SINGLE CHANNEL
ECG and MONITOR
J1010
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JORVET SINGLE CHANNEL ECG
J-1010

**FRONT PANEL**

- Ground
- Carry handle
- AC cord Plug in
- ON//OFF switch

**BOTTOM PANEL**

- Fuses
- Patient Lead
- Analog ports—not supported on this model
- Computer port—not supported on this model

**BACK PANEL**

**RIGHT SIDE**
GETTING THE MOST FROM YOUR ECG

The ECG tracing is a valuable diagnostic tool, and their interpretation can be a challenging task for the clinician and staff. However, with some simple study, the ECG will be an indispensable clinical parameter.

Some recommended indications for the use of the ECG include
- Any animal with a heart murmur or arrhythmia detected with a stethoscope
- Any animal with episodes of weakness or fainting, exercise intolerance, or sudden changes in activity level
- A hypothyroid dog or hyperthyroid cat
- Any animal with hypotension or hypertension
- Any patient being treated for congestive heart disease should have follow-up tracings as part of maintenance and control of the disease.
- Electrolyte imbalances such as Addison’s disease
- Breeds with predispositions to heart disease, such as Persian cats and Doberman Pinschers
- Geriatric exams can be greatly enhanced by the addition of a LEAD II rhythm strip screening. Should suspicious tracings exist, then a full 6-lead cardiograph analysis is recommended.

An ECG recording should always be evaluated in conjunction with complete patient history, clinical findings, radiographs, blood chemistries including electrolytes and blood gases, and urinalysis. The recording is not by itself a complete diagnosis but rather a look at the electrical activity of the myocardium, that can be affected by many disorders and artifactual interference.
HELPFUL HINTS FOR GETTING QUALITY ECG TRACINGS

♥ Use a rubber mat to insulate the patient from a stainless steel table.
♥ Select a quiet or remote area of the clinic for the procedure.
♥ *Leave the instrument turned off until the leads are attached and the animal is calm.*
♥ Right lateral recumbency is the standard body position for ECG recording in dogs and cats.
♥ If respiratory distress is evident, consider recording with the animal standing or in sternal recumbency.
♥ To obtain the most accurate tracings, care should be taken to avoid undo stress and minimize the “white coat” effect. Allow the animal to become familiar with its surroundings.
♥ Establishing contact with the patient is important, especially for the person administering the ECG.
♥ Consider owner participation in cases of small dogs or cats, or animals that are especially frightened. Small patients may be placed on the lap of the owner, or of another technician if it will alleviate stress.
♥ Some dogs will tolerate the procedure much better if standing on the floor rather than being placed on a table.
♥ Use of sedatives or tranquilizers is not advisable for diagnostic recordings. If used, possible effects on those tracings should be taken into consideration.
♥ Attach electrodes to the skin and moisten with 70% alcohol or ECG gel. When using alcohol, avoid excessive amounts, as alcohol may travel between leads. Essentially, this has the same effect as having electrodes touch each other.
INTRODUCTION

The Jorvet™ Single Channel ECG is a one-channel digital electrocardiograph, that records the 6 most common leads: I through aVF. 4 patient-comfortable limb leads and a ground are provided. It is equipped with an advanced wide range thermal-array printing system, single chip 32 bit microprocessor, and internal memory.

FEATURES

• High resolution built in thermal array printer (8 dot/mm)
• Installed rechargeable NiMH 12 volt battery will support approximately 50 patient examinations, depending on length of examinations
• Keypad one-touch buttons allow for easy set-up and operation
• LED screen is well-lit and easy to read
• Lead strips print patient information form (AUTO mode) as well as sensitivity, paper speed, and filter settings
• AUTO and MANUAL modes provide optimal customization for diagnostic interpretation
• The newer models (after mid-2008) are capable of dual voltage use: both 110v and 220v. The AC frequency, however, is set at 60Hz and does not change with the voltage. Voltage is controlled internally by the ECG based on the incoming current, per manufacturer specification.

