VetStat*
Electrolyte and Blood Gas Analyzer

Operator's Guide

IDEXX

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Contents

Introduction

The VetStat analyzer is an electrolyte and blood gas analyzer for veterinary use. This portable analyzer provides fast, accurate results via single-use disposable cassettes using samples of whole blood, plasma, or serum. The VetStat analyzer offers an easy-to-use touch-screen platform, convenient veterinary-specific menu options, and species-specific reference ranges for canine, feline, and equine samples.

The VetStat analyzer is designed to provide rapid results for sodium (Na^+), potassium (K^+), chloride (Cl^-), ionized calcium (Ca^{++}), hydrogen ion concentration (pH), partial pressure carbon dioxide (PCO_2), partial pressure oxygen (PO_2), total hemoglobin concentration (tHb), hemoglobin oxygen saturation (SO_2), total carbon dioxide (tCO_2), bicarbonate (HCO_3^-), and anion gap (AG). The table below provides important information regarding supported sample types, available reporting units and analyzer dynamic ranges for each parameter.

| Parameter | Sample Type | | | Available Units | | Dynamic Range |
	Whole Blood	Plasma	Serum	Default	Other	(Default Units)
Na^+	•	•	•	mmol/L		100–180
K^+	•	•	•	mmol/L		0.8–10
Cl^-	•	•	•	mmol/L		50–160
Ca^{++}	•	•	•	mmol/L	mg/dL	0.2–3.0
pH	•	•	•	pH units		6.6–7.8
PCO_2	•			mmHg	kPa	10–200
PO_2	•			mmHg	kPa	10–700
tHb	•			g/dL	mmol/L g/L	5–25
SO_2	•			%		60–100
tCO_2*	•			mmol/L		1.0–200.0
HCO_3^-*	•			mmol/L		1.0–200.0
Anion gap*	•			mmol/L		3–30

*These parameters are calculated from parameters measured by the VetStat analyzer.

See "Parameters" in this section for more information on the parameters listed above.

VetStat Principles of Operations

The VetStat analyzer is a microprocessor-based instrument measuring optical fluorescence from discrete sensors called optical electrodes (optodes).

A disposable, single-use cassette contains all of the elements needed for calibration, sample measurement, and waste containment. Specific calibration information from the cassette is read into the analyzer by scanning the cassette package using the bar code scanner. The cassette is then placed into the measurement chamber.

The analyzer warms the cassette to 37.0° ±0.1°C (98.6° ±0.1°F), and performs a calibration verification on the sensors for PCO_2 and PO_2 by passing a precision calibration gas mixture across the optode sensors. The pH and electrolyte channels are calibrated with precision buffer solution contained in the cassette. The tHb and SO_2 channels are factory-calibrated.

When calibration is verified, the analyzer aspirates the blood sample into the cassette and across the optode sensors. After equilibrating with the blood sample, fluorescence emission is then measured. After the measurement, the cassette containing the blood sample is removed from the analyzer and discarded. The analyzer contains no reagents, blood, or waste.

During each measurement, light originating from lamps in the analyzer is passed through optical filters so that photons of a specific energy are transmitted to the sensors, causing them to emit fluorescence. The intensity of this emitted light depends upon the partial pressure of oxygen (PO_2), partial pressure of carbon dioxide (PCO_2), hydrogen ion concentration (pH), or electrolyte concentration (Na^+, K^+, Cl^-, Ca^{++}) of the blood in direct contact with the sensors, as described above. The light emitted by the fluorescent sensors is measured by the analyzer after passing through lenses and additional optical components. A filter is used to isolate specific wavelengths of interest from this returning light for measurement by a light detector.

For tHb and SO_2, red and infrared light from one LED and two laser diodes is directed via dichroic beamsplitters and optical waveguides onto and through an optically polished window to the blood in the cassette over the O_2 sensor. This light is partially absorbed and reflected by the erythrocytes and sensor overcoat and then reflected back up into the instrument, traveling via an optical waveguide to a photodiode. The intensity of light reflected back at each wavelength varies in a well-defined way with the blood $ctHb$ and SO_2, and is used in their measurement.

The output signal of the detectors is converted by the microprocessor to a numeric readout in conventional units of measure and displayed on the touch screen. Other values commonly used for the assessment of oxygen and acid-base status are calculated from these measured values.

Parameters[1, 2, 3, 4, 5]

The various parameter descriptions provided in this section are based on current veterinary literature and are provided for general guidance only. As with any diagnosis or treatment, the primary care veterinarian should use clinical discretion with each patient based on a complete evaluation of the patient, including physical presentation and complete laboratory data. Diagnoses and treatment decisions are the ultimate responsibility of the primary care veterinarian.

Sodium

Sodium is the major cation of extracellular fluid. Its primary functions in the body are to chemically maintain osmotic pressure and acid-base balance, and to transmit nerve impulses. Sodium functions at the cell membrane level by creating an electrical potential between different cell membranes, causing the transmission of nerve impulses and neuromuscular excitability to be maintained. Sodium is involved in some enzyme catalyzed reactions as a cofactor. The body has a strong tendency to maintain a total base content, and only slight changes are found even under pathologic conditions.

Low sodium values (hyponatremia) usually reflect a relative excess of body water rather than a low total body sodium. Reduced sodium levels may be associated with low sodium intake; sodium losses due to vomiting or diarrhea with adequate water and inadequate salt replacement, diuretic overdosage or NaCl-losing nephropathy; osmotic diuresis; metabolic acidosis; adrenocortical insufficiency; congenital adrenal hyperplasia; dilution type due to edema; cardiac failure; hepatic failure; and hypothyroidism.

1. Kaneko JJ, ed. *Clinical Biochemistry of Domestic Animals*. 4th ed. San Diego, CA: Academic Press; 1989.
2. Thrall MA, Baker DC, Campbell TW, et al. *Veterinary Hematology and Clinical Chemistry*. Baltimore, MD: Lippincott, Williams and Wilkins; 2004.
3. Pagana KD, Pagana TJ. *Mosby's Manual of Diagnostic and Laboratory Tests*. Boston, MA: Mosby; 1998:133–135.
4. Willard MD, Tvedten H, Turnwald GH. *Small Animal Clinical Diagnosis by Laboratory Methods*. 3rd ed. Philadelphia, PA: WB Saunders; 1999.
5. DiBartola SP. *Fluid, Electrolyte and Acid-Base Disorders in Small Animal Practice*. 3rd ed. Philadelphia, PA: Elsevier; 2006.
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Elevated sodium values (hypernatremia) are associated with conditions of water loss in excess of salt loss through profuse sweating, prolonged hyperpnea, severe vomiting or diarrhea, diabetes insipidus or diabetic acidosis, increased renal sodium conservation in hyperaldosteronism, hyperadrenocorticism, inadequate water intake because of coma or hypothalamic diseases, dehydration, or excessive saline therapy.

The sodium value obtained can be used in the diagnosis or monitoring of all disturbances of the water balance, infusion therapies, vomiting, diarrhea, burns, heart, and kidney insufficiencies, central or renal diabetes insipidus, endocrine disturbances, and primary or secondary cortex insufficiency of the adrenal gland, or other diseases involving electrolyte imbalance.

Potassium

Potassium is the major cation in the intracellular fluid and functions as the primary buffer within the cell itself. Ninety percent of potassium is concentrated within the cell, and damaged cells release potassium into the blood. Potassium plays an important role in nerve conduction and muscle function, and helps maintain acid-base balance and osmotic pressure.

Elevated potassium levels (hyperkalemia) can be found in hypoadrenocorticism, oligouria, anemia, urinary obstruction, renal failure due to nephritis or shock, metabolic or respiratory acidosis, renal tubular acidosis with the K^+/H^+ exchange, and hemolysis of the blood. Low potassium levels (hypokalemia) can be found in excessive loss of potassium through diarrhea or vomiting, inadequate intake of potassium, malabsorption, severe burns, and increased secretion of aldosterone. High or low potassium levels may cause changes in muscle irritability, respiration, and myocardial function.

The potassium value obtained can be used to monitor electrolyte imbalance in the diagnosis and treatment of infusion therapies, shock, heart or circulatory insufficiency, acid-base imbalance, therapy with diuretics, various kidney problems, diarrhea, hyper- and hypofunction of adrenal cortex, and other diseases involving an electrolyte imbalance.

Chloride

Chloride is an anion that exists predominantly in extracellular spaces. It maintains cellular integrity through its influence on osmotic pressure. It is also significant in monitoring acid-base balance and water balance. In metabolic acidosis, there is a reciprocal rise in chloride concentration when the bicarbonate concentration drops.

Decreased levels of chloride are found in severe vomiting, severe diarrhea, ulcerative colitis, pyloric obstruction, severe burns, heat exhaustion, diabetic acidosis, Addison's disease, fever, and acute infections such as pneumonia. Increased levels are found in dehydration, Cushing's syndrome, hyperventilation, eclampsia, anemia, and cardiac decompensation.

Ionized Calcium

Calcium in blood is distributed as free calcium ions (50%); calcium bound to protein, mostly albumin (40%); and calcium bound to anions such as bicarbonate, citrate, phosphate, and lactate (10%). However, only free ionized calcium can be used by the body in such vital processes as muscular contraction, cardiac function, transmission of nerve impulses and blood clotting. The VetStat analyzer measures the ionized portion of the total calcium. In certain disorders, such as pancreatitis and hyperparathyroidism, ionized calcium may be a better indicator for diagnosis than total calcium. Abnormalities in albumin affect the total calcium, but not the ionized calcium.

Elevated calcium (hypercalcemia) may be present in various types of malignancy, renal failure, hyperparathyroidism, hypoadrenocorticism, and granulomatous diseases. Hypercalcemia occurs commonly in critically ill patients with abnormalities in acid-base regulation and losses of protein and albumin. Decreased calcium (hypocalcemia) is often noted with eclampsia, hypoparathyroidism, pancreatitis, renal disease, alkalosis, and ethylene glycol toxicity.

pH

The pH value of the blood, serum or plasma may be the single most valuable factor in the evaluation of the acid-base status of a patient. The pH is one of the most tightly controlled parameters in the body and indicates the balance between the renal (kidney), respiratory (lung), and blood buffer systems. The causes of abnormal blood pH values are generally classified as:

- Primary bicarbonate deficit—metabolic acidosis
- Primary bicarbonate excess—metabolic alkalosis
- Primary hypoventilation—respiratory acidosis
- Primary hyperventilation—respiratory alkalosis

An increased pH value (alkalemia) in blood, serum or plasma may occur because of an accumulation of plasma bicarbonate, or a loss of acidic fluids from the body such as from vomiting. Respiratory alkalosis is the result of an increased elimination of CO_2 through the lungs because of hyperventilation.

A decreased pH value (acidemia) in blood, serum or plasma may occur because of an increased formation of organic acids, an increased excretion of H^+ ions in certain renal disorders, an increased acid intake such as in ethylene glycol poisoning, or a loss of alkaline body fluids. Respiratory acidosis is the result of a decreased alveolar ventilation and may be acute as the result of pulmonary edema, airway obstruction or medication, or may be chronic as the result of obstructive or restrictive respiratory diseases.

PCO_2

The partial pressure of carbon dioxide (PCO_2) in arterial blood is used to assess how well the body eliminates carbon dioxide, a by-product of metabolism. A PCO_2 value below the normal range is called "respiratory alkalosis" and indicates hypocapnia, a condition caused by increased alveolar ventilation, such as hyperventilation. An arterial PCO_2 above the normal range is called "respiratory acidosis" and indicates hypercapnia. Hypercapnia is a sign of ventilatory hypoventilation and failure, resulting from cardiac arrest, chronic obstructive lung disease or chronic metabolic acid-base disturbances.

PO_2

The partial pressure of oxygen (PO_2) in arterial blood is used to assess how well the body is able to absorb oxygen in the lungs. Values below the normal arterial PO_2 (arterial hypoxemia) are usually caused by pulmonary, circulatory or respiratory abnormalities (e.g., bronchial obstruction, vascular problems, decrease in cardiac output, increased oxygen demand, anatomical heart defect, low inspired O_2 content). Generally, O_2 levels above 100 mmHg do not contribute significantly to the oxygen content since, with normal hemoglobin concentrations, a PO_2 of 80 to 100 mmHg provides a 97% saturation level (and a level greater than 100% cannot be achieved).

tHb

Hemoglogin is the main component of erythrocytes and is the primary vehicle for the transportation of oxygen within the bloodstream. In addition to its role in carrying oxygen, hemoglobin is an important component of the buffer system and is responsible for more than 80% of the nonbicarbonate buffering capacity of whole blood.

Decreases in the amount of hemoglobin in the blood can be a result of either decreased concentration of hemoglobin within the erythrocytes, and/or a decreased number of erythrocytes in circulation. Decreases in hemoglobin are most often caused by anemia, or a decrease in the number of erythrocytes in circulation. Anemias are usually classified as either regenerative or nonregenerative. Regenerative anemia may be caused by blood loss or hemolysis. Nonregenerative anemia may be caused by bone marrow disease, drug reactions, infectious diseases, or secondary to chronic inflammation, or renal disease. Other nonanemia causes of a

decrease in hemoglobin include iron deficiency, deficiency of other precursors to hemoglobin, portosystemic shunts, and hepatic atrophy.

Increases in the amount of hemoglobin in the blood are most often a result of polycythemia, or an increase in the number of erythrocytes in circulation. Polycythemia is usually classified as either relative or absolute. Relative polycythemia may be caused by splenic contraction, dehydration or hypovolemia. Absolute polycythemia may be caused by living in high altitudes, pulmonary or cardiac disease, primary polycythemia or excessive erythropoietin secretion secondary to renal tumors or rarely other renal conditions.

SO_2

Oxygen saturation (SO_2) is the percentage of hemoglobin that has oxygen bound to it. It can also be thought of as the percentage of actual oxygen content of the blood compared to the oxygen carrying ability of the blood. By using the hemoglobin-oxygen dissociation curve, the SO_2 can be correlated directly with the partial pressure of oxygen (PO_2) of the blood. An arterial oxygen saturation (S_aO_2) of greater than 93% is considered normal.

A decreased SO_2 usually correlates with a decreased PO_2 and is called hypoxemia. Hypoxemia may be caused by a primary lung disease inhibiting oxygen absorption, hypoventilation, circulatory abnormalities, or a decreased atmospheric pressure of oxygen. Alternate forms of hemoglobin that do not carry oxygen (such as methemoglobin, sulfhemoglobin or carboxyhemoglobin) or a decreased affinity of hemoglobin for oxygen may also result in a low S_aO_2.

An SO_2 result cannot exceed 100% and this is considered to be a normal finding.

tCO_2

tCO_2 is the total amount of carbon dioxide measured in the blood sample. tCO_2 is composed of:

- Bicarbonate (HCO_3^-)
- Carbonic acid (H_2CO_3)
- Carbon dioxide (CO_2)

The blood buffer system, which plays an important role in the acid-base status of the patient, uses these three forms of carbon dioxide. Because the amounts of H_2CO_3 and dissolved CO_2 in the blood are so small, tCO_2 is an indirect measure of the HCO_3^- ion. When the CO_2 content is measured on a serum or plasma sample, room air may affect the partial pressure of the CO_2. As a result, tCO_2 can be used as a rough guide to acid-base balance.

