Alarm Settings page and the Review filter settings

**Description**
- Detailed description of the cause of the alarm

**Factory Default Priority**
- Priority set in the factory default alarm profile: Information (white), Low (Cyan), Medium (Yellow) or High (Red)

**Min. Limit**
- Minimum value of possible limit settings, if applicable

**Max. Limit**
- Maximum value of possible limit settings, if applicable

**Factory Default Limit**
- Alarm limit set in the factory default profile

**Delay (s)**
- Delay in seconds after which the alarm is presented. This delay presents the sum of signal filter delays, algorithm detection delays, delays inserted to prevent false alarms and any other processing delays. These values have been measured in reasonable worst-case conditions. Wherever applicable, the measuring methods mentioned in the ANSI/AAMI standard EC 13 have been used.

*Note: Refer to the Surveyor S12/S19 patient monitor user manual for the list of alarms generated by these patient monitors which are bidirectionally communicated and managed by the Surveyor Central.*

<table>
<thead>
<tr>
<th>Message</th>
<th>Group</th>
<th>Description</th>
<th>Factory Default Priority</th>
<th>Range limits (resolution)</th>
<th>Factory Default Limit</th>
<th>Delay (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alarms Engine Error</td>
<td>None</td>
<td>The alarm handler cannot be reached; no alarms will be generated. Cannot be silenced.</td>
<td>Medium</td>
<td></td>
<td></td>
<td>20</td>
</tr>
<tr>
<td>ALARMS OFF</td>
<td>All Alarms Off</td>
<td>All alarms are off or suspended</td>
<td>Information</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Asystole</td>
<td>Electrocardiogram</td>
<td>Cardiac Arrest</td>
<td>High</td>
<td>2 — 8 sec (step 1 sec)</td>
<td>4 sec</td>
<td>Limit+2</td>
</tr>
<tr>
<td>Bigeminy</td>
<td>Extended Arrhythmias</td>
<td>A beat sequence of N, V, N, V, N, V has been detected</td>
<td>Information</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Bradycardia</td>
<td>Electrocardiogram</td>
<td>Heart rate is more than 10 bpm below the Low Heart Rate limit*</td>
<td>High</td>
<td>10 bpm less than Low HR limit</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>Couplet</td>
<td>Extended Arrhythmias</td>
<td>2 successive ventricular beats</td>
<td>Information</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Desaturation (S4)</td>
<td>SpO₂</td>
<td>SpO₂% is 10% below the Low SpO₂ set limit defined by the user</td>
<td>High</td>
<td>10% less than SpO₂ Low limit</td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Dominant Rhythm Change</td>
<td>Extended Arrhythmias</td>
<td>Very low correlation between the current beat and the incoming beats</td>
<td>Information</td>
<td></td>
<td></td>
<td>28</td>
</tr>
<tr>
<td>ECG Leads Off</td>
<td>Technical Alarms</td>
<td>One or more electrode is disconnected</td>
<td>Low</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>ECG Noise</td>
<td>Technical Alarms</td>
<td>ECG detection leads are noisy</td>
<td>Information</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>HD Full, No Storage</td>
<td>Technical Alarms</td>
<td>Data storage is disabled because the hard disk is full</td>
<td>Low</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>High Couplet Rate</td>
<td>Extended Arrhythmias</td>
<td>The number of ventricular couplets has reach the beat per minute limit</td>
<td>Information</td>
<td>2 — 30 bpm (step 2 bpm)</td>
<td>4 bpm</td>
<td>4</td>
</tr>
<tr>
<td>Message</td>
<td>Group</td>
<td>Description</td>
<td>Factory Default Priority</td>
<td>Range limits (resolution)</td>
<td>Factory Default Limit</td>
<td>Delay (s)</td>
</tr>
<tr>
<td>-------------------------</td>
<td>----------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>--------------------------</td>
<td>--------------------------</td>
<td>-----------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>High Ectopic Rate</td>
<td>Extended Arrhythmias</td>
<td>Ventricular beats are above the beat per minute limit. Ectopic rate is not calculated during ventricular rhythm and ventricular fibrillation</td>
<td>Information</td>
<td>2 — 50 bpm (step 2 bpm)</td>
<td>10 bpm</td>
<td>3</td>
</tr>
<tr>
<td>High Failure Rate</td>
<td>Extended Arrhythmias</td>
<td>Pacemaker output failures have reached the limit</td>
<td>Information</td>
<td>2 — 30 bpm (step 2 bpm)</td>
<td>4 bpm</td>
<td>5</td>
</tr>
<tr>
<td>High Heart Rate</td>
<td>Electrocardiogram</td>
<td>Heart rate is above the maximum limit</td>
<td>Medium</td>
<td>50 — 250 bpm (step 1 bpm)</td>
<td>120 bpm</td>
<td>10</td>
</tr>
<tr>
<td>High Non-Capture Rate</td>
<td>Extended Arrhythmias</td>
<td>Pacemaker non-capture rate has exceeded the limit</td>
<td>Information</td>
<td>2 — 30 bpm (step 2 bpm)</td>
<td>4 bpm</td>
<td>5</td>
</tr>
<tr>
<td>High Pause Rate</td>
<td>Extended Arrhythmias</td>
<td>Missing QRS complexes have reached the limit</td>
<td>Information</td>
<td>2 — 30 bpm (step 2 bpm)</td>
<td>4 bpm</td>
<td>4</td>
</tr>
<tr>
<td>High R-on-T Rate</td>
<td>Extended Arrhythmias</td>
<td>The number of ventricular R-on-T beats have reached the limit</td>
<td>Information</td>
<td>2 — 50 bpm (step 2 bpm)</td>
<td>2 bpm</td>
<td>3</td>
</tr>
<tr>
<td>HR Not Available</td>
<td>Technical Alarms</td>
<td>Heart rate is not received by the system for a period of time</td>
<td>Medium</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>Impedance Test</td>
<td>Technical Alarms</td>
<td>Transmitter impedance check is in progress</td>
<td>Information</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Invalid Channel</td>
<td>Technical Alarms</td>
<td>Telemetry channel setting is incompatible</td>
<td>Low</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Irregular Rhythm</td>
<td>Extended Arrhythmias</td>