GROUNDING

The J1010 is grounded during AC operation through the three-prong AC plug. During battery operation, a grounding wire (included) should be connected to the ground site on the back of the unit.
**BATTERY OPERATION**

The J1010 has an installed maintenance-free 12 volt NiMH rechargeable battery. Allow 10 hours to completely recharge the battery. 
Recharge in the AC operation mode: flip on the power switch at the back of the unit. 
Do not press the ON/OFF button. 
DO NOT charge the battery for more than 24 continuous hours. 
The unit may be left plugged in, but the power switch must be off to prevent damage to the battery. 
Battery charge status is indicated on the LED tracing screen (battery mode only). 
**FIG. 1** Indicator light flashes green during charging and turns to a solid green when charging is complete. 
**FIGURE 3** Turn the power switch off at this time. 
To operate solely on battery, use the ON/OFF button only. Do not flip on the power switch. 
On newer models after mid-2008, the battery will operate until it has been discharged. 
Remember to keep an eye on the BATTERY ICON on the screen to determine how much run time is left for any given monitoring session. 
During long term storage or extended periods of non-use, recharge the battery every 6 months. 
The battery will auto recharge during AC operation. Always check battery level on the screen before running on battery power.

![Battery icons](image1)

**LOADING THE ECG PAPER**

Depress the button on the left side of the machine to open the door of the paper cabinet, and lift the door off. 
**FIGURE 2** 
Reload paper printed side down and replace the door with the rubber roller sitting on top of the paper. 
Avoid slack in the paper tension and align the paper straight with the door edge. 
Adjust paper position as necessary if printing is off center. PAPER? alarm will appear on screen until the situation is remedied.

![Paper loading](image2)
KEYPAD FEATURES  FIGURE 3
DO NOT use sharp or metal objects on the keypads

**SEN**

**SENSITIVITY** selection available only in **MANUAL** mode. Choose from 0.5 cm/mV, 1 cm/ mV, or 2 cm/mV. **AUTO** mode selects this automatically.

♥ This feature increases or decreases sensitivity of the tracing, depending on the size of the QRS complex, e.g., if the tracing is off the paper, decrease the sensitivity.

♥ This cardiograph is calibrated at 1 cm/mV.

♥ Standard signal and ECG paper
At 1 cm/mV, each tiny square equals 0.1mV amplitude (height) and 0.02 sec duration (width) at 50 mm per second paper speed.

♥ Changing sensitivity affects amplitude only

**MODE**

Selects **MANUAL** or **AUTO** mode

♥ **AUTO FEATURES**
• Waveform sensitivity is automatically determined in response to the size of the QRS complex.
• Patient information form is printed. FIGURE 6 (page 13)
• Leads change automatically at the selected time interval
• Leads may also be changed manually using the ▶ ◄ buttons in set up
• Longer lead tracings are possible by holding down the MODE button.
• Set up operates in auto mode.

♥ **MANUAL FEATURES**
• Waveform sensitivity may be changed during recording if necessary.
• Recording is continuous until stopped, allowing for longer tracings of any lead desired
• Leads must be changed manually using the ▶ ◄ buttons in set up.
• Set up operates in manual mode.
START/STOP

Starts and stops the lead tracings.

ON/OFF

AC OPERATION
Flip the toggle switch on at
the back of the unit.
Depress the ON/OFF button
to illuminate the screen.

BATTERY OPERATION
Depress the ON/OFF button to
illuminate the screen.
The battery indicator symbol will be visible at
the upper right of the screen.  \textit{FIGURE 1}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{figure3.png}
\caption{Indicator Light}
\end{figure}

\textit{FIGURE 3}
SET  FIGURE 4

Operates in both manual and auto modes.

Make mode selection prior to set-up

AC FREQUENCY

Permanently set at 60 Hz

RECORD LENGTH

Select from 2 to 10 second recording intervals
FOR AUTO MODE ONLY
MANUAL MODE IS CONTINUOUS UNTIL STOPPED

RECORD SPEED

Select 25 mm/s or 50 mm/sec
LEAD II at 25 mm/sec is the “rhythm strip”
for assessing arrhythmias
P-QRST waveforms are measured at 50 mm/sec

EXTERNAL RECORD

Set at OFF.

PRINT HEAD TEST

Triangular Wave Test can be used to check control of baseline wander. Upper and lower limits of triangles should be visible within limits on graph paper if properly calibrated.