HCO_3^-

Bicarbonate (HCO_3^-) is an important component of the blood buffer system. The bicarbonate and chloride ions play a major role in maintaining electrical neutrality in the extracellular and intracellular fluid. Levels of HCO_3^- are regulated by the kidneys. HCO_3^- increases with alkalosis and decreases with acidosis.

Anion Gap

The anion gap is an expression of the value of the commonly measured anions subtracted from the value of the commonly measured cations. It is most commonly expressed as the equation:

$$\text{Anion gap} = (Na^+ + K^+) - (Cl^- + HCO_3^-)$$

Increases indicate titrational metabolic acidosis and an increase in unmeasured anions (lactic acid, ketones, salicylic acid, ethylene glycol, and uremic acids such as BUN and creatinine). This is generally associated with decreased bicarbonate (HCO_3^-) concentration loss by titration. The anion gap helps clarify mixed acid-base disorders such as concurrent metabolic acidosis and alkalosis.

Contents

Before you begin installing your VetStat analyzer, take a moment to look over the contents to ensure that you have the following:

- Power supply with power cord
- Battery
- Quality control material (either OPTI* CHECK)
- Gas bottle
- Thermal printer paper
- Multi-level standard reference cassette (SRC)
- Hemoglobin calibration cassette (HbCC)

NOTE: The SRC and the HbCC are located inside the analyzer's storage compartment.
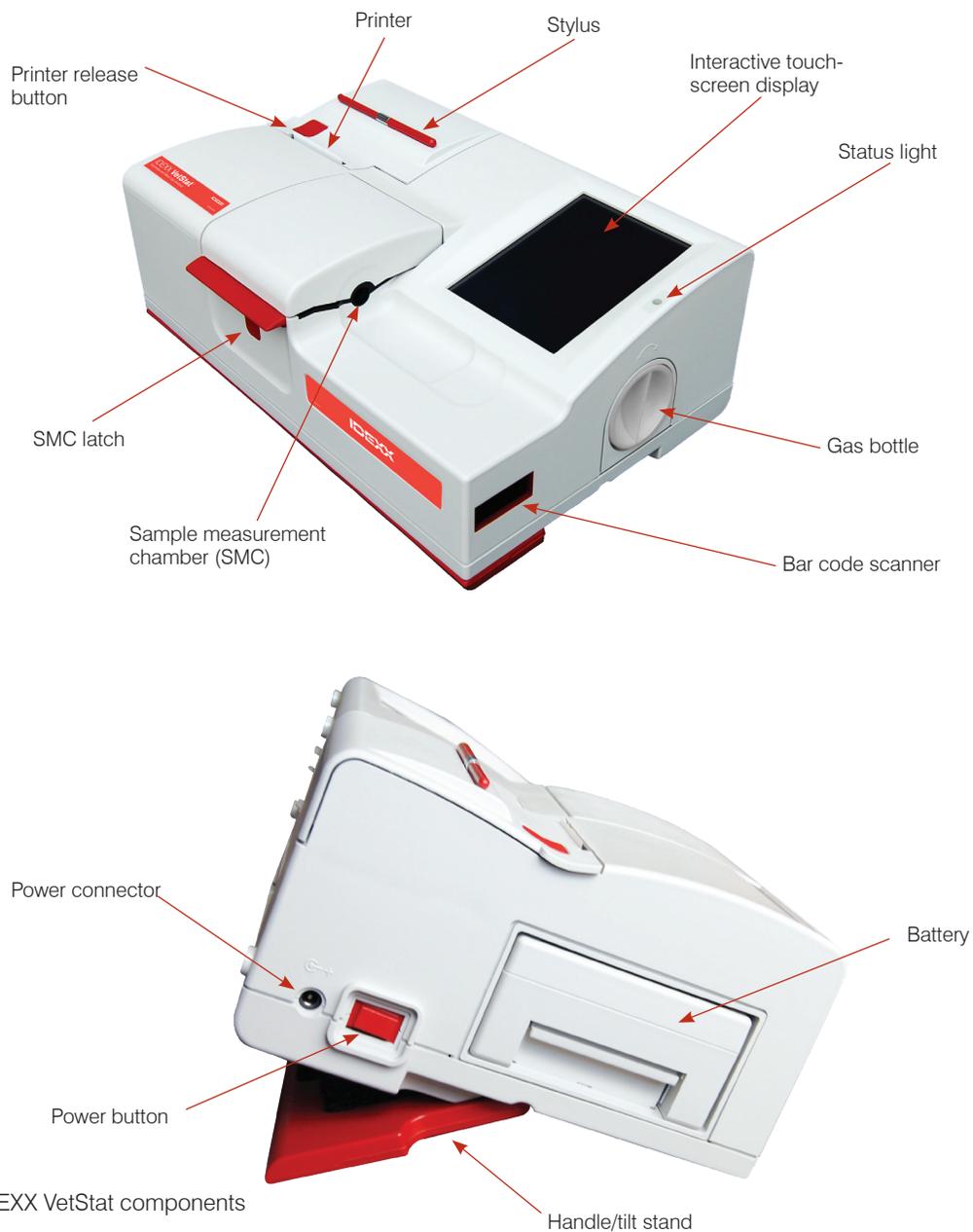
Figure 1. IDEXX VetStat components

Analyzer Components

Before installing the VetStat analyzer, it is important to familiarize yourself with the analyzer's components.

Interactive Touch-Screen Display

The analyzer activities are communicated to you through a back-lit touch screen, displaying the activities of the analyzer, sample results, and other relevant information.

You communicate with the analyzer through a graphical user interface that is used to perform all analyzer functions.

Status Light

To the right of the touch screen is a two-color status light. During operation you will see one of the following:

- **Green light**—The system is running a measurement and waiting for user action.
- **Blinking green light**—The system is in the process of calibration or measurement. Do not open the cover.
- **Red light**—Indicates an error that will terminate the process.
- **Blinking red light**—The system has encountered a problem and needs operator interaction before it will proceed.

Sample Measurement Chamber (SMC)

Inside the analyzer is the sample measurement chamber (SMC). To open the cover, press the red SMC latch.

Several LEDs and infrared lasers are located inside the sample measurement chamber.

Bar code Scanner

The bar code scanner, located on the right, reads quality control ranges (if applicable), as well as lot and expiration information from sample cassettes, quality control material, standard reference cassettes (SRCs) and gas bottles, and user-input bar codes for operator and patient IDs.

Thermal Printer

The thermal printer is accessed by pressing the red release button on the top left of the analyzer. The printer uses heat-sensitive paper to print measured values, quality control values, calibration values, and patient and diagnostic information.

Peristaltic Pump

Contained within the same compartment as the thermal printer is a peristaltic pump cartridge that is used to transport liquids and gases. All liquids are contained within the VetStat* cassette and do not enter the analyzer.

NOTE: The peristaltic pump cartridge is a replaceable item; see the "Cleaning and Maintenance" section for more information.

Model and Serial Numbers

The model and serial numbers are located on an identification plate on the bottom of the analyzer.

Back of Analyzer

On the back of the analyzer are:

- An **Ethernet port** for exporting data and connecting to a network.
- An **LED** that indicates the charging status of the battery.
- A **USB Type A port** to quickly load software and import/export data using a standard USB mass storage device.
- A **USB Type B** port for exporting serial data to a computer.
- A **storage compartment** that can hold an extra paper roll, the SRC, other supplies or accessories.

USB type B port

Storage compartment

USB type A port

LED

Ethernet port
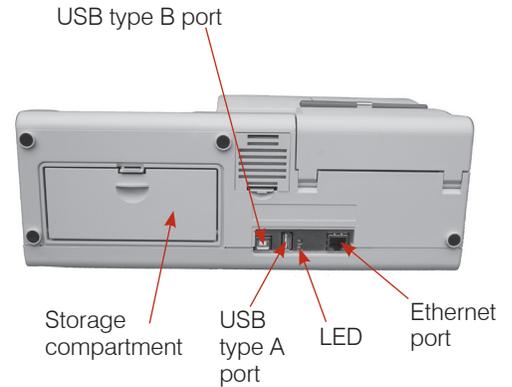
Figure 2. Back of the VetStat analyzer

Battery Pack

The rechargeable battery pack is located on the left next to the on/off switch. It is removed by squeezing the handle and sliding it out. The battery allows you to operate the VetStat analyzer without having to plug it into an electrical outlet. The battery is charged automatically whenever the analyzer's external power supply is plugged into an electrical outlet.

Power connector and power button

Next to the battery pack is the power connector where you can connect the VetStat analyzer to an external power supply. The power button is located on the left side of the unit next to the power connector. To power the analyzer off, press and hold the button for 2 seconds.

Carrying Handle

The VetStat is equipped with a carrying handle for easy transport. The handle can also be used as a tilt stand to place the analyzer at a convenient viewing angle for the user.

- To extend the handle to carrying position, place the analyzer on its back and position your fingers in the cutouts on each side of the handle. Push up until the handle is fully extended.
- To use the handle as a tilt stand, pull down on the handle and lock it in the lower position. Then turn the analyzer back to its original position.

Analyzer Setup and Installation

Safety Precautions

For your safety and the proper operation of your equipment, always follow these precautions when working with your VetStat* analyzer:

- Keep the analyzer away from all sources of liquids such as sinks and wash basins.
- Keep the analyzer away from explosive gases or vapors.
- Use only the power source supplied with the VetStat analyzer.
- Always handle blood samples and collection devices with care.
- Dispose of the VetStat* cassettes according to local regulations.

WARNING! LASER HAZARD

The IDEXX VetStat analyzer is a Class 1 laser product according to the requirements of IEC 60825-1.

The maximum energy output is as follows:

670 nm (LED): 40 microwatts maximum for 400 ms

780 nm (Laser): 40 microwatts maximum for 400 ms

850 nm (Laser): 40 microwatts maximum for 400 ms

Caution: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

WARNING! ELECTRIC SHOCK

- The analyzer is designed as a conventional device (closed, not waterproof type).
- Do not operate the analyzer in an explosive environment or in the vicinity of explosive anesthetic mixtures containing oxygen or nitrous oxide.
- This analyzer is suitable for continuous operation.
- The power plug must only be plugged into a ground socket. When using an extension cord, make sure that it is of the proper size and is properly grounded.
- Any breakage of the ground lead inside or outside the analyzer, or a loose ground connection, can cause a hazardous condition when operating the analyzer. Intentional disconnection of the grounding is not permitted.
- When replacing the fuses, make sure that they are of the same type and rating as the original fuses. Never use repaired fuses or short-circuit the fuse holders.

All service is subject to the terms of IDEXX's warranty and, after the warranty period, IDEXX's extended maintenance agreement, and must be performed by an authorized IDEXX service technician. For technical support or service, contact IDEXX Customer and Technical Support.

Choosing a Location

Location is important for trouble-free operation of your VetStat analyzer. Choose a site that is convenient for your sampling needs and meets the following physical requirements of the analyzer:

- Grounded electrical outlet, when operated with power supply
- Away from direct sunlight
- Room temperature (10°–30°C [50°–86°F])
- Relative humidity of 5%–95% (non-condensing)
- Away from strong electromagnetic fields such as those created by electric motors and x-ray equipment
- Away from explosive gases or vapors
- Placed on a hard, flat surface with no obstruction between the surface and the air vents on the bottom of the analyzer (this prevents overheating)

NOTE: These requirements also apply when the VetStat analyzer operates on battery power outside a laboratory setting.

Installing the VetStat Analyzer

Place the analyzer on a secure table top that allows plenty of working space and is convenient to a power connection.

1. Plug in the power supply.
   - Plug the power supply into the receptacle on the left side of the analyzer.
   - Plug the power cord into the power supply.
   - Plug the cord into a grounded electrical outlet.

   NOTE: To protect your VetStat analyzer and other electronic devices from damage caused by electrical power spikes, IDEXX recommends the use of a surge protector.

2. Install the battery pack.
   - Push the battery pack into the opening on the left of the VetStat analyzer.

     NOTE: The battery needs to be charged for at least 3 hours before using the VetStat analyzer on battery power. It is charged automatically whenever the analyzer's external power supply is plugged into an electrical outlet.

     NOTE: The lower LED on the back of the analyzer turns green while the battery is being charged. The top LED turns green when charging is complete.

3. Press the power button on the left side of the analyzer to power the analyzer **on**. The VetStat analyzer start-up screen displays.

4. Install the gas bottle.
   a. When the "Not Ready: Gas Not Installed" message appears, tap **New Gas Bottle.**
   b. When the "Scan Gas Bar code for New Gas Bottle" message appears, scan the bar code located on the gas bottle's package insert.

      NOTE: If the bar code is damaged or unreadable, tap the **Manual** button and enter the bar code using the numeric keypad.
   c. Open the gas bottle by unscrewing its cap.

d. Record the date of installation on the gas bottle for later reference.

> **NOTE:** The bar code on the gas bottle package insert contains expiration information. The VetStat analyzer will alert you when the gas is low or two weeks before the expiration of the gas bottle as a reminder to order a replacement.

e. When the "Please Insert Gas Bottle" message appears, insert the gas bottle in its housing and turn it clockwise until it is snug. Then tap **OK**.

> **WARNING:** Do not overtighten the gas bottle because this may cause damage to the VetStat analyzer.

f. When the "New Gas Bottle?" message appears, tap **Yes**.

> **NOTE:** If, after the initial installation, you need to remove a gas bottle and reinstall the same bottle, tap **No** at the "New Gas Bottle?" message. On the next screen, enter the number of weeks the gas bottle has been in use. Refer to the installation date that you recorded on the gas bottle.

5. Install the printer paper.

a. Press the red printer release button on the printer cover to access the printer.

b. Place the paper into the paper tray.

c. Pull the end of the paper upward and slightly out of the paper tray.

d. Hold the paper and close the printer cover.

Cassettes, Consumables and Accessories

Precautions and Warnings

- Use of calibration solutions, calibration gas or optodes that are not supported by IDEXX could void your warranty and extended maintenance agreement support coverage.

- Once used, the sample cassette holds animal body fluids. Handle with appropriate care and dispose of appropriately.

- VetStat* cassettes have been validated for use with canine, feline and equine samples.

- For in-vitro diagnostic use only.

- For veterinary use only.

Sample Cassettes

Customized, single-use, disposable sample cassettes are available for use with the VetStat analyzer (figure 3). Each cassette contains a sample fillport and removable syringe adapter (figure 4). The syringe adapter projects from the sample fillport and allows a syringe to be easily attached to the cassette. When sampling with a capillary tube, simply remove the syringe adapter from the fillport.

Figure 3. VetStat cassette

NOTE: The syringe adapter can be removed while the cassette is inside the sample measurement chamber.

IMPORTANT: The sample must not be injected, and the collection device (a syringe or capillary tube) must be seated firmly into the syringe adapter or sample fillport. The analyzer

Figure 4. Sample fillport and syringe adapter

will automatically aspirate the sample. See the "Sample Collection and Handling" section for more information on proper sampling technique.

The sample cassettes are stored at room temperature (10°–30°C/50°–86°F) and are packaged in sealed foil pouches. The bar code on the outside of each foil pouch contains lot, expiration and calibration information specific to the cassette.

NOTE: Sample cassettes should be disposed of in accordance with local, state and federal regulations.

