VitalView® 6

Data Acquisition Software

User's Manual

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1. Introduction

Overview

VitalView® is Windows® compatible software that provides data acquisition, summary and analysis tools for use with Starr Life Sciences' implantable telemetry and activity monitoring hardware. VitalView can continuously monitor/record up to a total of 192 channels of data from up to 128 subjects.

Implantable Telemetry - VitalView can simultaneously monitor up to 96 data channels from 32 E-Mitter® telemetric implants. Each E-Mitter is battery-free and powered wirelessly by an ER4000 underneath the cage in which the implanted animal is housed. Each E-Mitter provides continuous measurements of up to 3 data channels: gross motor activity, core body temperature and optional heart rate. The ER4000 collects data measured by the E-Mitter and communicates it via USB to the computer running VitalView.

Running Wheels and Cage Top Motion Sensor - VitalView can monitor up to 96 running wheels and/or cage-top infrared motion sensors connected to a PC through DP1224 DIO interface box(es). By utilizing powered USB hubs, you can monitor animals/cages anywhere in your lab that you can run a wire to.

VitalView software features:

- Continuous real-time display and recording of data
- Organize and label experimental subjects and parameters
- Export data to multiple formats

Features available without Security Dongle

- Import/convert legacy VitalView data and configuration files
- Data View/Filter/Analysis
- Export – Export data to multiple tabular and graphic formats

How to Use This Manual

- The various sections are arranged as a step-by-step setup guide for the entire system.
    - o Software Installation
    - o Hardware Setup
    - o Using VitalView Software
        - ▪ Experiment Setup
        - ▪ Data Acquisition
        - ▪ Data Manipulation - View/Import/Export and Analysis
- If you are only using VitalView for telemetry (ER-4000/E-Mitter) you can skip sections: "DP1224 Hardware Setup" and "DP1224 Software Setup"
- If you are only using VitalView to acquire data from devices attached through DP1224 I/O boxes you can skip sections: "ER-4000 Hardware Setup" and "ER-4000 Software Setup"
- Throughout the other sections, individual functions that are specific to ER-4000 or DP1224 are noted
- Troubleshooting and supplemental information are provided in the appendices

Minimum Computer Requirements

Operating System	Windows 7 or later
CPU	7th Generation Intel i5 or better
Hard Disk Space	4GB required for software, 500GB or greater recommended for data
System RAM	4GB required, 8GB or higher recommended
Screen Resolution	1024 X 768 or higher
Interface Requirements	1 USB Port for Hardware Dongle
	1 USB Port supports up to 32 ER4000/Emitter attached in series (RS232 Serial Adapter required)
	1 USB Port per each DP1224 - Up to 4 X DP1224s -Or- 1 USB Port → USB Hub (Powered)→ Up to 4 X DP1224s
	- Internet Connection for Events notification via E-Mail and/or Text - Access to E-Mail server
Recommended Accessories	Powered USB Hub(s) – To provide sufficient USB ports and equipment spacing flexibility
	Uninterruptable Power Supply (UPS) to prevent disruption of Desktop PC, ER4000s and Powered USB hubs

Recommended: Do not run other software on your Windows PC while VitalView is acquiring data
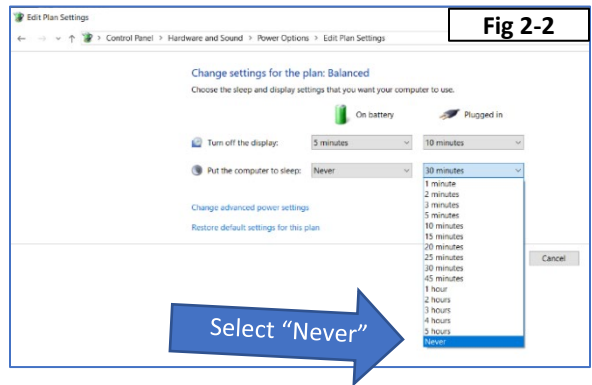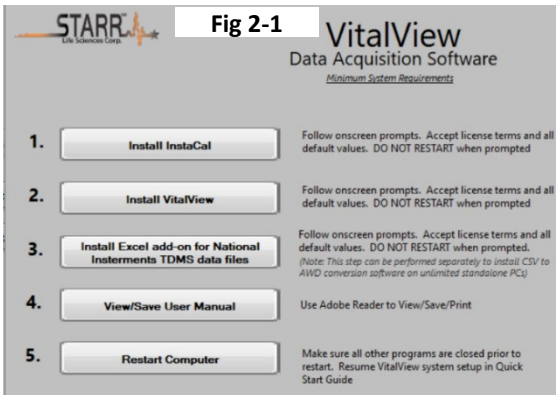
2. VitalView Software Installation

Download from: https://www.starrlifesciences.com/resource/vitalview-software-download/. Follow on-screen instructions.