FILTER SETTING*

0.05 - 150 Hz  No filter is selected
0.5 - 35 Hz  Filters baseline drift
Filters HUM (AC interference)
Filters EMG 35 Hz interference
AC, 0.5 Hz  Filters baseline drift
Filters HUM
0.5 - 25 Hz  Filters baseline drift
Filters HUM
Filters EMG 25 Hz

*See troubleshooting section for examples
FIGURE 4  (actual word display may vary, functions are the same)
SET-UP DIRECTIONS  

**FIGURE 4**  

*DO NOT use metal or sharp objects on the keypads*  

♥ Complete machine set-up before placing electrodes on the patient ♥

♥ Select either MANUAL or AUTO mode  
♥ PUSH SET BUTTON TO BRING UP THE SCREEN  
♥ Use ▲ arrows to highlight the selection  
♥  
♥ Use ◄ ► arrows to toggle through settings and make selections  
♥ Move through all options as directed above until all desired changes are made.  
♥ Push the SET button to save changes and exit to the tracing screen.  
♥ Set up is saved until changed again, or until the unit is turned off.  
♥ Settings return to factory default each time the unit is turned off.  
FACTORY DEFAULT SETTINGS ARE  
AUTO  
3 sec  
25mm/sec  
LEAD I

For quick LEAD II set up, there will be just 3 easy steps to follow:  
1. Turn the ECG on  
2. As soon as the tracing screen is visible, PRESS THE MODE BUTTON  
   (this puts the unit in manual mode)  
3. PRESS THE ► BUTTON once (this puts the unit in LEAD II)  
   **NOTE: You do not need to go into the set-up screen to use the arrow keys.**

**You are now in LEAD II, 25mm/sec, MANUAL MODE for continuous monitoring and/or printing. Continuous monitoring is best performed in AC, not battery operation.**

**This quick change into LEAD II should take only 4-6 seconds.**
ATTACHING THE LIMB ELECTRODES

Attach four limb electrodes to soft muscular, not bony, areas at the limb joints using the following steps.

1. Clean the skin with a cotton moistened with alcohol to remove oil.
2. Connect the patient cable to the electrodes.
3. Apply a small amount of 70% alcohol or electrode gel on the surfaces of the electrodes.
4. Clip the cleaned electrode site with the electrode.

PATIENT CABLE TIP COLOR COATING

Firmly insert the lead tip of the patient cable to the electrode, matching the tip color and electrode site. Refer to the table below.

<table>
<thead>
<tr>
<th>SITE</th>
<th>CODE</th>
<th>COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIGHT FORE LIMB</td>
<td>RA</td>
<td>WHITE</td>
</tr>
<tr>
<td>LEFT FORE LIMB</td>
<td>LA</td>
<td>BLACK</td>
</tr>
<tr>
<td>RIGHT REAR LIMB</td>
<td>RL</td>
<td>GREEN</td>
</tr>
<tr>
<td>LEFT REAR LIMB</td>
<td>LL</td>
<td>RED</td>
</tr>
</tbody>
</table>
PROBLEM SOLVING WITH CATS

Unlike humans and most dogs, the cardiac axis is not aligned top right to bottom left in cats. The heart has a tendency to lie more centrally with its apex more ventral than the atria, i.e., the heart points downward towards the ground when the animal stands. This gives rise to one of the common problems with monitoring cats, finding the strongest signal to present to the RA and LL electrodes.

The best signal is derived top/bottom axis i.e. Lead II in humans, with RA looking at the top of the heart and LL at the bottom. In cats, as stated, the axis may not lie across the body (see figure 1). As lead II may not align with the cat’s axis, the signal is small and sometimes cancels. Therefore, by moving RA more centrally onto the cat’s body above the top, and LL onto the cat’s body below the bottom of the heart, a much larger signal will be obtained.

The plane in which the cat’s heart lies within its body may also vary.

The “top” of the heart may be more dorsal and the “bottom” more ventral. In this case, we would refer to the base/apex axis (see figure 2) when the following instructions should be followed.

1. Move LL to the left apex of the heart.

2. Move RA to the V10 position (over the dorsal spinous process of the seventh thoracic vertebra) and LL to the V4 position (sixth left intercostal space at the costochondral junction). It will be necessary to annotate the printouts, if any, with actual configurations used to avoid later confusion.
Patient information form prints in **AUTO MODE ONLY**. **FIGURE 6**

After properly placing the leads, tracings will be displayed onscreen before printing begins. To begin recording, press **START**.

♥ The on-screen symbol || (stopped) changes to ▲ (recording). ♥

In the **AUTO** mode, all leads will be recorded in order, at the previously selected time interval until the **STOP** button is pressed.

**LO** indicator means no (not hooked up) or low heart rate. The patient’s heart rate will be displayed in this area.

If recording is stopped and restarted, the leads will continue in order, but a new patient form (**AUTO** mode) will print each time.

To run a longer tracing of any desired lead, hold down the **MODE** button. To stop recording, release the **MODE** button and press **STOP**. **WORKS ONLY IN THE AUTO MODE**.

Recording is continuous in the **MANUAL** mode.