Standard Reference Cassettes (SRC)

Standard reference cassettes (SRCs) are reusable sensor cassettes used for daily quality control testing. SRCs can be found in the storage compartment of your analyzer. Each new analyzer comes with a multi-level SRC cassette.

NOTE: The SRC calibrations are separate from the quality control procedure, which is described in the "Quality Control" section.

Hemoglobin Calibration Cassette (HbCC)

A reusable hemoglobin calibration cassette (HbCC) is provided with the analyzer and is used to calibrate the hemoglobin channel. The HbCC verifies the measurement optics and electronics, and corrects any potential drift. It is important to run the HbCC once every three months.

The HbCC is packaged in a foil pouch that contains the HbCC expiration date and lot number. **Do not discard this pouch after opening the HbCC.** To ensure optimal performance of the HbCC, place the cassette inside the foil pouch when it is not in use. Store the HbCC in the storage compartment located on the back of the analyzer.

Storage compartment
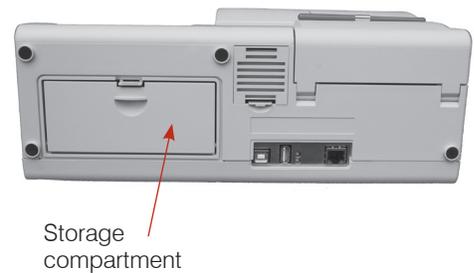
Figure 5. Storage compartment on the back of the VetStat analyzer

Other Accessories and Consumables

Calibration Gas Bottle

Use: For the calibration of pH, PCO_2 and PO_2 in the VetStat analyzer

Contents: Each disposable, low-pressure cylinder contains approximately two liters of gas (at less than 145 psi at 21°C).

Composition:

Oxygen	14.0 ±0.02%
Carbon Dioxide	6.0 ±0.02%
Nitrogen	Balance

Storage: Stable when stored at 4°–30°C (39°–86°F) until its expiration date

Disposal: Dispose of according to the safety regulations applicable at your facility

IMPORTANT: If the analyzer is being shipped via air, it is critical that the gas bottle is removed before shipping.

CAUTION: The gas bottle is a pressurized bottle. Protect it from sunlight and do not expose it to temperatures exceeding 50°C (122°F). Refer to the package insert for further information on the calibration gas.

Battery Charger—110 V

Use: For fast charging of the battery pack for the VetStat analyzer

Contents: Each charger contains a power supply with circuitry

Input Voltage: 110 V AC, 47–63 Hz

Storage: Refer to the package insert

External Battery

Use: Allows the VetStat analyzer to operate on battery power

Specifications: 11.1 V, 5600 mAh

Peristaltic Pump

Use:	Transports liquids and gases
Storage:	Room temperature
Specifications:	Replace once per year (see the "Cleaning and Maintenance" section for more information)

Quality Control Material

An initial supply of quality control materials are provided with the VetStat analyzer. Additional quality control materials are available for purchase from IDEXX.

OPTI* CHECK:

Use:	Assayed quality control materials that monitor the measurement of pH, PCO_2, PO_2, sodium, potassium, chloride, ionized calcium, total hemoglobin content and oxygen saturation in the IDEXX VetStat Electrolyte and Blood Gas Analyzer
Active Ingredients:	Formulated using aqueous organic and carbonate buffers at equilibrium with predetermined levels of oxygen, carbon dioxide, nitrogen, with salts, buffers and polystyrene beads
Storage:	Store unopened ampules at room temperature (10°–30°C/50°–86°F). Do not use beyond the expiration date. Do not freeze. Refer to the package insert for more information.

Thermal Paper

Use:	For the printing of patient, quality control and calibration values, as well as patient and diagnostic information
Composition:	Thermal, document-grade, resistant to fading
Storage:	Room temperature

Changing the Printer Paper

The thermal printer paper supplied by IDEXX contains an indicator strip to alert you when the paper roll needs to be changed.

To change the paper:

1. Press the red printer release button on the printer cover to access the printer.
2. Place the paper into the paper tray.
3. Pull the end of the paper upward and slightly out of the paper tray.
4. Hold the paper and close the printer cover.

Calibration

Sample Cassettes

Each lot of sample cassettes is calibrated during the manufacturing process. Every sample cassette package is then labeled with a bar code containing this calibration information, as well as its lot number and expiration date.

NOTE: See the "Cassettes, Consumables and Accessories" section for more information on sample cassettes.

The sample cassette's bar code is read by scanning the cassette package using the bar code scanner. The sample cassette is then installed and an automatic calibration verification is performed using a precision gas mixture and the sample cassette's internal storage buffer.

During the calibration and measurement processes, diagnostic tests are automatically performed to ensure correct operation of the analyzer and measurement of the sample cassette. These tests include automatic checks of the sample cassette for temperature control; fluidic control during calibration; proper equilibrium behavior of the sensors during calibration and measurement; automatic detection of bubbles and short sample during aspiration; and automatic detection of low gas, low battery, dirty optics or worn pump conditions.

Hemoglobin Calibration Cassette (HbCC)

Calibration of the hemoglobin channel is required every 3 months. This calibration is performed using the hemoglobin calibration cassette (HbCC). The hemoglobin calibration verifies the measurement optics and electronics, and corrects any potential drift.

Running the HbCC

1. From the Home screen, tap **Quality Control**, and then tap **HbCC.**

2. Use the alphanumeric keypad to enter the lot number of the HbCC (found on the cassette's foil pouch or on the top of the cassette), and tap **OK**.

3. When the "Open Cover" message appears, press the button to open the sample measurement chamber (SMC) cover.

4. When the "Clean Optics and Inside of Cover" message appears, gently clean the optics window and the inside top cover of the sample chamber with a soft lint-free cloth, and then tap **OK**.

5. Gently wipe both sides of the HbCC with a clean, dry, lint-free cloth and examine the cassette to ensure it is clean. Insert the cassette into the chamber and press down to properly seat it.

6. Close the SMC cover. The VetStat analyzer automatically detects the presence of the HbCC and begins the calibration process, which is indicated on the touch screen. During this time (approximately 60 seconds), a progress bar is displayed.

7. When the calibration is complete and the message appears indicating to do so, open the SMC cover, remove the hemoglobin calibration cassette and then close the SMC cover.

    IMPORTANT: The HbCC is reusable. After removing the HbCC, return it to its foil pouch and store it in the storage compartment located on the back of the analyzer.

8. The analyzer prints the Hemoglobin Calibration report, showing the previous and new calibration results and calibration factors.

Standard Reference Cassettes (SRCs)

Standard reference cassettes (SRCs) are used to check the electronics and the optics of the VetStat analyzer. To ensure optimal performance, IDEXX recommends that SRC measurements be confirmed within acceptable ranges once each day that the analyzer is in operation. Three SRC levels are available for the VetStat analyzer; each one tests a different optical range. A multi-level SRC is provided as part of the initial analyzer shipment because it measures the high, normal, and low optical ranges.

These special test cassettes contain a stable optical sensor simulator that is measured by the analyzer in exactly the same manner as other cassettes, and provides assurance that all measured parameters are consistent. The results obtained should fall within the limits supplied with the SRCs.

IMPORTANT: On the SRC report, you may see results for parameters that you are not testing on patient samples. It is important that you contact IDEXX Customer and Technical Support to report any failing SRC results.

Running Standard Reference Cassettes

IDEXX recommends running levels 1 and 3 (high and low values) of the Standard Reference Cassette (SRC) as a daily quality control for the VetStat analyzer.

1. On the Home screen, scan the bottom bar code on the SRC package by holding it 2–3 inches (5–8 cm) from the bar code scanner located on the bottom-right corner of the analyzer (figure 6).

   - The red line from the bar code scanner should cover the entire bar code.

   - A beep indicates a valid bar code.

   - A red status light indicates an invalid bar code (e.g., SRC expired).

   - If the bar code is damaged or unreadable, tap **Manual Entry** and enter the bar code digits using the keypad.

   OR

   From the Home screen, tap **QC Manager**> **SRC**.

Figure 6. Home screen

2. If Non Secure User ID Entry is enabled in the security settings, you will be asked to enter the user ID.

   NOTE: Bar coded user IDs may be entered from this screen using the bar code scanner.

3. If prompted with "WARNING! - New SRC Lot," tap **Continue**.

4. Select the desired levels and tap **OK**.

5. Open the sample chamber cover by pressing down on the center of the red latch.

6. Examine the SRC to ensure it is clean and press down to insert it into the chamber.

7. Close the sample measurement chamber cover.

   After the cover has been closed, the analyzer begins the measurement process, which is indicated on the display screen. During this time (about 60 seconds per level), a progress bar is displayed.

   When the measurement is complete, the unit displays the results.

8. Tap **Next** to display additional results.

9. Tap the Level 2 and Level 3 tabs to display the results for the respective levels.

NOTE: If SRC measurements are completed prior to running cassettes with liquid controls, all analytes will be displayed. To reduce the displayed analytes, run liquid controls on the desired cassette styles.

- The analyzer automatically checks the results against the analyzer's reference ranges and stores the results in its internal database.

- For parameters within range, **Pass** is displayed.

- For parameters out of range, or if an internal drift is detected, **Fail** is displayed.

NOTE: The printout starts automatically when the first results are displayed. This feature may be turned off in setup.

10. Tap the **Back** arrow to exit the results screen.

11. Open the sample measurement chamber cover and remove the SRC.

10. Return the SRC to its pouch immediately after removal from the analyzer.

11. Close the sample measurement chamber cover. If the SRC test fails, gently clean the SRC, the optics window and the inside cover of the SMC with alcohol and a lint-free cloth and repeat this process (see the "Cleaning and Maintenance" section). If it fails again, call IDEXX Customer and Technical Support.

NOTE: Verify with your particular regulatory agency and your internal policy regarding number of levels and frequency of SRCs to be run.

Additional Printing Options for SRC Results

To print SRC reports or SRC statistical information:

1. From the Home screen, tap **Data Manager**.

2. In the Measurement section, tap **SRC** (figure 7).

3. On the Data>SRC Measurement screen (figure 8), select the run (located on the left) that you want to review.

4. Tap the applicable button on the right (figure 8):

Button	Description
View	Displays the SRC results
Print	Prints the SRC results
Delete	Deletes the selected SRC results
Mark	Allows for multiple SRC runs to be selected at one time
All	Selects all SRC run results currently stored in the database
Up	Displays the previous page of SRC results
Down	Displays the next page of SRC results
Statistics	Generates statistics based on all stored data for SRC measurements

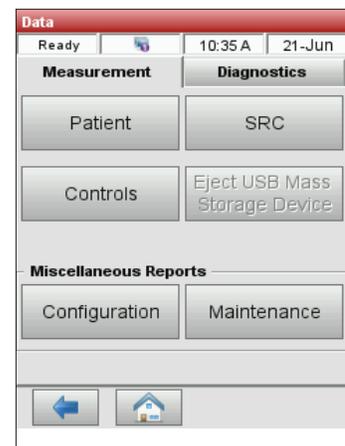5. Tap **Home** to return to the Home screen.
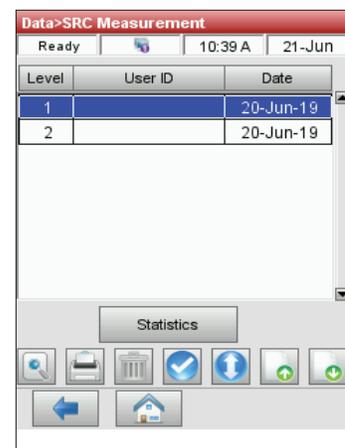

Figure 7. Printing options

Figure 8. SRC measurement

Quality Control

The purpose of a quality control procedure using the quality control fluid (OPTI* CHECK) is to ensure reliable patient values over the clinically significant ranges for all the measured parameters.

OPTI CHECK is used to verify the performance of the VetStat* cassettes, electronics and optics.

NOTE: The SRCs, which must be run daily, verify only the performance of the analyzer's electronics and optics.

A control measurement can be made using any sample cassette lot or sample cassette type, and any level of the quality control samples (level 1, 2 or 3). It is recommended that you use the most comprehensive cassette available in your inventory. For example, if you have a sample cassette for Na^+, K^+ and Cl^-, as well as a sample cassette for pH, PCO_2, Na^+, K^+ and Cl^-, the latter sample cassette should be used for quality control. Policies regarding the measurement of quality control samples are at the discretion of your veterinary practice.

As a minimum, IDEXX recommends that quality control samples—level 1, 2 or 3—be performed:

- When the analyzer is first installed
- Once every four weeks for a routine check
- If you think your results are incorrect

IDEXX recommends that you use a different level of control each month.

Running Quality Control

1. From the Home screen, tap **QC Manager**, and then tap **Control**.
2. If Non Secure User ID Entry is enabled in the security settings, enter the user ID (bar coded user IDs can be added using the bar code scanner).
3. Select the desired level and tap **OK**.

   NOTE: If a new lot number of QC material is used, make sure the ranges have been entered into the system prior to running a sample.

4. Scan the bar coded strip on the VetStat cassette package by holding it 2–3 inches (5–8 cm) from the bar code scanner located on the bottom-right corner of the analyzer to automatically record the lot and calibration information for the specific cassette.

   - The red line from the bar code scanner should cover the entire bar code.
   - The unit will beep and the status light will turn green to confirm a valid bar code.
   - In the event that a cassette has expired, the LED will turn red.

   NOTES:

   - Refer to special handling instructions inside the cassette box for refrigerated cassettes.
   - If the bar code is damaged or unreadable, tap **Manual Entry** and enter the bar code digits printed on the bar code label using the numeric keypad.
   - A control measurement may be made using any VetStat cassette lot or cassette type.

5. Open the sample measurement chamber cover by pressing the red latch.

6. Open the sample cassette pouch and remove the sample cassette. Wipe any excess moisture from the cassette with a clean, dry, lint-free cloth.

    NOTE: If the QC sample is to be introduced with a capillary tube, remove the syringe adapter before placing the cassette into the chamber.

7. Insert the sample cassette into the chamber. Press down to ensure that it is seated.

    NOTE: Run cassettes immediately after opening pouch. Do not run if cassette has been out of pouch for more than 15 minutes.

8. Close the SMC cover. The analyzer starts to calibrate, as indicated on the screen.

    NOTE: If the sample measurement chamber cover is opened while the status light is green, the cassette calibration will be canceled and the cassette must be discarded.

9. After the calibration is complete:

    *   Remove a quality control ampule from the box of controls and mix the contents by gently inverting (do not shake vigorously—excessive bubbles may form and affect results), being careful not to heat it with your hands. Invert the ampule for 10 seconds.

    *   Gently tap the head of the ampule with your fingernail to remove any liquid.

    *   Carefully open the ampule by breaking off the top.

        NOTE: To ensure proper measurement, run the control fluid immediately after opening the ampule.

        NOTE: Protect your fingers by using gloves or tissue while breaking the ampule.

    *   Aspirate directly from the ampule, holding the ampule at a 45° angle during aspiration (use a new ampule of control material for each analysis), or use an unheparinized capillary tube to withdraw a small amount of control material from the ampule for aspiration (be sure to push the tube firmly into the fill port).

10. When the syringe adapter is fully submerged in the control fluid, tap **OK**. The quality control sample is automatically aspirated into the cassette and the measurement starts. The status light flashes green, indicating that the cover should not be opened.