Installation Media (CD/DVD or USB flash drive available upon request)

Insert the Installation Media into your PC. If installation does not start automatically open the CD/USB drive through the Windows® file browser and double-click VitalView_6_Installer.exe

When you run the installation software Figure 2-1 Should Appear

Perform steps 1-5 and follow the on-screen instructions

Fig 2-1

VitalView
Data Acquisition Software
Minimum System Requirements

1. **Install InstaCal** — Follow onscreen prompts. Accept license terms and all default values. DO NOT RESTART when prompted

2. **Install VitalView** — Follow onscreen prompts. Accept license terms and all default values. DO NOT RESTART when prompted

3. **Install Excel add-on for National Insterments TDMS data files** — Follow onscreen prompts. Accept license terms and all default values. DO NOT RESTART when prompted. *(Note: This step can be performed separately to install CSV to AWD conversion software on unlimited standalone PCs)*

4. **View/Save User Manual** — Use Adobe Reader to View/Save/Print

5. **Restart Computer** — Make sure all other programs are closed prior to restart. Resume VitalView system setup in Quick Start Guide

Fig 2-2

Select "Never"

ADVISORY NOTICE:

TO AVOID DISRUPTION OF VITALVIEW DATA COLLECTION DISABLE WINDOWS SLEEP MODE IN WINDOWS® SETTINGS (FIG 2-2)

IF YOUR COMPUTER SYSTEM CLOCK IS CHANGED, MANUALLY OR BY AN AUTOMATED WINDOWS® PROCESS (DAYLIGHT SAVINGS/TIME ZONES), VITALVIEW WILL NOT APPLY THE NEW SETTINGS UNTIL AFTER THE COMPUTER HAS BEEN RESTARTED.

IF A DATA ACQUISITION SESSIONS WILL BE AFFECTED BY A SYSTEM TIME CHANGE YOU CAN AVOID INCONSISTENCIES IN DATA TIMING BY DISABLING WINDOWS AUTOMATIC TIME SETTINGS AND SETTING THE WINDOWS SYSTEM CLOCK MANUALLY (FIG 2-3).
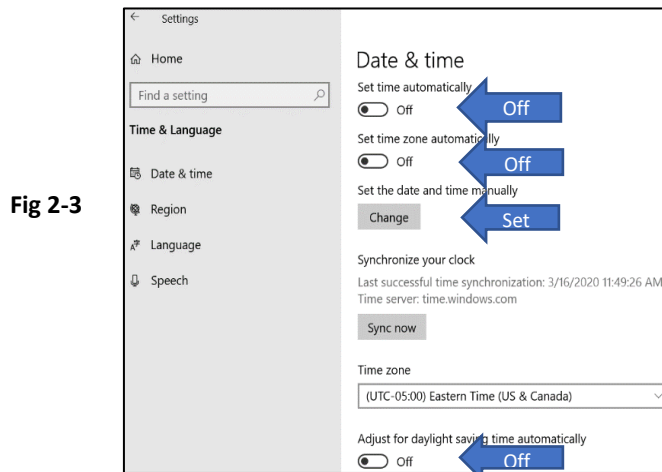
Fig 2-3

Install Hardware Dongle

After the computer restarts, plug in the USB Hardware Dongle (Fig 2-3) provided by Starr Life Sciences

Install Dongle driver software

1. Start Windows Device Manager
   - Windows 10 →Type "Device Manager" into search window at lower left corner of Windows Desktop
   - Windows 7 → Windows Control Panel → System Hardware
2. Find Dongle (WF2008) in the list of devices (Fig 2-4)
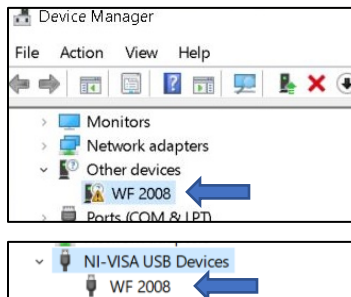3. Right click on WF2008 and select "Update Driver" (Fig 2-5)