In both **AUTO** and **MANUAL** modes, leads may be changed during operation by using the ◂► buttons. (These buttons are operable without bringing up the **SET** screen.)

It is not necessary to stop recording in order to change leads.

Sensitivity may be changed during operation in the **MANUAL** mode.
**TROUBLESHOOTING**

**PAPER ALARM**  **PAPER?**
Alarm appears on tracing screen

**CAUSES / SOLUTIONS**
- Paper out?
- Paper mis-feed, mis-align?
- ✔Correct as needed

**LOSS OF POWER**

**CAUSES / SOLUTIONS**
- Loose AC cord, plug, connection?
- Battery has discharged
- Electrical power loss
- AC interference from other equipment
- ✔TURN POWER OFF BEFORE TROUBLESHOOTING
- Check AC cord and connections
- Recharge battery

*During battery operation power is automatically cut off after 5 minutes of non-use. If the battery is fully charged, restart operation using the ON/OFF button.*
### TROUBLESHOOTING

**AC Interference**

Appears on the ECG as even-peaked, regular voltages superimposed throughout the tracing. It may appear in conjunction with muscle tremor.

Causes:
- Dirty or corroded lead wire tips or electrodes
- Loose electrode connection
- Patient or technician touching an electrode during recording
- Patient touching any metal part of a bed or examination table
- Broken lead wire, patient cable or power cord
- Electrical devices in the immediate area, lighting, concealed wiring in walls or floors
- Improperly grounded electrical outlet

**Muscle Tremor Interference (EMG)**

Appears on the ECG as random, irregular voltages superimposed on the tracing. It may resemble or occur in conjunction with AC interference.

Causes:
- Patient is uncomfortable, tense, nervous or apprehensive
- Patient is cold and shivering
- Patient has neuro or muscular disorder
- Examination table is too narrow or short to support limbs comfortably
- Patient may have “white coat” effect

See “Getting a Quality ECG” for suggestions
Wandering Baseline

Appears on the ECG as a fluctuation of the tracing up and downward on the grid.

Causes:
• Dirty or corroded electrodes
• Loose electrodes or electrodes positioned on a bony area
• Insufficient or dried out Alcohol or Electrode Gel
• Rising and falling of chest during normal or apprehensive respiration

When wandering baseline occurs:
• Clean skin with alcohol or acetone if necessary
• Reposition electrodes
• Check the electrode connections
• Assist the patient in relaxation

Other

When an electrosurgical unit is used with the cardiograph, noise generated by an ESU is superimposed on the ECG waveforms.

Equipment in the same room as the cardiograph may generate noise which is superimposed on the ECG waveforms.
• Noise generated by an electrosurgical unit
• Noise from AC power line
• Spike noise caused by electrostatic energy as shown below
Read Between the Lines

Learning to interpret electrocardiograms will prove invaluable to your patients and practice

By: Naomi L. Burtnick, MT (ASCP)

So you are a veterinary technician and you would like to learn how to interpret electrocardiograms (ECGs). Great idea! What is reasonable to expect of yourself? Even veterinarians can be somewhat daunted by all those squiggly lines.

After 20 years as a technician in the cardiology section of the Veterinary College at the University of Minnesota, I can testify that learning to read ECGs is fun, well within your grasp, and can be a tremendously satisfying skill to have tucked under your belt.

You can master the technique of recording an ECG as well as learning the fundamentals of arrhythmia interpretation. Although, measuring the ECG to assess heart chamber enlargement is certainly not beyond your skill level, it can be a tedious phase of the learning process. The good news is that your veterinarian can use other tools, such as radiographs and ultrasound to determine heart chamber size. This allows us to focus on arrhythmias which are more fun and require almost no measuring.

Recording the ECG

The ECG can be recorded with the patient right side down or in a standing position with any standard ECG strip chart recorder.

1. Attach the electrode clips directly to the skin (taking care to attach the correct electrodes to the appropriate limbs) and moisten with alcohol or gel to assure good contact.

2. Enter a 1 cm = 1 mV calibration signal.

3. Record lead II for about a minute at 25 mm/sec to assess arrhythmias. Increase the length of the tracing if an arrhythmia is seen. If you are determined to measure waveforms as well, record a brief tracing at 50 mm/second.

It’s helpful to center the tracing on the paper so that both the top and bottom of the waveforms can be seen. Also, decrease the sensitivity to 1/2 cm = 1 mV if the QRS complexes go off the paper.

The Normal ECG

Next on the agenda is learning what a normal ECG looks like and why.