    Upon completion of the measurement, the results are displayed, and pass or fail status is indicated.

11. Tap the **Back** arrow to accept or reject the results.

    *   If the results are acceptable, tap **Accept**. The results are stored in the database.

    *   If the results are not acceptable, tap **Reject.** Rejected results are not stored in the database.

    *   Tap **Review** if you want to view the results again.

    NOTE: After you choose to accept or reject the results, the results are automatically printed. Call IDEXX Customer and Technical Support to report any failing result.

    NOTE: Data will be exported using the configured export method when the results are printed.

    NOTE: The automatic printout feature may be turned off in the setup settings.

12. When prompted, open the sample measurement chamber cover, remove the cassette and close the cover.

13. Tap the **Back** arrow or **Home** to return to the Home screen.

Additional Print Options for Quality Control Results

The VetStat* analyzer can print reports containing information on the mean, standard deviation (SD) and coefficient of variation (CV) of stored quality control data.

1. From the Home screen, tap **Data Manager**.

2. In the Measurement section, tap **Controls** (figure 9).

3. In the Data> Control Measurement screen (figure 10), select the run (located on the left side of the screen) that you want to review.

4. Tap the applicable button on the right (figure 10):

| Button	Description
View	Displays the quality control (QC) results
Print	Prints the QC results
Delete	Deletes the selected run
Mark	Allows for multiple QC runs to be selected at one time
All	Selects all QC run results currently stored in the database
Up	Displays the previous page of QC results
Down	Displays the next page of QC results
Statistics	Generates statistics based on all stored data for QC measurements

5. Tap **Home** to return to the Home screen.
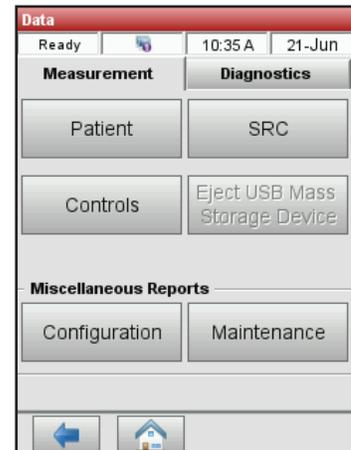
Figure 9. Data screen

Figure 10. Data> Control Measurement screen

Sample Collection and Handling

Anticoagulants

Lithium heparin is the recommended anticoagulant. Reference ranges for the VetStat* analyzer have been established based on the use of lithium heparin as the anticoagulant. Anticoagulants such as EDTA, citrate, oxalate, fluoride and sodium heparin may have a significant effect on blood pH and/or electrolyte levels and should not be used.

Collection Devices

Syringes

For fast, easy blood collection, IDEXX recommends the Vital Signs lithium-heparin syringe. These syringes contain the recommended anticoagulant, lithium heparin, so there is no need to transfer the sample to a lithium-heparin collection tube. Using this syringe allows you to run the sample immediately after collecting it from the patient.

NOTE: There is no need to heparinize the needle when using the Vital Signs lithium-heparin syringe. If you choose a different syringe to collect the patient sample, do not heparinize the syringe with anything other than lithium heparin.

When using a syringe to collect and run samples, mix the specimen thoroughly before analyzing it by gently inverting or rolling the syringe between both hands. Also be sure to expel any air bubbles.

Capillary Tubes

The recommended capillary tube is the Drummond 200 μL lithium-heparin capillary tube. These tubes are preferred because they are coated with the recommended anticoagulant, lithium heparin, which prevents the sample from clotting while in the tube.

To prevent damage to the cassette, use only capillary tubes with fire-polished ends. Do not pack the capillary tube with clay.

Sample Volume Requirements

A minimum of 125 μL of sample is required for the analysis. However, to avoid the introduction of air into the sample cassette, syringes and capillary tubes should be filled with a minimum of 200 μL of sample.

Whole-Blood Samples

Whole-blood samples can be arterial, capillary or venous.

- Arterial blood is needed only when the practitioner is looking for a meaningful interpretation of PO_2. PO_2 is measured only with the respiratory cassette.

- Capillary samples are acceptable for the evaluation of all parameters except PO_2.

- Venous blood is more commonly collected and is acceptable for the evaluation of all parameters except PO_2.

Whole-Blood Collection

To prevent clotting, whole-blood samples require the addition of an anticoagulant. Use only lithium heparin as the anticoagulant (see "Anticoagulants" in this section).

Collect the sample into any of the following:

A.   a lithium-heparin syringe (Vital Signs 1mL)

B.   a lithium-heparin capillary tube (Drummond 200 μL)

C.   an untreated syringe with immediate transfer to a lithium-heparin blood-collection tube

A.   Collection with a Lithium-Heparin Syringe

1.   Fill the syringe with a minimum of 200 μL (0.2 cc) of whole blood.

2.   Carefully remove the needle from the syringe and roll the syringe between your fingers to mix the sample.

3.   Expel any air bubbles.

4.   Proceed immediately to analysis. When the analyzer prompts you, place the syringe onto the syringe adapter of the cassette (figure 11).

Figure 11. VetStat* cassette with syringe adapter and syringe attached

VetStat cassette   syringe adapter   lithium-heparin syringe

B.   Collection with a Lithium-Heparin Capillary Tube

1.   Fill the capillary tube with 200 μL (0.2 cc) of whole blood.

2.   Roll the capillary tube between your fingers to mix the sample.

3.   Expel any air bubbles.

4.   Proceed immediately to analysis. When the analyzer prompts you, place the capillary tube into the sample fillport of the cassette (figure 12).

Figure 12. VetStat cassette with capillary tube attached

VetStat cassette   capillary tube
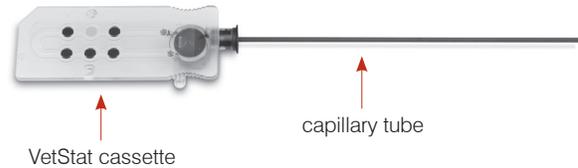
   IMPORTANT: Be sure to remove the syringe adapter from the cassette.

C.   Collection with an Untreated Syringe

1.   Fill the syringe with a minimum of 200 μL (0.2 cc) of whole blood.

2.   Immediately transfer the whole blood to a lithium-heparin collection tube. To ensure the proper sample-to-lithium-heparin ratio is achieved, be sure to fill the tube to the tube manufacturer's specifications.

3.   Cap the tube and gently invert the sample for 30 seconds to ensure it is well mixed.

4.   Remove the needle from a clean 1 mL syringe and aspirate a minimum of 200 μL (0.2 cc) of heparinized whole blood from the lithium-heparin tube.

   NOTE: Some syringes may not fit appropriately onto the cassette's syringe adapter, which will affect analyzer performance. For this reason, a Becton Dickinson* 1 mL syringe is recommended (figure 13).

Figure 13. Becton Dickinson 1 mL syringe

5. Expel any air bubbles.

6. Proceed immediately to analysis. When the analyzer prompts you, place the syringe onto the syringe adapter of the cassette. (figure 14)

Whole-Blood Handling

Analyze whole-blood samples immediately (within 5 minutes of collection). If the analysis is delayed, store the sample in an ice batch and analyze it within one hour of collection. Discard the sample if the analysis is delayed for more than one hour from collection.

Figure 14. VetStat* cassette with syringe adapter attached, Becton Dickinson 1 mL syringe

Plasma Samples

When collecting plasma samples for use on the VetStat* analyzer, use only lithium heparin as the anticoagulant.

Plasma Sample Collection

1. Fill the untreated syringe with a minimum of 200 μL (0.2 cc) of whole blood.

2. When using an evacuated tube, allow the sample to draw naturally into the tube by vacuum. When not using an evacuated tube, remove the needle from the syringe and immediately transfer the whole blood to a lithium-heparin collection tube.

   NOTE: To ensure the proper sample-to-lithium-heparin ratio is achieved, be sure to fill the tube to the tube manufacturer's specifications.

3. Cap the tube (not applicable if using an evacuated tube) and gently invert the sample for 30 seconds to ensure it is well mixed.

4. Centrifuge the sample for 10 minutes in a standard centrifuge (8,000 rpm) or 120 seconds in a high-speed centrifuge (12,000–16,000 rpm)

5. Remove the needle from a clean 1 mL syringe and aspirate a minimum of 200 μL (0.2 cc) of plasma from the lithium heparin tube.

   NOTE: Some syringes may not fit appropriately onto the cassette's syringe adapter, which will affect analyzer performance. For this reason, a Becton Dickinson 1 mL syringe is recommended.

6. Expel any air bubbles.

7. Proceed immediately to analysis. When the analyzer prompts you, place the syringe onto the syringe adapter of the cassette.

Plasma Sample Handling

If storage is required, separate the plasma from the cells, tightly cap the sample tube, and store the plasma at 4°–8°C (39°–46°F) for up to 48 hours. If longer storage is required, freeze the plasma. Allow the plasma to return to room temperature prior to analysis. PO_2 should not be measured with a plasma sample because the oxygen level will change rapidly when exposed to room air.

Serum Samples

Serum Sample Collection

1. Fill an untreated syringe with a minimum of 200 μL (0.2 cc) of whole blood.

2. When using an evacuated tube, allow the sample to draw naturally into the tube by vacuum. When not using an evacuated tube, remove the needle from the syringe and immediately transfer the whole blood to an untreated serum collection tube.

3. Cap the tube (not applicable if using an evacuated tube) and allow the sample to stand for 20 minutes to ensure it is fully clotted.

   NOTE: Samples allowed to clot for more than 30 minutes should not be used.

4. Centrifuge the sample for 10 minutes in a standard centrifuge (8,000 rpm) or 120 seconds in a high-speed centrifuge (12,000–16,000 rpm).

5. Remove the needle from a clean 1 mL syringe and aspirate a minimum of 200 μL (0.2 cc) of serum from the serum collection tube.

   NOTE: Some syringes may not fit appropriately onto the cassette's syringe adapter, which will affect analyzer performance. For this reason, a Becton Dickinson 1 mL syringe is recommended.

6. Expel any air bubbles.

7. Proceed immediately to analysis. When the analyzer prompts you, place the syringe onto the syringe adapter of the cassette.

Serum Sample Handling

If storage is required, separate the serum from the clot, tightly cap the sample tube, and store the serum at 4°–8°C (39°–46°F) for up to 48 hours. If longer storage is required, freeze the serum. Allow the serum to return to room temperature prior to analysis. PO_2 should not be measured using a serum sample because the oxygen level will change rapidly when exposed to room air.

Running a Patient Sample

Running a patient sample on the VetStat* analyzer is simple and fast. Follow the instructions outlined below for whole-blood, plasma and serum sample analysis.

1. Make sure that the VetStat analyzer is at the Home screen.

2. Read the sample cassette information into the analyzer by scanning the bar code using the bar code scanner located at the bottom right of the analyzer.

   - The bar code needs to face the analyzer.

   - A beep and a green status light indicate a valid bar code.

   - If the bar code is damaged or unreadable, tap **Manual** and enter the bar code using the alphanumeric keypad on the touch screen.

3. If requested, enter your Operator ID.

4. Press the cover release button to open the sample measurement chamber (SMC).

5. Insert the sample cassette:

   - Open the sample cassette foil pouch and remove the cassette.

   - Gently wipe both sides of the cassette with a clean, dry, lint-free cloth to remove excess moisture.

   - Insert the cassette into the SMC. Press down to ensure the cassette is seated.

   - Close the SMC cover.

   - The status light turns green. Do not open the SMC cover while the status light is green because this will cancel the cassette calibration process, and the cassette must then be discarded.

6. During the calibration process, enter the patient information by selecting the applicable button.

   - **STAT**—This option is ideal for emergency situations and requires entering only the species before aspirating the patient sample. You can enter the applicable patient information after the sample analysis.

   - **New Patient**—Use this option to enter patient data before the sample analysis.

   - **Last Patient**—Select this option when analyzing the most recent patient entered into the VetStat analyzer. The patient information is automatically entered on the touch screen. After verifying that the information is correct, tap the **Back** arrow to proceed to sample analysis.

   Tap the **Back** arrow when you are done entering the patient information.

   NOTE: For more information on entering patient data, see "Patient Data Entry" in this section.

7. When the calibration process is complete, the status light turns off, and the "Mix and Place the Sample" message appears.

   NOTE: When using a syringe, mix the syringe sample well by rolling it gently between your hands and inverting it end over end. Be sure to expel any air bubbles before attaching the syringe to the cassette's syringe adapter.

   NOTE: The analyzer retains calibration information for 10 minutes. If the sample is not attached to the cassette within 10 minutes from calibration, the analyzer will display a message to discard the cassette.

8. Attach the sample to the cassette (figures 15 and 16) and tap **OK**. Do not inject the sample. It will automatically be aspirated by the analyzer.
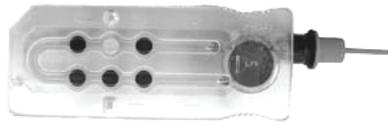
Figure 15. VetStat* cassette

Figure 16. Sample fillport and syringe adapter

- When using a capillary tube, remove the syringe adapter from the cassette and attach the capillary tube to the cassette fillport.

  NOTE: You can remove the syringe adapter while the cassette is in the SMC.

- When using a syringe, attach the syringe to the red syringe adapter and make sure that the syringe adapter is not touching the syringe plunger.

IMPORTANT: The sample can be attached at any time during the calibration process. After attaching the sample, tap **OK**. After the cassette calibration, the automatic sample aspiration begins and the measurement process immediately follows.

As the sample is being measured, the "Cassette Measurement in Process. Please wait." message appears. Do not open the SMC cover during the measurement process. The sample can be removed 3–5 seconds after the analyzer begins to make a ticking sound.

9. When the analysis is complete, the results appear on the touch screen and automatically print. Tap the **Back** arrow or **Home** to modify patient information or to finalize results. After the results are finalized, the analyzer prompts for the cassette to be removed.

10. Open the SMC cover. Remove the cassette and discard it, following local, state and federal regulations. Close the SMC cover.

Patient Data Entry

When entering patient information, several patient data screens appear. The screens that appear depend on the type of cassette you are using for patient measurement.

To enter patient data:

1. Tap the **STAT**, **New Patient** or **Last Patient** button (figure 17).

2. Select the species (figure 18).
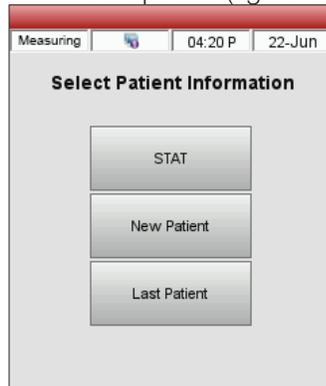
Figure 17. Measurement> Select Patient Information screen
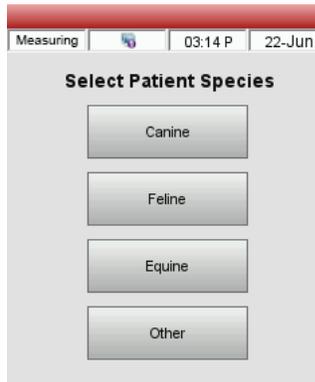
Figure 18. Measurement> Select Patient Species screen

3. Select the patient's gender (figure 19).

4. Enter the patient's age (figure 20).

   NOTE: Enter the patient's age in either years or months. You cannot enter both.