<td>The rhythm of the ECG is irregular for more than a minute</td>
<td>Information</td>
<td></td>
<td></td>
<td>23</td>
</tr>
<tr>
<td>Low Battery</td>
<td>Technical Alarms</td>
<td>The transmitter battery is low</td>
<td>Information</td>
<td></td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>Low Heart Rate</td>
<td>Electrocardiogram</td>
<td>Heart rate is below the minimum limit</td>
<td>Medium</td>
<td>20 — 150 bpm (step 1 bpm)</td>
<td>50 bpm</td>
<td>10</td>
</tr>
<tr>
<td>Low QRS Voltage</td>
<td>Extended Arrhythmias</td>
<td>QRS voltage is below 1.5 times that of the detection threshold</td>
<td>Information</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Low Storage, Deleting...</td>
<td>Technical Alarms</td>
<td>No storage is available, system is deleting old stopped sessions</td>
<td>Low</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Low System Battery</td>
<td>Technical Alarms</td>
<td>The system battery is low and the node is shutting down (UPS related)</td>
<td>Information</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Missing QRS</td>
<td>Extended Arrhythmias</td>
<td>R-R interval is greater than or equal to 180% of the average R-R interval</td>
<td>Information</td>
<td></td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Multifocal Ectopics</td>
<td>Extended Arrhythmias</td>
<td>Ventricular beats with different morphologies have been detected within the last “limit” beats</td>
<td>Information</td>
<td>3 — 31 bpm (step 1 bpm)</td>
<td>15 bpm</td>
<td>3</td>
</tr>
<tr>
<td>New ST Reference</td>
<td>ST Change</td>
<td>A new ST reference has been set</td>
<td>Information</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>No AC Power</td>
<td>Technical Alarms</td>
<td>System is running on battery power (UPS related)</td>
<td>Information</td>
<td></td>
<td></td>
<td>6</td>
</tr>
<tr>
<td>No ECG Monitoring</td>
<td>Technical Alarms</td>
<td>Valid ECG signal has not been detected for a period of time</td>
<td>Medium</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>No Radio Signal</td>
<td>Technical Alarms</td>
<td>The transmitter is out of range or switched off</td>
<td>Information</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Pacemaker Non-Capture</td>
<td>Extended Arrhythmias</td>
<td>No QRS complex is detected within 300 ms after a pacemaker spike</td>
<td>Information</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Pacemaker Output Failure</td>
<td>Extended Arrhythmias</td>
<td>No QRS complex or Paced beat has been detected for the time equivalent to the set pacemaker rate</td>
<td>Information</td>
<td></td>
<td></td>
<td>5</td>
</tr>
<tr>
<td>Message</td>
<td>Group</td>
<td>Description</td>
<td>Factory Default Priority</td>
<td>Range limits (resolution)</td>
<td>Factory Default Limit</td>
<td>Delay (s)</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>--------------------------</td>
<td>---------------------------</td>
<td>-----------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Patient Call</td>
<td>Technical Alarms</td>
<td>A transmitter button has been pressed</td>
<td>Information</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Printer Error</td>
<td>Technical Alarms</td>
<td>The network printer is in error (e.g. out of paper)</td>
<td>Low</td>
<td></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Printer Offline</td>
<td>Technical Alarms</td>
<td>The network printer is off line</td>
<td>Low</td>
<td></td>
<td></td>
<td>16</td>
</tr>
<tr>
<td>Protocol Aborted</td>
<td>Protocol Events</td>
<td>The protocol has been cancelled</td>
<td>Information</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Protocol Completed</td>
<td>Protocol Events</td>
<td>The protocol has completed</td>
<td>Information</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>(Protocol Event)</td>
<td>Protocol Events</td>
<td>User customized message indicating an event for the Protocol in progress</td>
<td>Low</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>(Protocol Phase) End</td>
<td>Protocol Events</td>
<td>The last event from the in progress protocol phase; latching alarm</td>
<td>Low</td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Pulse Rate High (S4)</td>
<td>SpO2</td>
<td>Pulse rate is above the maximum limit</td>
<td>Low</td>
<td>50 — 250 bpm</td>
<td>120 bpm</td>
<td>23</td>
</tr>
<tr>
<td>Pulse Rate Low (S4)</td>
<td>SpO2</td>
<td>Pulse rate is below the minimum limit</td>
<td>Low</td>
<td>20 — 100 bpm</td>
<td>50 bpm</td>
<td>23</td>
</tr>
<tr>
<td>QTc High</td>
<td>Resting ECG</td>
<td>QTc (Welch Allyn correction) above limit</td>
<td>Low</td>
<td>300 — 600 ms</td>
<td>500 ms</td>
<td>70</td>
</tr>
<tr>
<td>QTc-Bazett High</td>
<td>Resting ECG</td>
<td>QTc (Bazett correction) above limit</td>
<td>Low</td>
<td>300 — 600 ms</td>
<td>500 ms</td>
<td>70</td>
</tr>
<tr>
<td>QTc-Fridericia High</td>
<td>Resting ECG</td>
<td>QTc (Fridericia correction) above limit</td>
<td>Low</td>
<td>300 — 600 ms</td>
<td>500 ms</td>
<td>70</td>
</tr>
<tr>
<td>Radio Interference</td>
<td>Technical Alarms</td>
<td>The telemetry receiver is receiving signals from another source</td>
<td>Information</td>
<td></td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Receiver Error</td>
<td>Technical Alarms</td>
<td>Receiver initialization failed (presents a number from 1 to 6 for service)</td>
<td>Low</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Repairing Database</td>
<td>Technical Alarms</td>
<td>Database is corrupt and is being repaired. No storage during repair.</td>
<td>Low</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Rest ECG Taken</td>
<td>Resting ECG</td>
<td>A Resting ECG has been taken</td>
<td>Information</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Rhythm Relearn</td>
<td>Electrocardiogram</td>