You probably already know all the anatomy you need. The heart has four chambers: two atria and two ventricles. They are connected by a conduction system that spreads an electrical current that enables the heart to contract. The ECG is simply a graphic recording of this electrical activity during the different phases of the cardiac cycle.

The normal sequence of electrical activation in the heart is as follows:

1. Sinoatrial (SA) node - located in the right atrium.
2. Atrioventricular (AV) node - conduction link between the atria and ventricles.
3. Left and right bundle branches - located in the left and right ventricles.

The following waveforms are part of a single heart beat:

- P wave - corresponds to atrial contraction
- PR interval - corresponds to the time it takes for the impulse to pass through the AV node
- QRS waves - correspond to ventricular contraction
- Q is the first negative deflection.
- R is the first positive deflection.
- S is the negative deflection that follows the S wave.

Note: Not all QRS complexes have a Q and an R and an S. That’s OK.

- T wave - represents ventricular relaxation. T waves can be positive or negative, but every QRS complex has to have one. If it contracts it has to relax before it can contract again.

Calculating the Heart Rate

The heart rate (beats/min) can be calculated easily by counting the number of beats (R-R intervals) between two sets of marks in the margin of the ECG paper (3 seconds at 25 mm/sec) and multiplying by 20. ECG rulers are also available. This is all the measuring that’s necessary.
Recognizing Arrhythmias

This is where you will be of most help to you patient and the staff at your clinic. Think how much more interesting your job will be if you watch a monitor during a surgery; you can be responsible for alerting the doctor if abnormal beats occur.

To recognize arrhythmias you need to know two things:
1. The site of origin of the abnormal beat.
2. Recognize deviations from the normal rate of automaticity for that site.

Site of Origin

Three different sites can be identified on lead II by the following features:

Atrial origin - These beats originate from nowhere in the atria other than the SA mode. They look just like a normally conducted beat except that their timing is very early. A big hint is that the P wave of the atrial beat touches the T wave of the beat before it.

Junctional origin - These beats originate near the AV node and have a negative deflection P wave, or no P wave, with a normally conducted, short duration QRS complex.

Ventricular origin - These beats originate somewhere in the ventricles. No P waves are evident. QRS complexes are wide and bizarre appearing and may be positive or negative polarity.

Intrinsic Rates of Automaticity

Atrial, junctional and ventricular sites each have a normal rate of automaticity (the ability to initiate impulses), but may respond in the following abnormal ways:

- Too fast (tachycardia)
- Too irritable (premature)
- Too slow (bradycardia)
- Absent (block)

Normal pacemaker rates in the dog:

A great rule of thumb: Whichever site is fastest will drive the heart.

A Case Example

Here’s an example to get you thinking along these lines. A 7-year-old male boxer lethargically walks into the exam room with a history of exercise intolerance. You run a lead II rhythm strip that looks like the following:

How are we going to analyze it? Scanning from left to right you see a P wave, PR interval, R wave (it’s OK for a QRS complex not to have a Q an R and an S) and a negative T wave. In other words, a normally conducted beat, which is followed by two more normally conducted beats. The fourth beat has a large, wide QRS complex with a big negative T wave. What site do you think it originates from? It can’t be atrial because there is no P wave. It can’t be junctional (near the AV node) because it’s too wide and sloppy looking and junctional beats should be of normal duration. But it definitely fits the criteria for a ventricular origin beat! To further describe it we also use the term “premature” because it comes before the next expected normal beat. Next, are four more normally conducted beats followed by another VPC (ventricular premature contraction). Wouldn’t it be nice if they all came labeled! Can you spot the next VPC on the strip?

This strip is recorded from the same dog one hour later. As you can see, there are five normally conducted beats followed by a long run of ventricular origin beats.

A Second Case Example

A middle aged female miniature schnauzer faints while walking into the exam room, then gets up as if nothing happened. The ECG you run looks like this:

Clearly, that long flat line is not normal. But how do we decide what site in the heart is creating the problem? As was mentioned earlier, in the normal sequence of electrical activation in
the heart the SA node (the primary pacemaker of the heart) stimulates the atria generating a P wave, the impulse continues though the AV node (PR interval), and down into the ventricles (QRS complex). But in this case, there is no P, PR or QRS which implies that the SA node never started the whole sequence or was blocked in the process. Hence, the term “SA block” to describe this abnormality. SA block is a feature of a conduction disease called sick sinus syndrome. Surgically implanting an artificial pacemaker will restore almost normal quality of life.