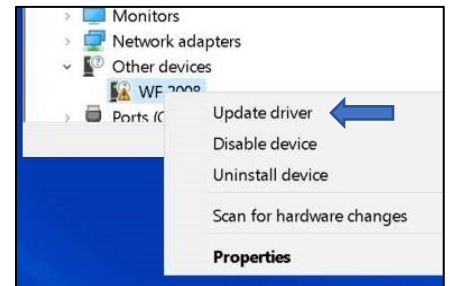**Fig 2-3**   **Fig 2-4**   **Fig 2-5**

4. Select "Browse my computer…" (Fig 2-6)
5. Click "Browse" button and find folder "KeyCode Driver" Fig (2-7)
   - Default location = C:\Starr Life Sciences\VitalView\KeyCode Driver
   - Root Directory will be different if specified by user during installation
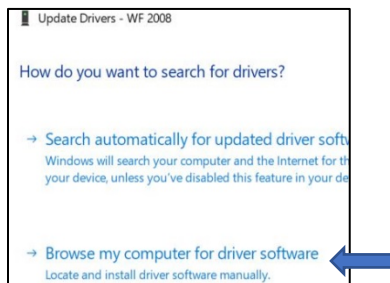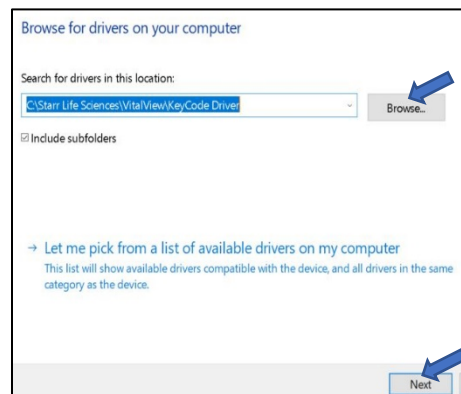6. Click "Next" (Fig 2-7)

Fig 2-6   **Fig 2-7**

Start VitalView software

1. Start VitalView software from: Windows Start button →Starr Life Sciences
2. Click Settings button → "System" tab - Figure 2-8 should appear.

   The Hardware Dongle has been preloaded with software license keys that were purchased from Starr Life Sciences

   The software modules are listed at the bottom of the screens. The selection boxes associated with purchased software should be checked. (If not contact Starr Life Sciences)
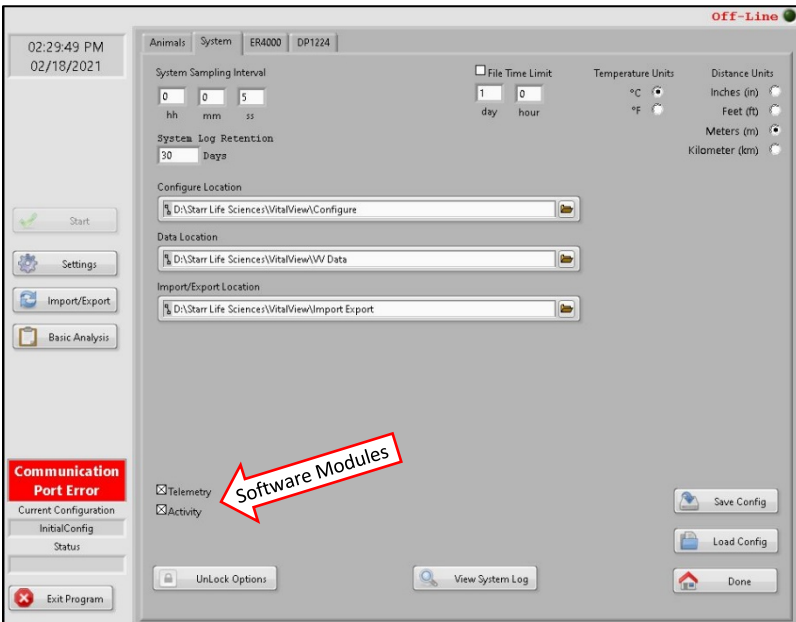