<td>The system is learning the rhythm type (dominant QRS type)</td>
<td>Information</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>R-on-T Beat</td>
<td>Extended Arrhythmias</td>
<td>Detected Ventricular beats occur earlier than half of the previous R-R interval</td>
<td>Information</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>SpO2 Check Sensor (S4 only)</td>
<td>Technical Alarms</td>
<td>The probe is no longer applied to the patient.</td>
<td>Low</td>
<td></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>SpO2 Communication Error</td>
<td>Technical Alarms</td>
<td>A technical fault has been detected in the S4.</td>
<td>Low</td>
<td></td>
<td></td>
<td>40</td>
</tr>
<tr>
<td>SpO2 High (S4)</td>
<td>SpO2</td>
<td>% SpO2 is above the set limit</td>
<td>Medium</td>
<td>52 — 100% (step 1%)</td>
<td>100%</td>
<td>18</td>
</tr>
<tr>
<td>SpO2 Low (S4)</td>
<td>SpO2</td>
<td>% SpO2 is below the set limit</td>
<td>Medium</td>
<td>50 — 98% (step 1%)</td>
<td>90%</td>
<td>18</td>
</tr>
<tr>
<td>SpO2 Low Quality</td>
<td>Technical Alarms</td>
<td>The SpO2 signal is weak or noisy.</td>
<td>Information (from S4) Low (other devices)</td>
<td></td>
<td></td>
<td>10</td>
</tr>
<tr>
<td>SpO2 Noise</td>
<td>Technical Alarms</td>
<td>The SpO2 signal is degraded by noise and/or motion artifact, so that % SpO2 and PR cannot be calculated.</td>
<td>Low</td>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Message</td>
<td>Group</td>
<td>Description</td>
<td>Factory Default Priority</td>
<td>Range limits (resolution)</td>
<td>Factory Default Limit</td>
<td>Delay (s)</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>--------------------------</td>
<td>---------------------------</td>
<td>-----------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>SpO2 Not Available</td>
<td>Technical Alarms</td>
<td>No valid SpO2 signal is available and there is no probe fault detected; probe may not be applied to the patient</td>
<td>Low</td>
<td></td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>SpO2 Pulse Search</td>
<td>Technical Alarms</td>
<td>Searching for valid SpO2 signal</td>
<td>Information</td>
<td></td>
<td></td>
<td>11</td>
</tr>
<tr>
<td>SpO2 No Sensor</td>
<td>Technical Alarms</td>
<td>SpO2 sensor has been detached from the monitor/transmitter</td>
<td>Low</td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NOTE: When used with the S4, acknowledging this alarm suspends SpO2 monitoring.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SpO2 Sensor Error</td>
<td>Technical Alarms</td>
<td>A technical fault in the sensor has been detected.</td>
<td>Low</td>
<td></td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>ST Decrease</td>
<td>ST Change</td>
<td>ST decrease with respect to the ST reference level above the limit in one lead or greater than 70% of the limit in more than one lead simultaneously</td>
<td>Medium</td>
<td>1.0 ― 9.0 mm (step 0.5 mm)</td>
<td>2.0 mm</td>
<td>80</td>
</tr>
<tr>
<td>ST Increase</td>
<td>ST Change</td>
<td>ST increase with respect to the ST reference level above the limit in one lead or greater than 70% of the limit in more than one lead simultaneously</td>
<td>Medium</td>
<td>1.0 ― 9.0 mm (step 0.5 mm)</td>
<td>2.0 mm</td>
<td>80</td>
</tr>
<tr>
<td>ST Relearn</td>
<td>ST Change</td>
<td>The system is initializing the ST level measurement</td>
<td>Information</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Storage Disabled</td>
<td>Technical Alarms</td>
<td>Data storage is disabled because the storage system is unavailable</td>
<td>Low</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Storage Space &lt;24 hr</td>
<td>Technical Alarms</td>
<td>Less than 24 hours of storage space is available on the storage disk</td>
<td>Low</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Sustained VTACH</td>
<td>Ventricular Tachycardia</td>
<td>Sustained Ventricular Tachycardia with a duration of more than 15 sec</td>
<td>High</td>
<td>15 sec</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Synchronizing Clock</td>
<td>Technical Alarms</td>
<td>The local clock is not in synch with the time server and the system is synchronizing</td>
<td>Information</td>
<td></td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>Tachycardia</td>
<td>Electrocardiogram</td>
<td>Heart rate is more than 30 bpm above the High Heart Rate limit</td>
<td>High</td>
<td>30 bpm more than High HR limit</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Trigeminy</td>
<td>Extended Arrhythmias</td>
<td>A beat sequence of N, N, V, N, N, V, N, N, V has been detected</td>
<td>Information</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Ventricular Rhythm</td>
<td>Extended Arrhythmias</td>
<td>3 or more successive ventricular beats with rate below the VTACH rate limit and no VTACH alarm</td>
<td>Information</td>
<td></td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Ventricular Run</td>
<td>Extended Arrhythmias</td>
<td>3 or more successive ventricular beats with rate above the VTACH rate limit have been detected and no VTACH alarm Note: If the total run is less than VRUNLENGTH beats it will not be reported until it ends. Information</td>
<td>VTACH length beats + 2 s</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VFIB</td>
<td>Electrocardiogram</td>
<td>Ventricular Fibrillation</td>
<td>High</td>
<td></td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>VTACH</td>
<td>Ventricular Tachycardia</td>
<td>Ventricular Tachycardia with a duration of more than the number of beats limit and above the rate limit.</td>
<td>Medium</td>
<td>3 ― 100 beats (step 1 beat)</td>
<td>10 beats,</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100 ― 200 bpm (step 1 bpm)</td>
<td>120 bpm</td>
<td></td>
</tr>
</tbody>
</table>
19. TELEMETRY MONITORING PRINTOUT EXAMPLES