Don’t feel pressured to learn everything at once. It will be extremely helpful even if you only learn how to record an ECG well. Simply recognizing that an abnormal beat has occurred and alerting your veterinarian will be appreciated. The key is running lots of ECGs and trying to learn a little more from each one.

Naomi L. Burtnick, MT (ASCP) works at Veterinary Specialty Referral Center, VETMED (Dr. Tilley & Associates), in Sante Fe, NM.
Some electrocardiographic complexes to emphasize differences in rate, rhythm, and shape.

**Normal Sinus Rhythm**

Impulses originate at SA node at normal rate

All complexes evenly spaced; rate 60 to 100 / minute

**Sinus Bradycardia**

Impulses originate at SA node at slow rate

All complexes normal, evenly spaced; rate <60 / minute

**Sinus Tachycardia**

Impulses originate at SA node at rapid rate

All complexes normal, evenly spaced; rate >100 / minute

**Sinus Arrhythmia**

Impulses originate at SA node at varying rate

All complexes normal but rhythmically irregular. Longest PP or RR interval exceed shortest by 0.16 second or more

**Nonsinus Atrial (Coronary sinus) Rhythm**

Impulses originate low in atrium" travel retrograde as well as distally

P waves inverted in leads II, III, and aVF

**Normal Sinus Rhythm**

Impulses originate at SA node at normal rate

Variations in P wave contour, PR interval, PP, and RR intervals
Some electrocardiographic complexes to emphasize differences in rate, rhythm, and shape.

Idioventricular Rhythm

Rate < 40 / minute

Accelerated Idioventricular Rhythm (AIVR)

Rate 40 to 120

Ventricular Tachycardia

Rate > 120

Ventricular Fibrillation

Pacer Rhythm

Pacemaker spike
P Wave: the P wave is the first positive deflection and represents atrial depolarization. It normally appears smoothly rounded and recedes each QRS complex at a specific interval.

P-R Interval: the P-R interval represents impulse conduction through the atria and into the AV node. It extends from the beginning of the P wave to the onset of the Q wave.

QRS Complex: the QRS complex represents ventricular depolarization. It consists of three deflections. The Q wave is the first negative deflection after the P wave. It results from the initial left-to-right septal depolarization. The R wave is the first positive deflection after the P wave. The S wave is the negative deflection following the R wave.

S-T Interval: the S-T segment extends from the end of the S wave to the beginning of the T wave.

T Wave: the T wave represents ventricular repolarization. Normally this wave is positive and symmetrical, but drugs, change in position, electrolyte imbalance, and food intake may alter the T wave.

Q-T Interval: the Q-T interval extends from the beginning of the QRS complex to the end of the T wave. It represents ventricular depolarization and repolarization.

U Wave: the U wave is a small positive deflection after the T wave. It reflects repolarization of the Purkinje fibers. This wave is not usually visible on the ECG.

Technical or mechanical problems that are superimposed on the normal P-QRS-T complexes are known as artifacts. Other equipment in the area that uses electrical current may cause artifacts. Muscle tremor or body movement may also cause artifacts, and efforts should be made to calm the animal and make it comfortable. It is important to place the electrode clips correctly and hold the limbs away from the body during right recumbent position to prevent the electrodes from moving with the thoracic respiratory motions.

Indications for Electrocardiography
Electrocardiography is useful in clinical veterinary practice:
1. In the definitive diagnosis of cardiac arrhythmias.
2. As an adjunct to determine cardiac enlargement (dilatation or hypertrophy)
3. As an indicator of certain electrolyte, acid-base, systemic, or metabolic disorders.
4. To individualize heart failure therapy.

The Abnormal Electrocardiogram
The first and most important step in ECG interpretation is differentiating between normal and abnormal waveforms. The second step is differentiating between the various abnormal ECG patterns and correlating them with known cardiac entities.

A Simple Checklist:
1. Are the P waves present?
   a. If not, is there other evidence of atrial activity (fibrillatory waves)?
2. What is the relationship between atrial activity and QRS complexes?
   a. What are the atrial and ventricular rates?
   b. Is a P wave related to each QRS complex?
   c. Does a P wave precede or follow the QRS complex?
   d. Is the P-R and R-R interval constant?
3. Are the P waves and QRS complexes regular or irregular?
4. Are the QRS complexes wide or normal?
5. Is the ventricular rhythm regular or irregular?
6. Are there pauses or premature complexes that require explanation?
Electrocardiographical Signs of Pathological Changes in the Heart

Right atrial enlargement
P wave is usually tall, slender, and peaked.