5. Enter the required patient data (figure 21).

Figure 19. Measurement> Select Patient Gender screen
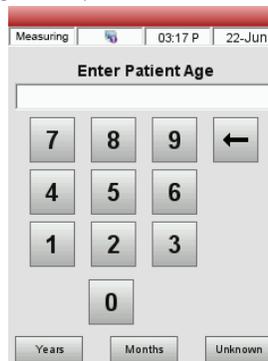
Figure 20. Measurement> Enter Patient Age screen
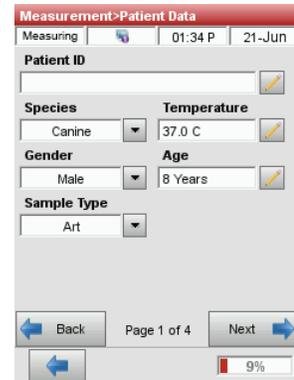
Figure 21. Required patient data

NOTE: Patient data entry fields vary depending on which patient data your practice has set up and which type of cassette you are running. The respiratory and fluid therapy cassettes require additional data entry.

Additional Options for Patient Reports

The VetStat analyzer's Data Manager screen allows you to:

• Reprint patient results

• View patient results

• Delete patient results

The analyzer's database can store up to 200 patient results, which can be viewed, reprinted or deleted at any time.

To print, view or delete patient results:

1. From the Home screen, tap **Data Manager**.

2. In the Measurement Reports/Statistics section, tap **Patient**. A list of patient results appears on the screen.

3. Select the patient data (located on the left of the screen) that you want to review.

4. Tap the applicable button on the right:

Button	Description
View	Displays the patient results
Print	Prints the patient results
Delete	Deletes the selected patient results
Mark	Allows for multiple patient results to be selected at one time
All	Selects all patient runs stored in the database
Up	Displays the previous page of patient results
Down	Displays the next page of patient results

5. Tap **Home** to return to the Home screen.

System Management

Your VetStat* analyzer is shipped preset to easily perform sampling operations. Through the touch screen, you can:

- Enter patient data.
- Print patient, quality control and calibration reports.
- Enter additional information to tailor the analyzer's performance to match the particular needs of your practice.

NOTE: For safety and security, certain VetStat customization can be protected by a security code. The analyzer's programming or existing parameters can then be changed only by entering the correct security code.

NOTE: All of the system settings reside in the analyzer memory, even after the power is turned off.

From the Home screen, you have access to the following VetStat features:

- Data Manager
- Quality Control Manager
- System Manager

Data Manager

The Data Manager feature allows you to print patient, standard reference cassette (SRC) and quality control information.

- To learn about printing patient information, see "Additional Options for Patient Reports" in the "Running a Patient Sample" section.
- To learn about printing standard reference cassette information, see "Additional Printing Options for SRC Results" in the "Calibration" section.
- To learn about printing quality control information, see "Additional Print Options for Quality Control Results" in the "Quality Control" section.

The Data Manager also contains diagnostic reports for patient information, SRCs, controls and errors, as well as a configuration report.

Quality Control

The Quality Control feature allows you to run quality control using OPTI* CHECK and an SRC or an HbCC.

- To learn about performing quality control using OPTI CHECK or VetStat Control materials, see the "Quality Control" section.
- To learn about running a standard reference cassette, see "Running Standard Reference Cassettes" in the "Calibration" section.
- To learn about running an HbCC, see "Running the HbCC" in the "Calibration" section.

System Manager

Within the System Manager feature, there are many options you can use to customize your VetStat analyzer to accommodate your clinic's needs.

Tap the **System Manager** button on the Home screen to access the System screen (figure 22), where you can set the date and time, run diagnostics and set up the VetStat analyzer.

Figure 22. System Manager screen

Setting the Date and Time

1. From the Home screen, tap **System Manager** to access the System screen.

2. Tap **Date and Time** to display the Date and Time Settings screen.

   • To select the time format, tap either the **12-hr** or **24-hr** option.

   • To edit the time or date, tap that field's **Edit** button. The alphanumeric keypad appears. Use the keypad to change the date/time settings.

3. Tap **Save** to save your settings.

4. Tap the **Back** arrow to return to the System screen or tap **Home** to return to the Home screen.

Performing Diagnostics

The Diagnostics screen contains detailed information that can be useful during troubleshooting.

Setting Up the VetStat Analyzer

The Setup screen lets you set up quality control materials, the displays for printed reports and system security. You can also customize several other features from the Setup screen.

Setting Up the Quality Control Material

When you open a new box of OPTI CHECK, the lot number should be entered into the analyzer, along with the target ranges. Each QC level of control has its own unique lot number printed on the information sheet contained in the control box.

1. From the Home screen, tap **System Manager** and then tap **Setup**.

2. Tap **Control**.

3. Take the bar code sheet out of the OPTI CHECK box and scan **Bar code A** for the applicable level of OPTI CHECK.

   • Hold the bar code 2–3 inches (5–8 cm) from the bar code scanner located on the bottom-right corner of the analyzer.

   • The red line from the bar code scanner should cover the entire bar code.

   • A beep and a green status light indicates a valid bar code.

4. Scan **Bar code B** when prompted. These two bar codes contain all necessary lot information for each level, and may be confirmed on the subsequent screens.

5. Confirm the lot number, expiration date, and control type on the package insert supplied with the control material. If the bar code is unavailable, tap **Manual Barcode** and enter the control information manually.

   Do not enter control limits manually prior to scanning or manually entering the control bar code information.

6. Tap the **Ranges 1** tab to confirm the assay ranges on the package insert supplied with the control material. If the bar code is unavailable, press the pencil icon to enter the numbers using the keypad.

7. Press **Ranges 2** to go to the next display to enter the ranges for all other measured parameters available with this control material.

   You will find the assay ranges printed on the data sheet in the box of control material. Alternately you may develop your own assay ranges from multiple measurements according to your hospital's procedures.

   Although it is recommended you review all analyte assay ranges, you may tap **Save** at any time after the bar code is scanned, and the ranges will be accepted from the bar code.

8. Repeat this procedure for each QC Level.

Setting Up Patient Information

The Patient Information feature lets you define which patient information is requested during each measurement and which information is printed.

1. From the Home screen, tap **System Manager** and then tap **Setup**.

2. On the Patient/QC tab, tap **Patient Entry**.

3. To add patient entry options to your list of patient information, select the desired function in the Available Functions field and then tap the **Down** arrow to move it to the Selected Functions field. Tap the **Up** arrow to remove a Selected Function option from the Selected Functions list.

4. Select the **Required** check box next to each patient entry option that you want to make a required entry.

   The default options for patient information:

   - Patient ID (25 alphanumeric characters)
   - Sex (unknown, male or female)
   - Temperature (default value 37.0°C)
   - Species: Canine, Feline, Equine, Other
   - Age
   - Sample Type: Art (Arterial), Ven (Venous)
   - Comment Field (50 alphanumeric characters)
   - HO2
   - Requisition ID (15 alphanumeric characters)
   - Client ID (11 alphanumeric characters)
   - Pplat (default value 0)
   - Mvol (VE) (default value 0 L)
   - PIP (default value 0)
   - Liter Flow (default value 000.00 Lpm)

- Tvol (VT) (default value 0 mL)
- PS (default value 0)
- Rate (f) (default value 0 bpm)
- CPAP (default value 0)
- FIO2 (default value 0.21)
- RQ (default value 0.84)
- Bilevel Pressure (default value 0.00/0.00)
- I/E Ratio (default value 0)

5. Tap **Save** to accept the changes.

6. Tap the **Back** arrow to return to the Setup screen or tap **Home** to return to the main menu.

Setting Up Calculated Parameters

With this menu, you can select the calculated parameters for each cassette style to be printed on the patient report. The printout order is fixed; however, calculated parameters may be selected for inclusion in/exclusion from the printout.

To specify the parameters to calculate and report on:

1. From the Home screen, tap **System Manager** and then tap **Setup**.

2. On the Patient/QC tab, tap **Calculated Parameters**.

3. Select the cassette type.

4. Select the parameters to be printed and then tap **Save**.

5. Tap the **Back** arrow to return to the Setup screen or tap **Home** to return to the Home screen.

Setting Up Measurement Limits

The Measurement Limits screen provides the normal ranges for canine, feline and equine arterial and venous samples.

To view the normal ranges for canine, feline and equine:

1. From the Home screen, tap **System Manager** and then tap **Setup**.

2. From the Setup screen, tap **Measurement Limits**.

3. On the **Species 1** tab, select the Species and Sample Type.

4. Tap the **Reference** tab to view the normal ranges for each species and sample type. (See "Appendix A Normal Ranges" for a list of the normal ranges the VetStat analyzer uses for each species.)

5. Tap **Save** to save your settings.

   NOTE: To return the analyzer to its default settings, tap the **Defaults** button.

6. Tap the **Back** arrow to return to the Setup screen or tap **Home** to return to the Home screen.

Setting Units

The Units screen lets you change the units of measurement for barometer/partial pressures, temperature, total hemoglobin and output resolution.

1. From the Home screen, tap **System Manager** and then tap **Setup**.

2. From the Setup screen, tap the **System** tab and then tap **Units** (figure 23).

3. On the Units screen, select the desired unit of measurement (figure 24).

Your VetStat analyzer has been factory preset to the following units:

Barometer/Partial Pressures: mmHg

Temperature: °C

tHb: g/dL

Ca^{++}: mmol/L

Resolution: Low

NOTE: When units are changed, the system automatically recalculates related units using the new unit parameter. See "Appendix B: Technical Specifications" for more information on high and low resolutions.
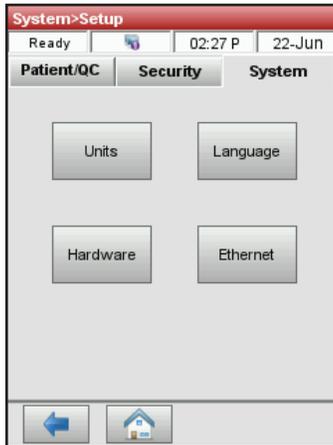
Figure 23. System Manager> Setup screen
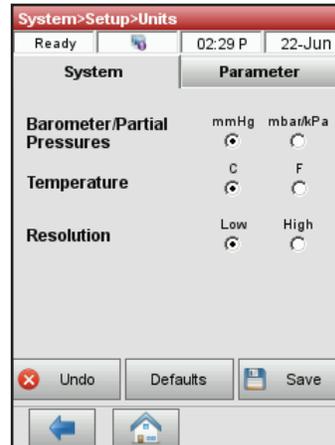
Figure 24. System Manager> Setup> Units screen

4. Tap **Save** to save the settings.

   NOTE: To return to the original factory settings, tap the **Defaults** button.

5. Tap the **Back** arrow to return to the Setup screen or tap **Home** to return to the Home screen.

Setting Up Security

The Security screen allows you to:

- **Settings**—Use this option to set up various security settings including User IDs and User Groups.

- **Change Password**—Use this option to change your password while you are logged on.

- **Reinitialize**—Use this option to delete the database and return to the system default settings.

   To access the Security menu:

   1. From the Home screen, tap **System Manager** and then tap **Setup**.

   2. On the System Setup screen, tap **Security**.

   To select the Security settings:

   1. From the Home screen, tap **System Manager** and then tap **Setup**.

   2. On the Security tab, tap **Settings**.

3. Enter your User ID and password when prompted.

4. In the User ID Entry menu, edit the security settings as desired:

- Select **None** to disable all security options.

- Select **Non-Secure User ID Entry** to request a user ID before patient testing, QC testing, maintenance activities and running an Hb calibrator.

- Select **Secure User ID Entry** to set up secure user IDs and create groups of users with certain privileges. When this option is enabled, users will be asked to log in to the VetStat before they can perform any operations.

    The user ID can be entered by bar code scanner for easy access. Once logged in, the VetStat will enter the user ID for all activities performed by the user automatically.

5. Select the **Password Enable** check box to require users to enter their password before using the analyzer (system default is PASSWORD).

- Select the **Expiration Enable** check box to allow an administrator to set an expiration date for each user ID.

- Select a **Logon Timeout** time in minutes that allows users to log into the analyzer after the specified length of inactivity.

To set up user IDs:

The analyzer can store up to 300 user IDs.

1. From the Home screen, tap **System Manager** and then tap **Setup**.

2. On the System Setup screen, tap the **Security** tab and then tap **Settings**.

3. On the Users tab, tap the plus sign icon to enter a new user to be added to the list of authorized users.

4. *To create a new user,* on the User Information screen, tap the pencil icon to enter the user ID (up to 25 characters). Then enter the user ID expiration date, if required.

    OR

    To edit an existing user, select the user and then tap the pencil icon. You can then:

    - Reset the user's password by tapping **Reset Password**.

    - Delete the user by tapping the trash can icon.

    - Print a list of all of the users currently stored in memory by tapping the printer icon.

To set up user groups:

1. From the Home screen, tap **System Manager** and then tap **Setup**.

2. On the System Setup screen, tap the **Security** tab, tap **Setting** (contact Customer Support for username and password), and then tap **Groups**.

3. Tap the plus sign icon to add a new user group.

4. Tap the pencil icon to enter a unique name for the new user group.

5. Tap **Functions** to assign functions to the user group: The list at the top of the screen shows all of the available functions. Select the function that you want to assign to your user group from the list at the top of the screen. Then tap the **Down** arrow to move it to your list in the selection field at the bottom of the screen. Tap the **Back** arrow to remove an item from the selection list.

6. Tap **OK** to accept the changes.

7. Edit the **users** in your group, as needed, using the tools on the bottom half of the screen:

   - Add users to your group by tapping the plus sign icon next to the bottom half of the screen.

   - Remove users from your group by selecting their user ID and tapping the trash can icon.

8. Edit the **user group**, as needed, using the tools on the top half of the screen.

   - Edit the user group by tapping the pencil icon.

   - Delete the user group by tapping the trash can icon.

9. Tap the **Back** arrow to return to the Setup screen or tap **Home** to return to the Home screen.

To set up a password:

1. From the Home screen, tap **System Manager** and then tap **Setup**.

2. On the Security tab, tap **Change Password**.

3. Tap the pencil icon to enter a new password. Retype the password when prompted.

4. Tap **OK** to accept the changes.

5. Tap the **Back** arrow to return to the Setup screen or tap **Home** to return to the Home screen.

Setting Quality Control Lockout Requirements

This menu can be used to lock out operators unless some form of QC is peformed. IDEXX recommends using each option described below. Each facility should develop their own policies on the frequency and type of QC based on the regulatory requirements. The analyzer is factory-set with lockout options turned off. To change these settings, follow the steps below:

To set quality control lockout requirements:

1. From the Home screen, tap **System Manager** and then tap **Setup**.

2. On the Patient/QC tab, tap **Lockout**.

3. Tap the desired quality control lockout options:

   - **SRC Lockout Enable—**This option lets you require that one, two or three SRC levels be run at regular intervals: every 8 hours, every 12 hours, every 24 hours or every 7 days. If the required number of SRC levels are not run within the specified time frame, patient measurements cannot be run on the VetStat analyzer.

     NOTE: The selected time interval begins when this feature is enabled.

   - **QC Lockout Enable—**This option lets you require that one, two or three OPTI CHECK or VetStat quality control materials be run at regular intervals: every eight hours, every 12 hours, every 24 hours or every seven days. If the required number of quality control materials are not run within the specified time frame, patient measurements cannot be run on the VetStat analyzer.