12-lead ECG with Interpretation, 4×3+1 Format with Grid
12-lead ECG with Interpretation, 4×3+3 Format with Grid
Gray
Roland
ID#: 148392
5/19/1943
Gender: Male
54 yr

01/14/2008 14:59:10

Note: Limb leads might have been placed on torso

<table>
<thead>
<tr>
<th>Lead</th>
<th>0.2s</th>
<th>Amplitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aVR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aVL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>aVF</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>V2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Vent rate: 72
PR int: 121
QRS Dur.: 79
QT/QTc: 427/481
QTc Bazett: 465
QTc Fridericia: 454
P-R-T axes: 29 85 76
Avg RR: 826

ECG: 10 mm/mV, 25 mm/s, Site#0, Tele 3 [0.05 - 150]
12-lead ECG without Interpretation, 6x2 Format with Grid
Single lead ECG, no grid
Rhythm (user-defined leads and parameters) with Grid
ST Report: 20 seconds of current ECG, Averaged ST of current ECG compared to reference ECG, ST trend for 3 hours, HR, and Ectopy
TELEMERTY MONITORING PRINTOUT EXAMPLES

Page 104

Trend - Page 1: ST change, HR, and Ectopy

ST @60ms (mm)

<table>
<thead>
<tr>
<th></th>
<th>Δ</th>
<th></th>
<th>Δ</th>
<th></th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>-2.0</td>
<td>-1.9</td>
<td>aVR</td>
<td>2.5</td>
<td>2.4</td>
</tr>
<tr>
<td>II</td>
<td>-2.9</td>
<td>-2.9</td>
<td>aVL</td>
<td>-0.6</td>
<td>-0.5</td>
</tr>
<tr>
<td>III</td>
<td>-0.9</td>
<td>-0.9</td>
<td>aVF</td>
<td>-1.9</td>
<td>-1.9</td>
</tr>
</tbody>
</table>

ST Reference time: 23:40:23

HR(VF6) 60(0)
QTc QTcE QTcF 380.338 388 368

Patterson Michael
ID: 506025
10/15/1943
Gender: Male
63 yr

11/09/2006 09:30:42

104
Example of Trend - Page 2: ST change, HR, Ectopy, Intervals, QT and QTc

(Note: Page 2 trends are user selected)

ST @ 60ms (mm)

<table>
<thead>
<tr>
<th></th>
<th>Δ</th>
<th>Δ</th>
<th>Δ</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>-2.0</td>
<td>-1.9</td>
<td>aVR</td>
<td>2.5</td>
</tr>
<tr>
<td>II</td>
<td>-2.9</td>
<td>-2.9</td>
<td>aVL</td>
<td>-0.6</td>
</tr>
<tr>
<td>III</td>
<td>-0.9</td>
<td>-0.9</td>
<td>aVF</td>
<td>-1.9</td>
</tr>
</tbody>
</table>

ST Reference time: 23:40:23

Patterson
Michael
ID#: 586925
10/15/1943
Gender: Male

63 yr

11/09/2006 09:30:42

HR (VFB): 60 (0)
QTc: 386/388 @ HR80
QTcE: 386/388 @ HR80
QTcF: 386/388 @ HR80

PR (ms)

QRS (ms)

QT (ms)

QTc (ms)

QTcB (ms)

QTcF (ms)

HR (ms)
Review Screen Print, sample 1: 180 seconds of leads II, III, V1, and V5

ST @60ms (mm)