Left atrial enlargement
Increased duration of the P wave, notching of the P wave.

Left Ventricular Enlargement
As a result of the increased muscle mass the height of the R wave is increased, the QRS complex is delayed or altered in conduction, the S-T segment is depressed, and the T wave is changed.

Conduction Abnormalities

Sinoatrial Block
Sinoatrial (SA) block is a disturbance of conduction in which the SA nodal impulse is blocked from depolarizing the atria.
Causes: dilatation, fibrosis, cardiomyopathy, drug toxicity, and electrolyte imbalances.
ECG: SA block is suggested when pauses in the rhythm are precise multiples of normal R-R intervals. The P wave and the QRS complexes are usually of normal configuration.

Figure 4-17 sinoatrial block or arrest in a female miniature schnauzer with syncope. Note the ventricular escape complex (arrow).

First Degree AV Block
A delay or interruption in conduction of a supraventricular impulse through the AV junction and bundle of His is called AV block.
First-Degree AV block may occur in animals that are clinically normal and healthy.
ECG: Prolonged P-R interval, QRS complex and P wave are usually normal.

Figure 4-19: First-Degree and second-degree AV block in a dog with syncope. The P-R interval is prolonged (0.14 second). Every other atrial impulse is conducted (2:1 second-degree block).

Second-Degree AV Block
Second-degree AV block is characterized by an intermittent failure or disturbance of AV conduction. The second-degree AV block can further be characterized as Mobitz type I (Wenckebach phenomenon) usually type A and Mobitz type II, usually type B.
ECG: One or more P waves are not followed by QRS-T complexes.

**Complete Heart Block**
Complete heart block occurs when AV conduction is absent and the ventricles are under the control of pacemakers below the area of the block.
Clinical signs associated with complete heart block are syncope, sudden death, and congestive heart failure.
ECG: The ventricular rate is slower than the atrial rate (more P waves than QRS complexes).

![ECG Complete Heart Block](image)

**Arrhythmias**
An arrhythmia is an abnormality in the rate, regularity, or site of cardiac impulse and/or disturbance of impulse conduction. During normal sinus rhythm, the cardiac impulse originates in the SA node and spreads throughout the atria, AV node and His-Purkinje system, and ventricles.

**Arrhythmias Originating in the Sinus Node**

**Sinus Tachycardia**
Sinus tachycardia is the most common arrhythmia in the dog and the cat. All ECG criteria are normal except that the heart rate is above 160 bpm in the dog and above 240 bpm in the cat.
Examples of physiologic conditions associated with sinus tachycardia include pain, fright, or excitement. Pathological conditions include fever, shock, anemia, infection, congestive heart failure, hypoxia, and hyperthyroidism. Drugs that can cause sinus tachycardia include atropine, epinephrine, ketamine, and vasodilators.

**Sinus Bradycardia**
A regular sinus rhythm slower than the normal sinus heart rate is sinus bradycardia. Sinus bradycardia can occur from severe systemic disease (e.g. renal failure), from toxicities, with dilated cardiomyopathy in the cat, or during end-stage heart failure.
Physiologic causes of sinus bradycardia include increased vagal tone due to carotid sinus pressure, eyeball compression, or elevated intracranial pressure.
Drug induced causes include tranquilizers, digitalis, quinidine, morphine, and various anesthetic agents.
ECG criteria are normal except that the heart rate is less than 70 bpm in the dog and less than 160 bpm in the cat.

**Sinus Arrest**
Sinus arrest is a failure of SA nodal impulse formation caused by depressed automaticity.
ECG: The rhythm can be regular or irregular with pauses demonstrating a lack of P-QRS-T complexes.
Arrhythmias Originating in the Atrial Muscle

Atrial Premature Complexes
Atrial premature complexes arise from ectopic atrial foci. They are frequently caused by cardiac disease and may progress to atrial tachycardia or atrial fibrillation. Atrial premature complexes are often caused by atrial enlargement from acquired chronic valvular insufficiency, primary myocardial disease, right atrial hemangiosarcoma, hyperthyroidism, digitalis toxicity, general anesthesia, and various drug, chemical or noxious stimuli.

![Atrial premature complexes (arrows) and P mitrale in a dog with congestive heart failure.](image)

Figure 4-36 Atrial premature complexes (arrows) and P mitrale in a dog with congestive heart failure.

ECG: Usually normal heart rate, but the rhythm is irregular due to the premature P wave that disrupts the normal sinus-initiated P wave rhythm.