   - **New Lot Lockout Enable—**This option lets you require that quality control materials be run when a new lot of sample cassettes is in use.

4. Tap **Save** to save the quality control lockout settings.

5. Tap the **Back** arrow to return to the Setup screen or tap **Home** to return to the Home screen.
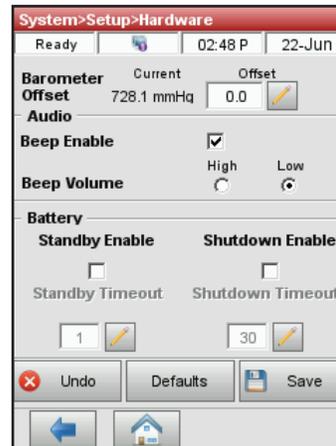
Setting Up Hardware

The Hardware screen lets you adjust the hardware options.

1. From the Home screen, tap **System Manager** and then tap **Setup**.

2. On the Systems tab, tap **Hardware** (figure 25).

3. On the Hardware screen, adjust the hardware options as desired (figure 26).
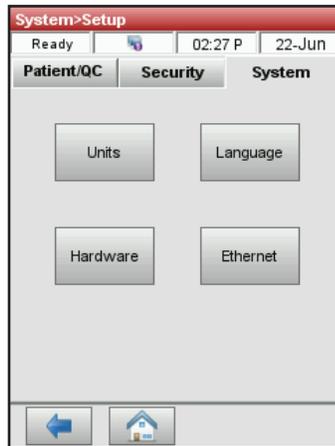
Figure 25. System Manager> Setup screen

Figure 26. System Manager> Setup> Hardware screen

    a. **Barometer Offset—**The offset is the difference between the default barometric pressure and the barometric pressure obtained by your weather station.

       To change the barometric pressure, tap the **Edit** button, enter the new numbers and tap **OK**.

       NOTE: Make sure to use the absolute barometric pressure and not the altitude-corrected pressure (check with your local weather service or airport).

       NOTE: You can change barometric pressure units from mmHg to mbar.

    b. **Beep Enable/Beep Volume**

- Tap the **Beep Enable** checkbox to turn on the VetStat analyzer's audible alarm (beep). A check mark appears in the checkbox.

- Tap the desired **Beep Volume** option (**High** or **Low**) for the VetStat analyzer's audible alarm.

    c. **Communication Auto Export/Communication Format**

       This hardware option is not currently available.

    d. **Battery: Standby Enable and Shutdown Enable**

- Tap the **Standby Enable** checkbox to automatically turn off the VetStat analyzer's backlight when the analyzer goes into standby mode.

- The **Shutdown Enable** options include **Off**, **1 minute** to **120 minutes**. If you select the minute option, the VetStat analyzer will go into standby mode when not used within that amount of time.

4. Tap **Save** to save the settings.

    NOTE: Tap the **Defaults** button to return the VetStat analyzer to its default settings.

5. Tap the **Back** arrow to return to the Setup screen or tap **Home** to return to the Home screen.

    NOTE: To exit standby and resume normal operation, tap the touch screen.

Cleaning and Maintenance

Setting a maintenance reminder

The VetStat* analyzer has a function that allows you to select maintenance reminder options which will alert you when analyzer cleaning is due. Any maintenance actions that you perform through the maintenance reminders will be captured in the maintenance log of the analyzer.

To set up a maintenance reminder:

When a maintenance reminder is set, the analyzer will remind you when the next analyzer cleaning is due.

1. From the Home screen, tap **System Manager** and then tap **Maintenance**.
2. Enter the User ID, if enabled.
3. On the Maintenance screen, tap **Setup**.
4. On the Setup screen, select the **Cleaning Reminder** check box.
   - Select **Weekly** for a weekly maintenance reminder.
   - Select **Monthly** for a monthly maintenance reminder.

Daily maintenance

No daily maintenance is required for the VetStat analyzer.

Weekly maintenance

The sample measurement chamber (SMC) should be cleaned once a week.

Open the top cover and clean the optics surface as well as the underside of the SMC cover with a lint-free cloth, dampened with a dilute alcohol or dilute bleach cleaner as needed. Be sure to remove all blood residue with a 10:1 diluted bleach solution. A cotton swab may be used for cleaning the smaller parts of the SMC.

Quarterly maintenance

Calibration of the tHb channel is required every 3 months. This calibration is performed using the tHb Calibrator cassette and verifies the measurement optics and electronics and corrects any potential drift. The tHb Calibrator cassette can be found in the storage compartment in the back of your analyzer.

1. From the Home screen, scan the bottom bar code on the calibration cassette by holding it 2–3 inches (5–8 cm) from the bar code scanner. Ensure the red line from the scanner covers the entire bar code. A beep and a green LED indicates a valid bar code.

   OR

   On the QC menu, tap **QC Manager**, tap **QC**, and then tap **tHb Calibrator**.
2. Enter the User ID, if required.
3. When the new tHB calibrator warning appears, tap **Continue**.
4. Gently clean the optics window and the inside top cover of the sample chamber with a soft lint free cloth and then tap **OK**.

5. When prompted, open the SMC cover by pressing down on the red latch.

6. Gently wipe both sides of the tHb Calibrator cassette with a clean dry cloth and examine it to ensure it is clean. Insert it into the chamber and press down to properly seat the cassette.

7. Close the sample chamber cover. The analyzer begins the calibration process.

8. When prompted, remove the cassette from the sample chamber and immediately return it to its pouch. The tHb calibration report will print automatically, showing both the old and new calibration factors. The calibration process is complete when the Ready screen appears.

Annual Maintenance

The peristaltic pump cartridge and gas I/O port seal must be replaced annually to ensure that your VetStat analyzer operates at peak performance.

**To replace the peristaltic pump cartridge and gas I/O port seal:**

1. Turn off the VetStat analyzer and open the printer cover door. The peristaltic pump is located to the right of the printer.

2. Remove the pump by firmly grasping the housing and pulling upward.

3. Using tweezers or hemostats, carefully pull out the two pump seals and discard them.

4. Insert the new seals, making sure the small diameter holes (flat top) are face down. Ensure that the seals are fully seated.

   NOTE: Seals are fully seated when the front seal is flush with the surface and the rear seal is approximately 1/8" (3 mm) below the surface.

5. With the nipples facing down, hold the new peristaltic pump cartridge next to the pump motor. Turn the motor shaft by hand so it aligns with the key-way of the pump spool. Then, align the pump cartridge with the motor shaft and push the cartridge down firmly until it is fully seated on the housing.

6. Press the pump cartridge roller down until it is firmly seated on the shaft of the pump motor.

7. Open the SMC cover. Remove the black gas I/O port seal (figure 27) by grasping it with a hemostat or tweezers and firmly pulling upward. Discard the old gas I/O port seal.

   WARNING: Do not push the hemostat or tweezers down into the port opening as this may cause damage to the analyzer.

8. Install the new gas I/O port seal with the rounded surface pointing up and press it into the recess. When fully seated, the I/O port seal is approximately 1/8" (3 mm) above the surrounding surface.

9. Test the peristaltic pump to ensure correct operation. From the Home screen, tap **System**, tap **Diagnostics** and then tap the **Tests** tab.

10. Tap **Pump** (figure 28) to test the pump motor. The pump should rotate smoothly without excessive noise. This diagnostic test automatically steps through all the speeds used during normal operation (7.5–120 rpm) and then returns to the Diagnostics> Tests tab.

Cassette seat   Gas I/O port
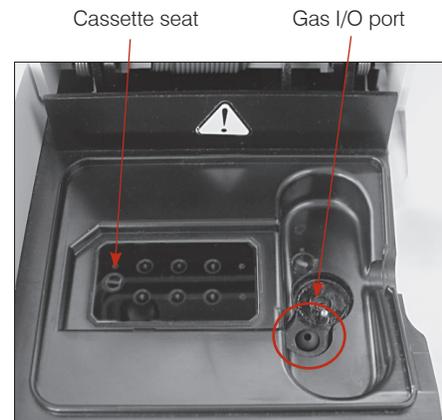
Figure 27. Inside the sample measurement chamber
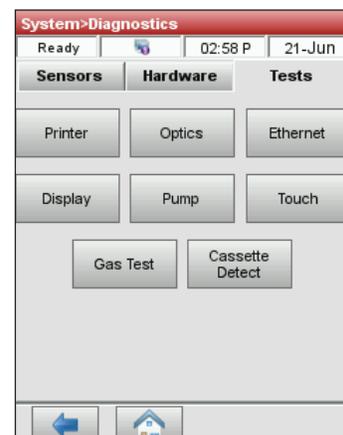
Figure 28. System Manager> Diagnostics> Tests> Pump

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When the diagnostic test is complete, run one sample in control mode, ensuring that the control measurement passes without errors (see "Running Quality Control" in the "Quality Control" section).

As-needed maintenance

To change the gas bottle:

The calibration gas bottle is designed to provide approximately 80 sampling operations. Its in-use expiration is 6 months from installation or the shelf life of the gas bottle (whichever comes first).

1. When prompted, tap **New Gas Bottle**.
2. Unscrew the gas bottle by turning the knob on the bottom counterclockwise.
3. When prompted, scan the new gas bottle bar code on the insert sheet by holding it 2–3 inches (5–8 cm) from the bar code scanner on the bottom-right corner of the analyzer. Record the date of installation on the gas bottle for later reference.

   NOTE: If the insert sheet is misplaced, you can enter the lot number on the gas bottle label manually. Tap **Manual** and enter the number using the numeric keypad.

   NOTE: The bar code contains expiration information. The VetStat analyzer will alert the operator two weeks before the gas bottle expires.

   NOTE: The gas bottle should always be stored with the cap on.

5. When prompted, remove the cap from the new gas bottle, insert it into its housing, and turn it clockwise until finger-tight. Then, tap **OK**.
6. When the new bottle message appears, tap **Yes**. The analyzer initiates a purge of the system and returns to the Home screen.

   NOTE: If you are reinstalling a used bottle, tap **No** and then enter the number of weeks the bottle has been in service using the numeric keypad.

To change the printer paper

The thermal printer paper supplied by IDEXX contains an indicator strip to alert you when the paper roll needs to be changed.

1. Press the red printer release button on the printer cover to access the printer.
2. Place the paper into the paper tray.
3. Pull the end of the paper upward and slightly out of the paper tray.
4. Hold the paper and close the printer cover.

To perform routine cleaning

The VetStat analyzer is designed to require very little maintenance. Routine cleaning consists of wiping the exterior analyzer surfaces including touch screen with a soft, damp cloth.

NOTE: Do not use cleaners with ammonia, abrasives, or greater than 10% bleach on the VetStat analyzer.

NOTE: Do not spray cleaning spray directly onto the screen.

Diagnostics and Alert Messages

Diagnostics

Your VetStat* Electrolyte and Blood Gas Analyzer has a number of useful diagnostic programs.

NOTE: Many of the diagnostics that can be performed on the VetStat analyzer require the assistance of an IDEXX Customer and Technical Support representative.

Sensors

On the Diagnostics> Sensors tab, you can check the following:

- Temperature
- LEDs
- Battery voltage
- Gas level
- Barometric pressure

To check system functions on the Sensors tab:

1. From the Home screen, tap **System Manager** to display the System screen.
2. Tap **Diagnostics** (figure 29) and then tap the **Sensors** tab (figure 30).
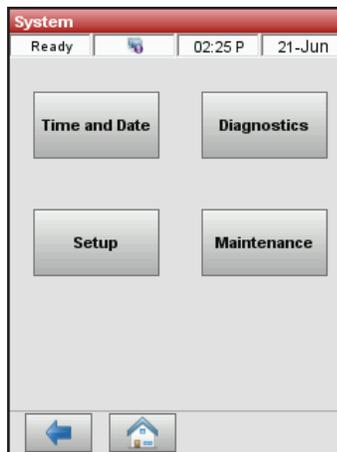
Figure 29. System Manager screen
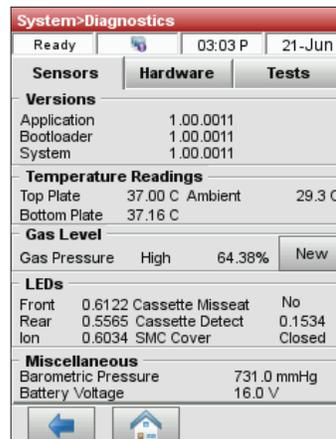
Figure 30. System Manager> Diagnostics> Sensors tab

- **Temperature—**In the "Temperature Readings" section, you can check the top plate, bottom plate and ambient temperatures.

  NOTE: If the top or bottom plate temperatures are out of range, the temperature display changes to red. Normal temperatures are:

    – Top plate: 36.95°–37.05°C
    – Bottom plate: 37.10°–37.2°C

- **Gas Level**—In the Gas Level section, you can check the percentage of gas remaining in the gas bottle. With a new gas bottle in place, the pressure should be approximately 99%; with the bottle removed, the pressure should be 00%.

  NOTE: To install a new gas bottle, tap **New** in the Gas Level section. Scan the bar code label located on the gas bottle's package insert. Tap **OK** to initiate a gas purge.

- **LEDs**—In the LEDs section, you can view the status of the analyzer's LEDs.

- **Barometric pressure/Battery voltage**—In the Miscellaneous section, you can check the barometric pressure and the battery voltage.

  – If the barometric pressure requires adjustment, see "Setting Up Hardware" in the "System Management" section.

  – If the battery voltage is below 11.8 V, the battery needs to be recharged or may need to be replaced. Perform the deep-discharge maintenance procedure and recheck.

3. Tap **Home** to return to the Home screen.

Hardware

On the Diagnostics> Hardware tab, you can check the following:

- Cooling fan
- Valve drive
- Gas valve
- Factory settings

To check system functions on the Hardware tab:

1. From the Home screen, tap **System**.

2. Tap **Diagnostics** and then tap the **Hardware** tab (figure 31).

   - **Fan**—To check the cooling fan, tap the **On/Off** button to start the test. When on is selected, you should feel the draft of the fan when you place your hand over the fan on the back of the analyzer.

   - **Gas Valve**—This test should be performed only with the assistance of an IDEXX representative. Contact IDEXX Customer and Technical Support.

   - **Valve Drive**—This test should be performed only with the assistance of an IDEXX representative. Contact IDEXX Customer and Technical Support.

   - **FSet (Factory Settings)**—Checking factory settings should be performed only by an IDEXX representative. Contact IDEXX Customer and Technical Support.

3. Tap **Home** to return to the Home screen.
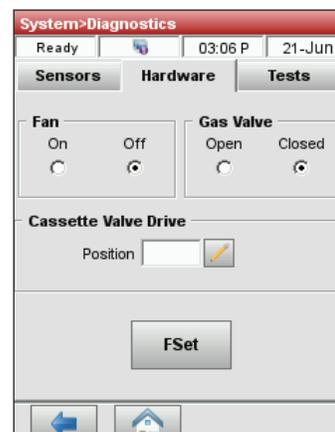
Figure 31. System Manager> Diagnostics> Controls tab

On the Diagnostics> Tests tab, you can check the following:

- Optics
- Cassette detect
- Display
- Gas test

- Printer
- Ethernet
- Pump motor
- Touch screen

To check system functions on the Tests tab:

1. From the Home screen, tap **System**.

2. Tap **Diagnostics** and then tap the **Tests** tab.

   - **Printer—**This test checks the operation of the printer. Tap **Printer** to start the test. The printer prints a test printout. Verify that the alphanumeric printout is legible and that all of the characters printed properly.