<table>
<thead>
<tr>
<th>Lead</th>
<th>Δ</th>
<th>aVR</th>
<th>Δ</th>
<th>aVL</th>
<th>Δ</th>
<th>aVF</th>
<th>Δ</th>
<th>aVR</th>
<th>Δ</th>
<th>aVL</th>
<th>Δ</th>
<th>aVF</th>
<th>Δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>0.1</td>
<td>0.0</td>
<td>aVR</td>
<td>0.0</td>
<td>aVL</td>
<td>0.0</td>
<td>aVF</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II</td>
<td>0.0</td>
<td>0.0</td>
<td>aVR</td>
<td>0.0</td>
<td>aVL</td>
<td>0.0</td>
<td>aVF</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>0.0</td>
<td>0.0</td>
<td>aVR</td>
<td>0.0</td>
<td>aVL</td>
<td>0.0</td>
<td>aVF</td>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ST Reference time: 11:15:44

Ventricular Run: 13:36:46 11/05/2006
St. Mary's Hospital
ECG: 4 mm/mV, 10 mm/s, Site: 0, Bed: (1,4), [0.05 - 150]
Review Screen Print, sample 2: 780 seconds of lead II only
Review Screen Print; sample 3: 12-Lead ECG at 10 mm/s
Automatic Protocol Printout

12-lead ECG with Interpretation: 4×3+1 Format with Grid (Time Point #2)
## End of Shift Report

**06/19/2016 14:10:15**

**SUMMARY REPORT**

<table>
<thead>
<tr>
<th>Patient: Site#0, Bed#8: (2,0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Report start time: 06/19/2016 10:10:15 to 14:10:15</td>
</tr>
<tr>
<td>Report duration: 4 hours</td>
</tr>
</tbody>
</table>

### OVERVIEW

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR Avg[min:max]</td>
<td>70 [41:94] (bpm)</td>
</tr>
<tr>
<td>VTb Rate Avg[min:max]</td>
<td>0 [0:0] (bpm)</td>
</tr>
<tr>
<td>QTc Linear Avg[min:max]</td>
<td>388 [379:411] @HR70</td>
</tr>
<tr>
<td>QTc Bazett Avg[min:max]</td>
<td>399 [379:448]</td>
</tr>
<tr>
<td>QTc Fridericia Avg[min:max]</td>
<td>390 [379:417]</td>
</tr>
<tr>
<td>Oxygen Saturation Avg[min:max]</td>
<td>96 [82:99] (%)</td>
</tr>
<tr>
<td>Pulse Rate Avg[min:max]</td>
<td>71 [36:94] (bpm)</td>
</tr>
</tbody>
</table>

### ALARMS LIST

<table>
<thead>
<tr>
<th>DATE</th>
<th>START</th>
<th>END</th>
<th>ALARM MESSAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>06/19/2016</td>
<td>14:06:52</td>
<td>00:00:00</td>
<td>SpO2 &lt; 90</td>
</tr>
<tr>
<td>06/19/2016</td>
<td>11:52:09</td>
<td>11:52:33</td>
<td>Heart Rate &lt; 50 bpr</td>
</tr>
<tr>
<td>06/19/2016</td>
<td>11:39:50</td>
<td>11:40:14</td>
<td>Heart Rate &lt; 50 bpr</td>
</tr>
<tr>
<td>06/19/2016</td>
<td>10:56:18</td>
<td>10:56:44</td>
<td>SpO2 &lt; 90</td>
</tr>
</tbody>
</table>

Mortara Instrument Inc. Site#0, Bed#8: (2,0)
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<th>QT Interval (ms)</th>
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20. TECHNICAL SPECIFICATIONS

Applied standards

Workstations, printer, monitor

UL-listed, Comply with FCC part 15, class B,
CE-labeled according to EU directives 73/23 (Low Voltage) and 89/336 (Electromagnetic Compatibility)

System

IEC 60601-1:2005 Ed:3 Medical electrical equipment Part 1: General requirements for basic safety and essential performance

European Union: CENELEC EN60601-1:2006 Medical Electrical Equipment Part 1: General Requirements for Basic Safety and Essential Performance

USA: AAMI ES60601-1:2005 Medical electrical equipment Part 1: General Requirements for Basic Safety and Essential Performance

Canada: CSA C22.2#60601-1:2008 Ed:3 Medical Electrical Equipment – Part 1: General requirements for basic Safety and essential performance


IEC 60601-1-8:2012-1 Edition 2.1, Medical Electrical Equipment – Part 1-8: General Requirements for Safety and Essential Performance – Collateral Standard: General requirements, tests, and guidance for alarm systems in medical electrical equipment and medical electrical systems

IEC 60601-2-49 Edition 2.0: 2011, Medical Electrical Equipment, Part 2-49: Particular requirements for the safety of multi-function monitoring equipment (only applicable items relating to distributed alarm systems)


ANSI/AAMI EC57:2012 -- Testing and reporting performance results of cardiac rhythm and ST segment measurement algorithms

ANSI/AAMI EC38:1998 (only applicable items relating to ST monitoring and reporting)


Part 11 of Title 21 of the USA Code of Federal Regulations; Electronic Records; Electronic Signatures (21 CFR Part 11). (applicable only where electronic records such as 12-lead resting ECG’s are produced).
ISO 9919:2005, Medical electrical equipment – Particular requirements for the basic safety and essential performance of pulse oximeter equipment for medical use (2nd Edition). – (only relates to T12S transmitter)


EN 980:2008 Symbols for use in the labeling of medical devices

EN 1041:1998 Information supplied by the manufacturer of medical devices

Standards for Privacy of Individually Identifiable Health Information (“Privacy Rule”) as defined per Health Insurance Portability and Accountability Act (“HIPAA”) of 1996 (amended through August 2002) per the United States 45 CFR Part 160 and Subparts A and E of Part 164,

IEC 80001-1 Edition 1.0 2010-10 Application of risk management for IT networks incorporating medical devices

Part 1: Roles, responsibilities and activities.