Atrial Fibrillation
Atrial fibrillation is common in the dog and is usually associated with severe organic heart disease. It is usually associated with chronic AV valvular insufficiency in small breeds, dilated cardiomyopathy in large and giant breeds, and congenital heart defects.

![Atrial fibrillation ECG](image)

ECG: Atrial and ventricular rates are rapid and totally irregular. Large oscillations waves replace the normal sinus P waves.

Arrhythmias Originating in the Ventricular Muscle

Ventricular Premature Complexes
Ventricular premature complexes (VPCs/PVCs) are impulses that arise from an ectopic ventricular focus. Cardiac causes of VPCs include congestive heart failure, myocardial infarction, neoplasia, pericarditis, traumatic myocarditis, idiopathic myocarditis in boxers and Doberman pinschers, and bacterial endomyocarditis. Secondary changes include changes in autonomic tone, hypoxia, anemia, uremia, pyometra, gastric-volvulus, pancreatitis, and parvovirus. Drugs that can cause VPCs include digitalis, epinephrine, anesthetic agents and atropine.
ECG: Heart rate is usually normal. The ectopic QRS complex is premature, bizarre, and often of large amplitude. The T wave is directed opposite to the QRS deflection. VPCs of identical shape are called unifocal when the QRS is variable, they are termed multiformed.

**Ventricular Tachycardia**

Ventricular tachycardia is a continuous series of three or more VPCs. The same conditions that cause VPCs also cause ventricular tachycardia.

ECG: QRS complexes are wide and bizarre with T waves directed opposite to the QRS deflection. There is no relationship between the QRS complexes and the P waves; the P waves may precede, be hidden within, or follow the QRS complexes.

**Ventricular Fibrillation**

Ventricular fibrillation causes cardiac arrest and is often a terminal event. Ventricular contractions are weak and uncoordinated. Cardiac output is essentially nonexistent.

ECG: The heart rate is rapid with irregular chaotic and bizarre waves. P waves cannot be recognized.
**Effect of Selected Diseases on the Electrocardiogram**

**Hyperkalemia**
Hyperkalemia is a common clinical problem in cats with urinary tract obstruction. Addison’s disease is a common cause of hyperkalemia in the dog.

**ECG Changes:**
- K+ > 5.5 mEq/l: T waves larger and peaked.
- K+ > 6.5 mEq/l: R wave decreased, QRS prolonged, P-R interval prolonged.
- K+ > 7.0 mEq/l: P wave amplitude decreased, P wave duration increased, QRS longer, P-R interval longer, Q-T interval prolonged.
- K+ > 8.5 mEq/l: P wave disappearance, atrial standstill, sinoventricular rhythm.
- K+ > 10.0 mEq/l: Ventricular fibrillation or ventricular asystole.

![Hyperkalemia Example](image)

Figure 4-30 (A) Hyperkalemia in a dog presenting with hypovolemic shock due to addisonian crisis. P waves are absent and T waves are tall and peaked. Serum potassium was 8.4 mEq/L. (B) After institution of therapy, P waves are present and the QRS-T complex is of smaller amplitude. Serum potassium was 4.8 mEq/L. (Tilley LP: Essentials of Canine and Feline Electrocardiography, 2nd Ed. Lea & Febiger, Philadelphia, 1985.)

**Pericardial Effusion**
ECG: Decreased QRS amplitude, S-T segment elevation in lead II and P-R segment depression in lead II.

![Pericardial Effusion Example](image)

Figure 4-31 Electrical alternans in a dog with pericardial effusion. Every other R wave alternates in amplitude.
WARRANTY AND MAINTENANCE

The J1010 has a 3-year warranty.

The factory-sealed, maintenance-free NiMH rechargeable battery has a 1 year warranty.

General maintenance is highly recommended for long life and quality performance of the cardiograph.

❤ Paper scraps and dust will accumulate in the paper cabinet, which should be cleaned routinely with a soft bristle brush or damp (NOT wet) lint-free cloth. Use de-ionized or distilled water only. DO NOT use alcohol, solvents, or detergents. They will damage the rubber and plastic parts.

❤ Clean external surfaces with a clean lint-free cloth. DO NOT use alcohol, solvents, or detergents.

❤ Place / store the unit away from dust, liquid spills, pet hair, and accidental damage.

❤ Consider using a soft dust cover to further protect the unit.

REPLACEMENT PARTS

J1010d1 Extra lead set, complete
J1010d2 Extra 4-wire limb lead only
J1010d3 Extra ECG paper rolls (each)