     NOTE: If the printout is deficient, you may need to replace the printer. Call IDEXX to order a replacement printer. Contact IDEXX Customer and Technical Support for further assistance.

   - **Optics—**Checking the analyzer optics should be performed only by an IDEXX representative. Contact IDEXX Customer and Technical Support for assistance.

   - **Pump motor—**Tap **Pump** to start the test. The pump motor test automatically steps through all the speeds used during normal operation (7.5–120 rpm) and then displays the Diagnostics> Tests tab.

   - **Display—**This test checks the proper functioning of the analyzer's LEDs. Tap **Display** to start the test. The analyzer display will turn red, then green and then blue.

   - **Cassette detect—**The purpose of this test is to calibrate the cassette detect function when the analyzer stops detecting the cassettes.

   - **Touch screen—**This test checks the proper functioning of the analyzer's touch screen. Tap **Touch** to start the test. Touch the screen; a dot should appear in the location you touched. If this does not happen, tap **Calibrate** and follow the instructions. Using a stylus or pointed object, touch the center of the calibration mark as it appears on the screen. When you are finished, tap **Save**.

     NOTE: Sharp objects can damage the screen.

   - **Gas Test—**This test is designed exclusively for use by an IDEXX representative. Contact IDEXX Customer and Technical Support to run this test.

3. Tap **Home** to return to the Home screen.

Measurement and Diagnostics Reports

You can print reports that provide information on the diagnostic and calibration tests that are performed on the VetStat analyzer.

Patient Measurement Report

The Patient Measurement report is available with results after each measurement.

To print the Patient Measurement report:

1. From the Home screen, tap **Data Manager** to display the Data screen.

2. In the Measurement Reports and Statistics section, tap **Patient**.

3. Select a patient and tap **Print** to print the Patient Measurement report. The printout details the measured signal in millivolts and drifts.

4. Tap the **Back** arrow to return to the Data screen.

SRC Measurement Diagnostics Report

To print the SRC Measurement Diagnostics report:

1. From the Home screen, tap **Data Manager** to display the Data screen.

2. In the Measurement Reports and Statistics section, tap **SRC**.

3. Tap **Print** to print the SRC Measurement Diagnostic report. The printout shows details of measured millivolts signals, as well as the observed drifts in measurement.

4. Tap the **Back** arrow to return to the Data screen.

Controls Measurement Diagnostics Report

To print the Controls Measurement Diagnostics report:

1. From the Home screen, tap **Data Manager** to display the Data screen.

2. In the Measurement Reports and Statistics section, tap **Controls**.

3. Tap **Print** to print the Controls Measurement Diagnostic report. The printout shows details of measured millivolts signals, as well as the observed drifts in measurement.

4. Tap the **Back** arrow to return to the Data screen.

Error Report

To print the Error report:

1. From the Home screen, tap **Data Manager** to display the Data screen.

2. In the Calibration Reports section, tap **Errors**.

3. On the Errors screen in the Error Log section:

    • Tap **Print** to print the error messages in the database.

    • Tap **Delete** to delete the error messages from the database. At the "Delete the Error Log?" message, tap **Yes** to delete all error messages.

4. Tap the **Back** arrow to return to the Data screen.

Configuration Report

To import/export the Configuration report:

1. From the Home screen, tap **Data Manager** to display the Data screen.

2. Insert the USB flash drive as instructed and select either the **Import** or **Export** option.

3. Tap the **Back** arrow to return to the Data screen.

    NOTE: After initial setup, a configuration report should be exported and kept in a safe place for later reference.

Alert Messages

Your VetStat* Electrolyte and Blood Gas Analyzer is designed to provide trouble-free service. At times, various alert messages may appear, requiring you to initiate corrective action.

If you need additional assistance, contact IDEXX Customer and Technical Support.

Message	Problem/Action
! Not Ready: Low Gas	The gas pressure is low. • Replace the gas bottle.
! Not Ready: Temperature out of range.	The temperature is out of range. • Wait for the analyzer to reach the correct temperature. • If the analyzer does not become ready within a reasonable time, check the temperature in System Manager> Diagnostics. **Temperature specifications:** 　Top plate: 36.95°–37.05°C 　Bottom plate: 37.10°–37.2°C **NOTE:** The cooling fan turns on if the temperature is >31.5°C and turns off if the temperature is <30.5°C.
! Not Ready: Cassette Detect	A cassette detect error has occurred. • Remove the cassette and turn the power off. Wait 30 seconds and turn the power back on. • If the message persists, contact IDEXX Customer and Technical Support.
! Not Ready: Low Battery	The battery voltage is low. • Operate the analyzer on AC power and/or recharge the battery.
Warning! No sample detected.	Sensors did not detect any sample. • Make sure the sample is properly attached, not clotted and does not contain air bubbles. Wait for the analyzer to recalibrate. • Remix the sample carefully. Tap **OK** to notify the analyzer that the sample is reattached and to reaspirate the sample.
Warning! Unstable pH. Check cassette.	Unstable pH (other measured parameter). **NOTE:** This message is a warning. The analyzer will, however, display a result for the parameter. • Remove the cassette and check for aspirated bubbles. If bubbles are visible in the cassette, rerun the sample with a new cassette.
Warning! Bad sensor—pH.	The pH (or other measured parameter) sensor is bad. • Tap **Cancel** to stop the measurement. • Tap **OK** to continue the measurement. If you continue, no results will be provided for the bad sensor or any calculated result that uses this measurement.
Warning! Low battery. One test remaining.	The battery voltage is low. • Tap **OK** to complete the current test. • Replace the battery or recharge it by plugging the analyzer into the main power supply as soon as possible.
Warning! Gas expires soon.	The gas bottle will expire in two weeks. • Tap **OK** to continue. Ensure that a new gas bottle is in inventory or has been ordered.

Message	Problem/Action
Warning! Low gas. One test remaining.	When the percentage in the gas bottle reaches 4%, this message appears. • Tap **OK** to complete the current test. • Replace the gas bottle at the completion of the test. **NOTE:** You can replace the gas bottle at the next warning, and the VetStat analyzer will automatically perform the necessary one-minute gas purge. Otherwise, use the standard procedure to perform the purge.
Warning! Check pump.	The peristaltic pump is becoming worn. • Tap **OK** to continue the measurement. • Perform a pump diagnostic if this warning persists. If the pump diagnostic fails, replace the pump cartridge (see the "Cleaning and Maintenance" section).
Warning! Check pump. Please remove cassette.	The peristaltic pump is becoming worn. • Remove the cassette. Retry with a new cassette. • Change the peristaltic pump cartridge (see the "Cleaning and Maintenance" section).
Warning! Bubble detected. Check cassette.	A bubble was detected at the light gates. • Remove the cassette. Tap **OK** to continue. • Examine the cassette and look for bubbles. If bubbles are visible, rerun the sample using a new cassette.
Warning! Hb Cal expires soon.	This message appears only once, before the three-month expiration of the hemoglobin calibration, and acts as a reminder to run the hemoglobin calibrator. • Tap **OK** to continue. • Ensure that an HbCC is in inventory or has been ordered.
Warning! Secure Op ID list is full.	The number of secure operator IDs stored in memory equals 300. • Tap **OK** to continue.
Stop! Low battery. Recharge now. *or* Stop! Low battery. Recharge and cycle power.	The battery is low. • Turn the power off, wait 30 seconds and then turn the power back on. • Install a freshly charged battery, recharge for up to 6 hours before the next sample is run, or operate the analyzer on AC power.
Stop! Low gas. Replace now.	The gas cylinder is empty. • Replace the gas cylinder and tap **OK**.
Stop! System error. Cycle power for reset.	The analyzer has detected an internal error. • Turn the power off, wait 30 seconds and then turn the power back on. • Discard the cassette.
Stop! Memory error. Database deleted.	Patient, quality control and other databases were deleted. • Tap **OK** and the analyzer will reinitialize.

Message	Problem/Action
Stop! Temperature out of range.	The temperature is out of range during any kind of measurement. • Tap **OK** and continue. • If the error message appears again, check the temperature in System Manager> Diagnostics. **Temperature specifications:** 　Top plate: 36.95°–37.05°C 　Bottom plate: 37.10°–37.2°C **NOTE:** The cooling fan turns on if the temperature is >31.5°C and turns off if the temperature is <30.5°C.
Error! Bad sensors. Discard cassette.	Two or more measured parameter sensors are bad. • Tap **OK**, discard the cassette and repeat the test with a new cassette.
Error! Possible clot. Discard cassette.	A sample error has occurred. This may be due to a clot or to a blockage preventing sample aspiration. • Tap **OK** and discard the cassette. Check the sample for clots. If present, redraw and analyze a new sample.
Error! Gas expired.	The gas bottle has expired, or you have used an invalid bar code. • Check the gas bottle label. Make sure the expiration date has not been exceeded. If expired, insert a new gas bottle. • Check the date setting in System Manager> Time and Date.
Error! Cassette misseat 1 (or 2). Reinsert.	The cassette was not properly placed into the chamber. • Open the SMC cover, remove and reinsert the cassette, and close the cover. Tap **Cancel** to continue. • Tap **Cancel** and then remove and discard the cassette. Repeat the test with a new cassette. **NOTE:** Be sure to wipe the cassette with a dry, clean, lint-free cloth before inserting it into the SMC. If the message still appears with a different cassette, turn the power off and wait 30 seconds. Then turn the power back on and retry.
Error! Cassette misseat 2. Discard cassette. 　*or* Error! Bad cassette. Discard cassette.	The cassette was not properly placed into the chamber or the cassette is damaged. • Tap **Cancel** and then remove and discard the cassette. Repeat the test with a new cassette. Be sure to wipe the cassette with a dry, clean, lint-free cloth before inserting it into the SMC. • If the message still appears with a different cassette, turn the power off and wait 30 seconds. Then turn the power back on and retry.
Error! Bad calibration. Discard cassette.	The analyzer did not calibrate because of internal problems or problems with the cassette. • Tap **Cancel** and then remove and discard the cassette. Repeat the test with a new cassette. Be sure to wipe the cassette dry with a clean, lint-free cloth before inserting it into the SMC. • If the message still appears with a different cassette, turn the power off and wait 30 seconds. Then turn the power back on and retry.
Error! Dirty optics. Clean cassette and optics. 　*or* Error! Dirty optics. Discard cassette.	The optics or the cassette are dirty. The analyzer is unable to calibrate because of dirty optics or a dirty cassette. • Remove the cassette. Wipe the cassette with a dry, clean, lint-free cloth. Inspect the optics on the bottom and top plates. Clean them, if necessary, with isopropyl alcohol. Reinsert the cassette, or discard it and insert a new cassette. Tap **OK** to continue with the test.

Message	Problem/Action
Error! Calibration expired. Discard cassette.	The cassette has been holding the calibration for more than 10 minutes without a sample being attached. • Tap **OK** and then remove and discard the cassette.
Error! Unstable sensors. Discard cassette.	A sample error has occurred. This may be due to a clot or large air bubble if two or more sensors are unstable. • Tap **OK** and then remove and discard the cassette. Check the sample for clots or bubbles. Rerun the test with a new cassette.
Error! Short sample. Discard cassette.	The analyzer was not able to aspirate enough contiguous sample fluid to cover the optode sensors after multiple aspiration attempts. If a bubble was detected, the analyzer attempted to restart the aspiration and was not able to aspirate enough sample. • Tap **OK** and then remove and discard the cassette.

Error! Invalid bar code.	The bar code is invalid; either the analyzer misread the bar code label, or the bar code label is invalid.
	
	• Tap **OK** to retry.
	
	• If the error message appears again, try entering the bar code manually.
	
	• Clean the bar code scanner.
	
	   – Using an alcohol prep pad or a lint-free cloth dampened with diluted alcohol, gently wipe the face of the scanner clean.
	
	   – Retry the bar code.

Error! Invalid bar code. Check time and date. *or* Error! Expired bar code. Check time and date.	The bar code is invalid; either the analyzer misread the bar code label, or the product (i.e., gas bottle, cassette or SRC) has expired. • Tap **OK** to retry. • Verify the product expiration date. • If the error message appears again, check the date in System Manager> Time and Date.
Error! Invalid bar code. Different QC lot.	The bar code is invalid. • Verify that <Scan A> and <Scan B> of the quality control material are from the same level and lot number. Tap **OK** to continue.
Error! Invalid tHb calibrator.	The cassette placed in the SMC is invalid. • Verify that the cassette placed in the SMC is a valid hemoglobin calibration cassette (HbCC). Tap **OK** to continue.
Error! Invalid QC lot.	The QC lot is invalid. • Tap **OK** to continue.
Error! Invalid SRC.	The SRC type is invalid. • Tap **OK** to continue. • Remove the SRC. • Configure the SRC data in Setup and retry.

Message	Problem/Action
Error! Expired SRC. Check time and date.	The SRC expiration date has been reached. • Tap **OK** and remove the SRC. • If the error message appears again, check the date in System Manager> Time and Date. • Configure a new SRC in Setup and retry.
Error! Setup QC.	A measurement of QC materials, either liquid or SRCs, was attempted prior to setting up. • Tap **OK** to continue. • Configure the SRCs and/or liquid QC material in Setup and retry. (See the "System Management" section.)
Error! Calibration out of range.	This error can occur during Hb calibration, and is triggered when the correction is greater than 10%. • Contact IDEXX Customer and Technical Support for assistance.