Fig 2-8

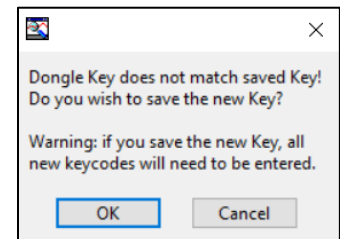*If the notification shown in Fig 2-9 appears click "OK" to dismiss*

Fig 2-9

NOTE: When using a 17" or smaller computer screen the VitalView interface may not fit

RECOMMENDED: Turn on "Auto-Hide" for Windows® Taskbar
Right click the Windows taskbar, select "Taskbar settings" then turn on "Automatically hide the taskbar"

To purchase additional software modules, contact Starr Life Sciences

3. Telemetry Hardware Setup (ER4000)

VitalView can communicate with up to 32 ER-4000 Energizer/Receivers. Before multiple ER4000s can be attached to your PC each ER4000 must be individually programmed with a unique ID#

Assign Unique ID#s

1. Plug a USB/Serial 9-Pin RS232 Adapter (ADPTR-USB/SERIAL) into a USB port.
   - Windows should automatically detect the new hardware and install drivers for the adapter
   - PLUG SERIAL ADAPTER INTO USB PORT ON COMPUTER. DO NOT ATTACH THROUGH A USB HUB
2. Open Windows Device Manager and note which COM Port number is assigned to the USB/Serial Adapter (COM5 in example Fig 3-1)
   - If the adapter doesn't appear in the list you may need to install driver software included with the adapter or provided online by the adapter manufacturer

> ## WARNING!
> When setting up 1 or multiple ER-4000s, ATTACH POWER CORDS LAST

> ## WARNING!
> Unplug all power cords from wall power before connecting/disconnecting any Serial/Y-Cables

Figure 3-2

Fig 3-1

Y-Cable
(VV-CBL-YxM)

To PC Serial Port or USB/Serial Adaptor

To ER4000

To Power Supply

VitalView ® Installed

(ADPTR-USB/SERIAL)

ER-4000 Energizer/Receiver (VV-ER4000-00)

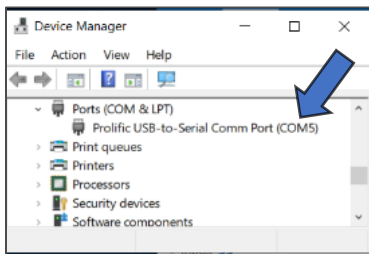Power Cord (PSCBL-xxx)

Power Supply (VV-PS-ER4000)
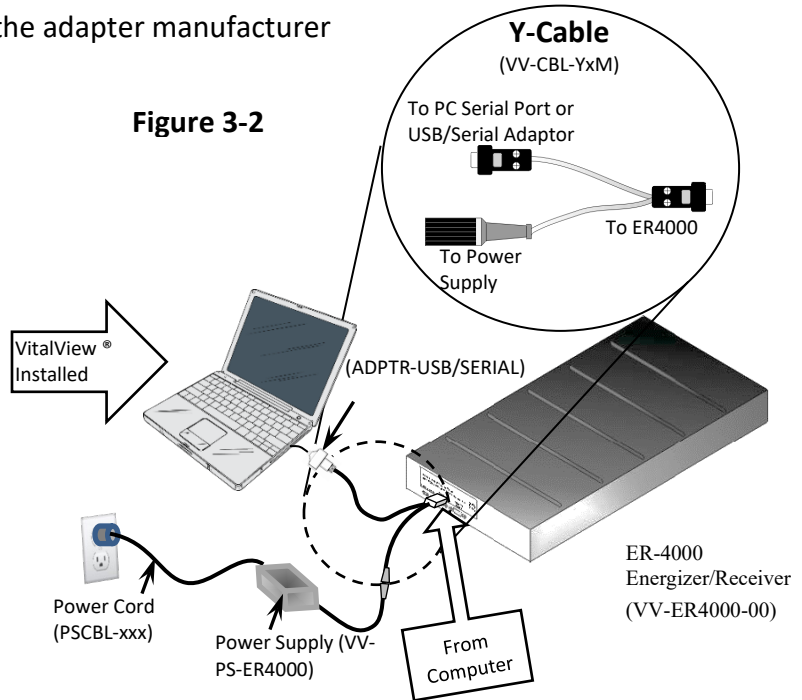
From Computer