Part 2-2: Guidance for the disclosure and communication of medical device security needs, risks and controls.


**Specifications**

**System**

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<th>Mode of Operation</th>
<th>Continuous</th>
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*NOTE: Refer to the Surveyor S12/S19 patient monitor user manual, part number 9515-183-51-ENG, for the specification of its parameters communicated to and managed by the Surveyor Central including associated ranges and accuracy.*

**ECG**

<table>
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<tr>
<th>ECG acquisition:</th>
<th>10-wire (12-lead): I, II, III, aVR, aVL, aVF, V1, V2, V3, V4, V5, V6 5-wire (7-lead): I, II, III, aVR, aVL, aVF, V 3-wire (1-lead): I, II or III</th>
</tr>
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<tbody>
<tr>
<td>Acquisition:</td>
<td>40,000 s/s (Surveyor S4) for pacemaker detection, reduced to 500 samples/s</td>
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<tr>
<td>Resolution:</td>
<td>2.5 µV.</td>
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<td>Dynamic range/offset tolerance:</td>
<td>±340 mV</td>
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<td>Input dynamic:</td>
<td>680 mV.</td>
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<td>Common Mode Rejection Ratio:</td>
<td>100 dB, up to 180 dB with digital filter at 50 or 60 Hz (ANSII/AAMI EC 13)</td>
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<td>Frequency response:</td>
<td>Diagnostic ECG-standard IEC 60601-2-25 and ECG monitoring standard IEC 60601-2-27</td>
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<tr>
<td>Input impedance:</td>
<td>200 MΩ (Surveyor S4)</td>
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<td>Defibrillator protection:</td>
<td>Only when used with Welch Allyn ECG cables</td>
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<tr>
<td>Beat detection:</td>
<td>Sensitivity 99.90%, positive predictivity 99.88% (AHA/MIT database)</td>
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<td>Beat recognition:</td>
<td>Normal, ventricular, paced, unknown</td>
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### Heart rate measurement:
- **Range:** 30-300 bpm; **Resolution:** 1 bpm
- **Measurement error (RMS) as measured according to ANSI/AAMI EC57:** 2.8% AHA database, 1.7% MIT database

### HR Averaging
- 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.

### ST level measurement:
- **Range:** -2500 to +2500 µV (-25 to +25 mm)
- **Resolution:** 10 µV (0.1 mm)
- **Measurement error:** Mean 8.5 µV, Standard Deviation 66 µV as measured according to ANSI/AAMI EC57 on the ESC-ST database

### Alarms

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<th>Number Alarms level</th>
<th>4 (high, medium, low, and information only)</th>
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<td>Visual alarm presentation</td>
<td>Color-coded text message by priority (red, yellow, cyan, white)</td>
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<td>Blinking, for active alarm</td>
<td>Stationary when alarm condition still present but silenced by operator</td>
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<tr>
<td>Audible alarm sound pressure level</td>
<td>Internal speaker 5 volume settings</td>
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<td>SPL ranges (measured according to IEC 60601-1-8 :2012):</td>
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<tr>
<td>HP Z240 Workstation</td>
<td>High priority alarms: 44.6 dBA to 73.6 dBA</td>
</tr>
<tr>
<td>Medium priority alarms: 44.5 dBA to 71.5 dBA</td>
<td></td>
</tr>
</tbody>
</table>

### Alarms groups

| Electrocardiogram: | Arrest: ..............................High priority, limits 2-8 seconds |
| Heart Rate: | VFIB:................................High priority |
| Bradycardia: | Medium/Low priority, low HR – 10 bpm |
| Low Heart Rate: | Medium priority, limit 20-100 bpm |
| High heart rate: | Medium priority, limit 50-250 bpm |
| Tachycardia: | High/Medium/Low priority, high heart rate + 30 bpm |

| Ventricular Tachycardia: | VTACH: ..............................High priority, 3 – 20 beat run length (user selectable), 100 – 200 beats/min (user selectable) |
| Sustained VTACH: | High priority, > 15 second duration |

| ST Change: | ST Increase: ..........................Medium/Low priority |
| ST Decrease: | Medium/Low priority |
| User-selectable limits 100-900µV (1 – 9 mm) change |
| User-selectable ST delay, post J-point (10-200 ms) |

| Extended Arrhythmias for telemetry patient monitoring: | Medium, low, On or Off (user selectable) |
| Trigeminy, Bigeminy, High Ectopic Rate, R-on-T Rate, High R-on-T Rate, Multifocal Ectopies, Couplet, High Couplet Rate, Ventricular Run, Ventricular Rhythm, Dominant Rhythm Change, Missing QRS, High Pause Rate, Irregular Rhythm, Low QRS Voltage, Pacemaker Output Failure, High Output Failure Rate, Pacemaker Non-Capture, High Non-Capture Rate |

| Extended Arrhythmias for S12/S19 patient monitoring: | Medium, low, or information only/On or Off (user selectable) |
| Ventricular Run, Ventricular Rhythm, Couplet, High Ectopic Rate, Bigeminy, Missing QRS, Irregular Rhythm, Pacemaker Non-Capture |

| Resting ECG for telemetry monitoring: (optional - requires 12-lead Interpretation) | Low or information only priority/On or Off (user selectable) |
| QTc High: | 300-600 ms |
| QTc-Bazett High: | 300-600 ms |
| QTc-Fridericia High: | 300-600 ms |
## Technical Specifications