IDEXX Customer and Technical Support

United States: 1-800-248-2483

Australia: 1300 44 33 99

Austria: 43 (0)1 206 092 729

Belgium: 32 (0)27 00 64 38

Brazil: 0800-777-7027

Canada: 1-800-248-2483

China (PRC): 400-678-6682

Czech Republic: 420-239018034

Denmark: 45 (0) 43 31 04 39

Finland: 358 (0)9 7252 2253

France: 33 (0) 810 433 999

Germany: 49 (0)69 153 253 290

Ireland: 353 (0)1 562 1211

Italy: 39 02 87 10 36 76

Japan: 0120-71-4921

Latin America: tecnico-latam@idexx.com

Luxembourg: 352 (0)34 20 80 87 22

Netherlands: 31 (0)70 700 7033

New Zealand: 0800 83 85 22

Norway: 47 24 05 51 10

Poland: 48 22 853 40 01

Russia: 7-4999-511-255

Singapore: 65 6807-6277

Slovakia: 421-268622417

South Korea: 080 7979 133

Spain: 34 932 672 660 or 34 916 376 317

Sweden: 46 (0)8 5198 9566

Switzerland: 41 (0)44 511 22 37

Taiwan: 0800 291 018

United Kingdom: 44 (0)20 3788 7508

Appendix A: Normal Ranges

The normal ranges for canine, feline and equine parameters are:

Parameter	Units	Canine		Feline		Equine	
		Low	High	Low	High	Low	High
Na$^+$ [1]	mmol/L	144	160	150	165	133	150
K$^+$ [1]	mmol/L	3.5	5.8	3.5	5.8	3.0	5.3
Cl$^-$ [1]	mmol/L	109	122	112	129	97	109
Ca^{++} [3, 4]	mg/dL	5.0	6.0	4.5	5.5	6.01	7.21
Ca^{++}	mmol/L*	1.25	1.50	1.13	1.38	1.50	1.79
pH arterial [2, 3]		7.36	7.44	7.36	7.44	7.35	7.47
pH venous [2, 3]		7.34	7.46	7.33	7.41	7.34	7.43
tCO$_2$ arterial [2, 3]	mEq/L	25.0	27.0	21.0	23.0		
tCO$_2$ venous [2, 3]	mEq/L	21.0	31.0	27.0	31.0		
HCO$_3^-$ arterial [2, 3]	mEq/L	24.0	26.0	20.0	22.0	22.0	29.0
HCO$_3^-$ venous [2, 3]	mEq/L	20.0	29.0	22.0	24.0	22.0	29.0
PCO$_2$ arterial [2, 3]	mmHg	36	44	28	32	36	46
PCO$_2$ venous [2, 3]	mmHg	32	49	34	38	38	48
PO$_2$ arterial [2, 3]	mmHg	90	100	90	100	80	112
PO$_2$ venous [2, 3]	mmHg	24	48	35	45	37	56
tHb [5]	g/dL	12.0	18.0	8.0	15.0	10.0	18.0
SO$_2$ [6, 7]	%	93	100	93	100	93	100

*Conversion to SI units: mg/dL x 0.25 = mmol/L

[†] Conversion to SI units: mg/dL x 0.0555 = mmol/L

NOTE: When selecting **Other** in the Species Selection screen, the normal ranges printed on the patient report are the analyzer's dynamic range. IDEXX does not provide normal ranges for species other than canine, feline and equine.

Appendix B: Technical Specifications

Measurement Range and Resolution

Parameter	Dynamic Range	Low Resolution	High Resolution
Na^+	100–180 mmol/L	1	0.1
K^+	0.8–10 mmol/L	0.1	0.01
Cl^-	50–160 mmol/L	1	0.1
Ca^{++}	0.2–3.0 mmol/L	0.01	
pH	6.6–7.8 pH units	0.01	0.001
PCO_2	10–200 mmHg	1	0.1
PO_2	10–700 mmHg	1	0.1
tHb	5–25 g/dL	0.1	
SO_2	60–100%	1	0.1

Barometric Pressure
300 to 800 mmHg

Operating Altitude
Up to 3048 m (10,000 ft)

Operating Parameters
Minimum sample size: 125 μL

Sample type: lithium heparinized whole blood, plasma or serum

Sample application: syringe or capillary

Sample input: automatic aspiration

Analysis time: <2 minutes

Ambient temperature range: 10°C–32°C (50°F–90°F)

Relative humidity range: 5%–95% (noncondensing)

Dimensions and Weight
Width: 14.2 inches (36.2 cm)

Depth: 9.1 inches (23.0 cm)

Height: 4.7 inches (12.0 cm)

Instrument weight: 8.65 lb (3.9 kg)

Battery weight: 0.94 lb (0.42 kg)

Default Settings

Parameter	Default
Patient ID	On
Operator ID	On/Off
Requisition ID	On/Off
Client ID	On/Off
Age	On
Gender	On
Species	On
Sample type	On
FIO_2	Off
Tvol	Off
MVol	Off
PIP	Off
Pplat	Off
PS	Off
CPAP	Off
Rate	Off
Liter Flow	Off
I/E Ratio	Off
Bi-Level	Off

Parameter	Default
Comment Field	On
Password	Disabled
QC Lockout (SRC Levels)	Off
QC Lockout (QC Levels)	Off
QC Lockout (New Lot)	Off
Units	Conventional
Temp	Centigrade
Time	24-hour
tHb	g/dL
Ca^{++}	mmol/L
Resolution	Low
Language	English
Battery Saver (Auto Off)	Always on
Battery Saver (Display)	Always on

Appendix C: Calculated Values

Units Used in Measured and Input Parameters for Calculations

Parameter	Unit	Parameter	Unit
pH	pH-unit	K	mmol/L
PCO_2	mmHg	Ca	mmol/L
PO_2	mmHg	Cl	mmol/L
tHb	g/dL	SO_2	%
Na	mmol/L		

Conversion Table for Units[1]

CTO_2, O_2CT, tCO_2	1 vol% = 1 mL/dL = 0.4464 mmol/L
tHb	1 g/dL = 10 g/L = 0.6206 mmol/L
barometric pressure, PCO_2, PO_2	1 mmHg = 1.3333 mbar = 0.1333 kPa
ionized calcium (Ca^{++})	1 mmol/L = 4.008 mg/dL = 2 mEq/L
	1 mmol/L = 18.02 mg/dL 1 mg/dL = 0.0555 mmol/L

Calculated Parameters and Equations[1, 2, 3, 4, 5, 6, 7]

The VetStat* Electrolyte and Blood Gas Analyzer can calculate various parameters using the measured values obtained during sample analysis. There are many different equations used to calculate these parameters. These equations are provided below.

Note: Calculated parameters, with the exception of HCO_3^-, do not have reference ranges.

The following calculated parameters have been tested for canine, feline and equine specimens and are verified to provide results that are suitable for veterinary use.

AG

The anion gap is a calculated parameter used to express the difference in concentrations of major cations and anions in the blood specimen.[1]

$$AG = (Na^+ + K^+) - (Cl^- + HCO_3^-) \qquad \text{[mmol/L]}$$

BE_{ecf}

The base excess of extracellular fluid is a quantity that reflects only the nonrespiratory components of acid-base balance (tHb = 5 g/dL).[2]

$$BE_{ecf} = 0.93 \cdot [14.83 \cdot (pH - 7.40) - 24.4 + HCO_3^-] \qquad \text{[mmol/L]}$$

NOTE: This equation is, as stated in the NCCLS, an approximation. It is not directly derived from the BE equation alone.

tCO$_2$

Total concentration of CO_2 in plasma, the sum of dissolved CO_2 and bicarbonate[2]

$$tCO_2 = HCO_3^- + (0.0307 \cdot PCO_2) \qquad\qquad \text{[mmol/L]}$$

HCO$_3^-$

Bicarbonate concentration in plasma[2]

$$HCO_3^- = 0.0307 \cdot PCO_2 \cdot 10^{(pH - 6.129)} \qquad\qquad \text{[mmol/L]}$$

The following calculated parameters require additional information beyond the measured values to calculate a result. In the absence of measured values, for example tHb or SO_2, the VetStat analyzer can use default values or measured values from other testing entered through the patient information screens. The analyzer will calculate the result based upon the equations below. The equations are from established and accepted methods in human diagnostics; they have not been derived using veterinary samples.

AaDO$_2$

The alveolar to arterial oxygen tension gradient ($PAO_2 - PaO_2$) is the difference between the alveolar oxygen tension and the measured oxygen tension of arterial blood.[3]

$$Aa(DO_2) = (PAO_2 - PaO_2) \qquad\qquad \text{[mmHg]}$$

AaDO$_2^t$

Alveolar to arterial oxygen tension difference corrected to patient temperature other than the default temperature (37°C) preprogrammed in the VetStat analyzer[3]

$$AaDO_2^t = PAO_2^t - PaO_2^t \qquad\qquad \text{[mmHg]}$$

where:

$$PAO_2^t = (P_{total} - PH_2O^t)\, FIO_2 - PACO_2^t\, [FIO_2 + (1 - FIO_2)/R]$$
$$\text{with } PH_2O^t = 47 \cdot 10^{[0.0237 - 0.0001\,(t - 37)]\,(t - 37)}$$
$$\text{and } PACO_2 = PaCO_2 \text{ (alveolar } PCO_2 = \text{ arterial } PCO_2)$$

*Apply above equation for $PAO_2^t \geq PO_2^t$,
otherwise $PAO_2^t = PO_2^t$*

BB

The buffer base is the concentration of buffering anions that is available in whole blood to buffer strong acids and consists mainly of protein anions and bicarbonate. Of the protein anions, hemoglobin is the most significant.[4]

$$BB = BE + 41.7 + 0.42 \cdot tHb \qquad\qquad \text{[mmol/L]}$$

BE

The base excess of the blood results from a calculation to determine the titratable base of the blood, which in principle is measured by titration of the blood with a strong acid or base to a pH of 7.4 with $PCO_2 = 40$ mmHg at 37°C.[2]

$$BE = (1 - 0.023 \cdot tHb) \cdot [(7.7 + 2.33 \cdot tHb) \cdot (pH - 7.40) - 24.4 + HCO_3^-]$$

$$\text{[mmol/L]}$$

BE(act)

Base excess at actual oxygen saturation[6]

$$BE_{(act)} = (1 - 0.0143 \cdot tHb) \cdot [(1.63 \cdot tHb + 9.5) \cdot (pH - 7.4) - 24.26 + HCO_3^-] -$$

$$0.2 \cdot tHb \cdot \left(1 - \frac{SO_2}{100}\right) \qquad [mmol/L]$$

cH+

Concentration (activity) of hydrogen ions in plasma[4]

$$cH^+ = 10^{(9-pH)} \qquad [nmol/L]$$

cH+t

Concentration of hydrogen ions corrected to patient temperature other than the default temperature (37°C) preprogrammed into the VetStat analyzer[2]

$$cHt = 10^{(9-pH^t)} \qquad [nmol/L]$$

nCa++

The ionized calcium value standardized to pH = 7.40

For blood:[2]

$$nCa^{++} (pH = 7.4) = Ca^{++} \cdot 10^{0.22 \cdot (pH - 7.4)} \qquad [mmol/L]$$

For plasma or serum:[2]

$$nCa^{++} (pH = 7.4) = Ca^{++} \cdot 10^{0.24 \cdot (pH - 7.4)} \qquad [mmol/L]$$

O₂Ct

Oxygen content is the sum of oxygen bound to hemoglobin as O_2Hb and the amount of oxygen dissolved in the plasma. This value is calculated from the measured O_2Hb, and tHb if available, and is estimated from the calculated SO_2 if the measured O_2Hb is not available and if the calculation of oxygen saturation is selected.[7]

$$O_2Ct = 1.39 \cdot \frac{O_2Hb}{100} \cdot tHb + 0.00314 \cdot PO_2 \qquad [vol\%]$$

NOTE: If PO_2 is not available, O_2Ct is calculated with $PO_2 = 90$ mmHg.

PCO₂t

PCO_2 value corrected to patient temperature other than the default temperature (37°C) preprogrammed into the VetStat analyzer[3]

$$PCO_2^t = PCO_2 \cdot 10^{0.019 \cdot (t - 37)} \qquad [mmHg]$$

pHt

pH corrected to patient temperature other than the default temperature (37°C) preprogrammed into the VetStat analyzer[3]

$$pH^t = pH - [0.0147 + 0.0065 \cdot (pH - 7.4)] \cdot (t - 37) \qquad [pH\text{-unit}]$$

PO_2^t

PO_2 value corrected to patient temperature other than the default temperature (37°C) preprogrammed into the VetStat analyzer[4]

$$PO_2^t = PO_2 \cdot 10^{\left[\frac{5.49 \cdot 10^{-11} \cdot PO2^{3.88} + 0.071}{9.72 \cdot 10^{-9} \cdot PO2^{3.88} + 2.30} \right] \cdot (t - 37)} \qquad \text{[mmHg]}$$

$st.HCO_3^-$

Standard bicarbonate of the blood, defined as the plasma bicarbonate concentration in blood that has been equilibrated at 37°C with a gas mixture having a $PCO_2 = 40$ mmHg.[4]

$$st.HCO_3^- = 10^{(st.pH - 6.022)} \qquad \text{[mmol/L]}$$

st.pH

Standard pH of the blood is defined as the pH value of a blood sample that has been equilibrated at 37°C with a gas mixture having a $PCO_2 = 40$ mmHg.[4]

$$st.pH = (0.8262 - 0.01296 \cdot tHb + 0.006942 \cdot BE) \cdot \log(0.025 \cdot PCO_2) + pH$$

$$\text{[pH-unit]}$$

1. Burtis CA, Ashwood ER, eds. Tietz *Textbook of Clinical Chemistry*, 2nd ed. Philadelphia, PA: WB Saunders; 1994.

2. Constable PD. Clinical assessment of acid-base status: comparison of the Henderson-Hasselbalch and strong ion approaches. *Vet Clin Pathol.* 2000;29(4):115–128.

3. NCCLS. *Definitions of quantities and conventions related to blood pH and gas analysis*, C12-A. 1994.

4. Marsoner HJ. *Quantities and Algorithms Related to Blood Gas and Acid Base Analysis*. AVL Medizintechnik Graz. 1995.

5. Zander R. Die korrekte Bestimmung des Base Excess (BE mmol/L) im Blut. *Anesthesiol Intensivmed Notfallmed Schmerzther*. 1995;30(1):36–38.

6. Simmons A, ed. *Hematology, A Combined Theoretical & Technical Approach*. Philadelphia, PA: WB Saunders; 1989:28–29.

7. Ehrmeye SS, *National Committee for Clinical Laboratory Standards (now Clinical & Laboratory Standard Institute). Fractional oxyhemoglobin, oxygen content and saturation, and related quantities in blood: terminology, measurement and reporting* (NCCLS document C25-T). 1992;12(11):10.

Appendix D: VetStat Logs

Daily

SRC Daily Runs

Week Ending:

SRC	Monday			Tuesday			Wednesday			Thursday		
Level 1	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials
Level 2	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials
Level 3	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials

SRC	Friday			Saturday			Sunday		
Level 1	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials
Level 2	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials
Level 3	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials	Pass/Fail	Date	Initials

Weekly

Month: **Year:**

	Week 1		Week 2		Week 3		Week 4	
Clean SMC	Date	Initials	Date	Initials	Date	Initials	Date	Initials

Month: **Year:**

	Week 1		Week 2		Week 3		Week 4	
Clean SMC	Date	Initials	Date	Initials	Date	Initials	Date	Initials

Month: **Year:**

	Week 1		Week 2		Week 3		Week 4	
Clean SMC	Date	Initials	Date	Initials	Date	Initials	Date	Initials

Month: **Year:**

	Week 1		Week 2		Week 3		Week 4	
Clean SMC	Date	Initials	Date	Initials	Date	Initials	Date	Initials

Monthly

Quality Control Monthly Runs

Month: **Year:**

	OPTI CHECK		
Level 1	Pass/Fail	Date	Initials
Level 2	Pass/Fail	Date	Initials
Level 3	Pass/Fail	Date	Initials

Quarterly

Year:

	Quarter 1		Quarter 2		Quarter 3		Quarter 4	
Perform Hb calibration	Date	Initials	Date	Initials	Date	Initials	Date	Initials

Annually

	Year:		Year:		Year:		Year:	
Replace peristaltic pump cartridge	Date	Initials	Date	Initials	Date	Initials	Date	Initials
	Year:		Year:		Year:		Year:	
Change gas I/O port	Date	Initials	Date	Initials	Date	Initials	Date	Initials

As Needed

Clean analyzer surfaces	Date	Initials	Date	Initials	Date	Initials	Date	Initials
Change gas bottle	Date	Initials	Date	Initials	Date	Initials	Date	Initials
Discharge battery	Date	Initials	Date	Initials	Date	Initials	Date	Initial