### Telemetry SpO₂:
- **(optional - requires T12S)**
- **Medium/On or Off (user selectable)**
  - SpO₂ Low: Medium priority, 50-98% saturation
  - Desaturation: High priority, 10% below SpO₂ low limit
  - Pulse rate low: Medium or Low priority, 20-100 pulse rate
  - Pulse rate high: Medium or Low priority, 50-250 pulse rate

### Technical Alarms – General
- Printer error (low priority)
- No AC Power (low priority)
- Printer off-line (low priority)
- Storage space < 24hr (low priority)
- Deleting old sessions (low priority)
- Hard disk full (low priority)
- Storage system unreachable (low priority)
- Repairing database (low priority)

### Technical Alarms for telemetry
- ECG Lead Off (low/information only priority)
- ECG Noise (low/information only priority)
- Patient Call (medium/low/information only priority)
- No Radio Signal (low/information only priority)
- Radio Interference (low/information only priority)
- Battery Low (information only)
- Electrode impedance test (information only)
- 12-lead ECG taken (information only)
- Synchronizing clocks (information only)
- System battery power low (information only)
- No Heart rate (medium information)
- ECG monitoring disabled (medium priority)
- Alarm engine fault (medium priority)
### Technical Alarms for patient monitoring

- Network Connection Lost (low priority)
- SpO2 Hardware Failure (low priority)
- SpO2 Unplugged (low priority)
- SpO2 Artifact (low priority)
- NIBP Artifact (low priority)
- NIBP Blocked Line (medium priority)
- NIBP Open Line (low priority)
- NIBP Timeout on Measurement (low priority)
- NIBP Measurement Failure (low priority)
- Temperature Unplugged (low priority)
- Temperature Too High (low priority)
- Temperature Hardware Failure (low priority)
- Respiration Leads Off (low priority)
- Respiration Artifact (low priority)
- Respiration Too High (low priority)
- CO2 Hardware Failure (low priority)
- CO2 Unplugged (low priority)
- CO2 Occluded Line (low priority)
- CO2 Too High (low priority)
- FICO2 Too High (low priority)
- Pressure Unplugged (low priority)
- Pressure Hardware Failure (low priority)
- Pressure Needs Calibration (low priority)
- Pressure Needs Zero (low priority)
- Pressure Artifact (low priority)
- Pressure Too Low (low priority)
- Pressure Pulse Rate Too Low (low priority)
- Pressure Too High (low priority)
- Pressure Weak Signal (low priority)
- Arrhythmia Disabled (low priority)
- Check Leads (low priority)
- Heart Rate Artifact (low priority)
- Monitor Low Battery (low priority)
- Art Line Open (high priority)

### Protocol events:

- Information only:
  - Protocol completed, Protocol aborted

- Medium, low or information only/On or Off (user selectable):
  - Step change, Phase change (user-selectable texts)

### ALARMS OFF:

- Information only with audible reminder (user selectable)

### Storage

<table>
<thead>
<tr>
<th>Period</th>
<th>Approximately up to 1200 days with redundant server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Continuous</td>
<td>12-lead ECG at 500 Samples/s @ 2.5 μV LSB (optional)</td>
</tr>
<tr>
<td>12 lead average waveform:</td>
<td>every 5 s:  500 Samples/s @ 2.5 μV LSB (optional)</td>
</tr>
<tr>
<td>Trends:</td>
<td>Heart rate, Ventricular rate, R-on-T rate, Couplet rate, Pause rate, Pacemaker Non-capture and Output Failure rates, PR-interval, QRS duration, QT interval QTc interval (Bazett + Fridericia), SpO2, ST</td>
</tr>
<tr>
<td>Alarms:</td>
<td>Physiological alarms, clinical alarms, protocol events, 12-lead ECG printout events</td>
</tr>
<tr>
<td>RR-intervals:</td>
<td>2 ms resolution</td>
</tr>
</tbody>
</table>

### Configuration

<table>
<thead>
<tr>
<th>Storage Configurations:</th>
<th>1) Storage on local workstation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2) Storage on redundant (RAID1+0) server</td>
</tr>
</tbody>
</table>
Component Configurations:
1) Receiving workstation with support for up to 16 channels
2) Control workstation with support for up to 48 channels
3) Control and receive on one workstation
4) Control, receive, and storage on one workstation
5) Storage on redundant (RAID1+0) network server

Maximum number of telemetry channels per system:
Up to 128 channels per Surveyor Central system (more than one Surveyor Central system is required above 64 patients).

NOTE: Surveyor Central components are designed to share an independent physical network. Connection to an external network is through an optional VPN security router.

Network

Digital local area network: IEEE 802.3, 100 Base T
Network protocol: IP
Data exchange protocol: UDP and TCP
Distance Switch-station: Max 100 m
Cable: 8 wire twisted pair Cat 5
Connectors: RJ-45
Router Firewall support: ICSA Firewall, ICSA VPN, EAL4, 240 Mb/s throughput
Router VPN support: VPN server, 40 Mb/s throughput
Router ports: 4 RJ-45 internal, 100 Base-T
1 RJ-45 external, 100 Base-T
Router IP addressing: Fixed or DHCP

Size

Central Workstation: 45 × 18 × 46 cm (18 × 7 × 18 inches) cables overall ≈ 10 cm (4 inches)
Redundant Network Server: 46 × 22 × 74 cm (18.2 × 8.6 × 29.2 inches)
Monitor: 56 × 28 × 38 to 49 cm (22 × 11 × 15 to 19 inches) unpacked with stand
Printer 40 × 45 × 42 cm (16 × 18 × 17 inches)
Keyboard: 46 × 4 × 17 cm (18 × 1.5 × 6.7 inches)
Mouse: 13 × 6.4 × 3.8 cm (5 × 2.5 × 1.5 inches)

Weight

Central Workstation: 11 kg (24 lbs.)
Redundant Network Server: 52 Kg (115 lbs.) Maximum (Fully Loaded Configuration)
Monitor: 6.8 Kg (15lbs.)
Printer 23.6 Kg (52 lbs.)
Keyboard: 1 Kg (2.2 lbs.)
Mouse: 128 grams (4.5 oz.)

Screen

Resolution with possible and recommended maximum number of monitoring slots per display:
19 “Single Display 1280×1024 dots: 16 slots possible/ 8 slots recommended
24 “Single Display 1920×1200 dots: 24 slots possible/ 16 slots recommended
19” Dual Display 1280×1024 dots: 32 slots possible/ 16 slots recommended
24” Dual Display 1920×1200 dots:48 slots possible/ 32 slots recommended
**Traces per Patient:**
Up to 12 on single-patient window, up to 2 on multiple-patient window

**Parameters per Patient:**
Up to 20 (user selectable)

**Sweep traces:**
10 or 25 mm/sec

**ECG sensitivity:**
5, 10, 20 or 40 mm/mV

**Size:**
19” or 24” LCD in single or dual display modes

---

**Printer**

<table>
<thead>
<tr>
<th>Technology:</th>
<th>Black and white laser jet, networked</th>
</tr>
</thead>
<tbody>
<tr>
<td>Printout types:</td>
<td>Rhythm, 12-lead ECG, ST report, Trends, End-of-Shift Report</td>
</tr>
<tr>
<td>12-lead ECG formats:</td>
<td>6x2, 3x4+1, 3x4+1+P, 3x4+3 @ 25 or 50 mm/s</td>
</tr>
<tr>
<td>Rhythm speeds:</td>
<td>5, 10, 25, 50 mm/s</td>
</tr>
<tr>
<td>Paper types:</td>
<td>A4 and Letter</td>
</tr>
<tr>
<td>Resolution:</td>
<td>1200 × 1200 dpi</td>
</tr>
<tr>
<td>Print speed:</td>
<td>55 ppm max</td>
</tr>
</tbody>
</table>

---

**Electrical characteristics**

<table>
<thead>
<tr>
<th>Uninterrupted Power Supply:</th>
<th>Recommended for each workstation and server location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>HP Z240 Workstation: 280 W</td>
</tr>
<tr>
<td></td>
<td>HPE ML350P Gen 9 Server: 500 W</td>
</tr>
<tr>
<td></td>
<td>(2) 24” LCD Displays: 44 W</td>
</tr>
<tr>
<td></td>
<td>USB Watchdog: 10 W</td>
</tr>
<tr>
<td></td>
<td>Router: 15 W</td>
</tr>
</tbody>
</table>

**Workstation UPS:**
Required UPS USB HID (Human Interface device) compliant. Recommended specifications: UPS rated for 500 VA (or greater) and with a runtime of at least 10 minutes at a 420 W or 465 VA load.

**Server UPS:**
Required UPS USB HID (Human Interface device) compliant. Recommended specifications: UPS rated for 800 VA (or greater) and with a runtime of at least 10 minutes at a 700 W or 760 VA load.

**Number of outlets needed:**
2 or 3, per workstation, depending on system configuration

**Voltage:**
100-240 V

**Rated Input Current**
Redundant (RAID1+0) 7.1 Amps (at 120 VAC) to 3.5 Amps (at 240 VAC) per Power Supply
## Redundant (RAID) Server Environmental Conditions

<table>
<thead>
<tr>
<th>BTU Rating:</th>
<th>1773 BTU/hr (at 120 VAC), 1715 (at 240 VAC) w/ 460 W power supply</th>
</tr>
</thead>
</table>
| Transporting: | -30° to +60°C  
5% to 95% humidity w/o condensation  
Maximum altitude of 9144 m (30,000 ft.). Maximum allowable altitude change rate is 457 m/min (1500 ft/min) |
| Operating: | +10° to +35°C  
10% to 90% humidity w/o condensation  
Maximum altitude of 3048 m (10,000 ft.). This value may be limited by the type and number of options installed. Maximum allowable altitude change rate is 457 m/min (1500 ft/min). |
## Workstation Computer Environmental Conditions

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BTU Rating:</strong></td>
<td>1569 BTU/hr max, 910 BTU/hr typical</td>
</tr>
<tr>
<td><strong>Transporting:</strong></td>
<td>-40° to +60°C</td>
</tr>
<tr>
<td></td>
<td>8% to 90% humidity w/o condensation</td>
</tr>
<tr>
<td></td>
<td>Maximum altitude 9,100 m (30,000 feet)</td>
</tr>
<tr>
<td><strong>Operating:</strong></td>
<td>+5° to +35°C</td>
</tr>
<tr>
<td></td>
<td>8% to 85% humidity w/o condensation</td>
</tr>
<tr>
<td></td>
<td>Maximum altitude 3,000 m (10,000 feet)</td>
</tr>
</tbody>
</table>