> ## Caution!
> Each ER-4000 must each be assigned a UNIQUE ID# before they can be connected together in series

3. Connect the first ER4000 using a Y-Cable (VV-CBL-YxM) (Fig 3-2)
   Note: x=length in meters
   - Male 9-Pin connector attaches to "From Computer" on ER4000
   - Female 9-Pin connector attaches to USB/Serial Adapter (or 9-Pin Serial Port)
   - Circular 5-Pin connector attaches to ER-4000 power supply (VV-PS-ER4000)

4. Plug the appropriate power cord (PSCBL-XXX) into the power supply and wall power outlet
   - *Note: When power is applied the green LED on the front panel should light momentarily then turn off. The red LED should continue to blink*
   - *Note: XXX = Country, E.g. US, EU, CHIN*

5. Run VitalView software

   If Vitalview is not running restart from Windows Start → Starr Life Sciences → VitalView

   I. Click <u>Settings</u> button then select "ER4000" tab (Fig 3-3)
   II. Set "ER4000 Com Port" to match COM Port in Windows Device Manager (Fig 3-1)
   - A single ID number should appear in the "ER4000 Detected" column (Fig 3-4)
   - If an ID# does not appear click "Rescan"
   - If an ID# still does not appear, unplug power cord from the ER4000 power supply, check all connections, plug the power cord back in and click "Rescan"

Fig 3-3

Fig 3-4
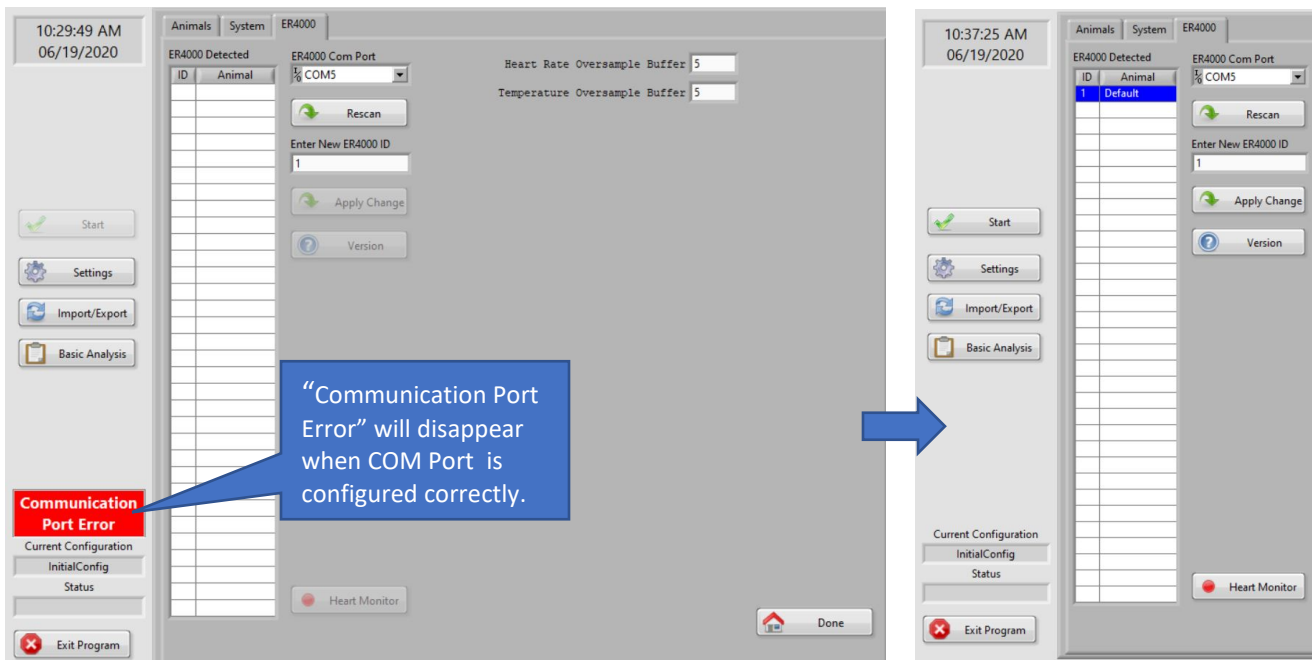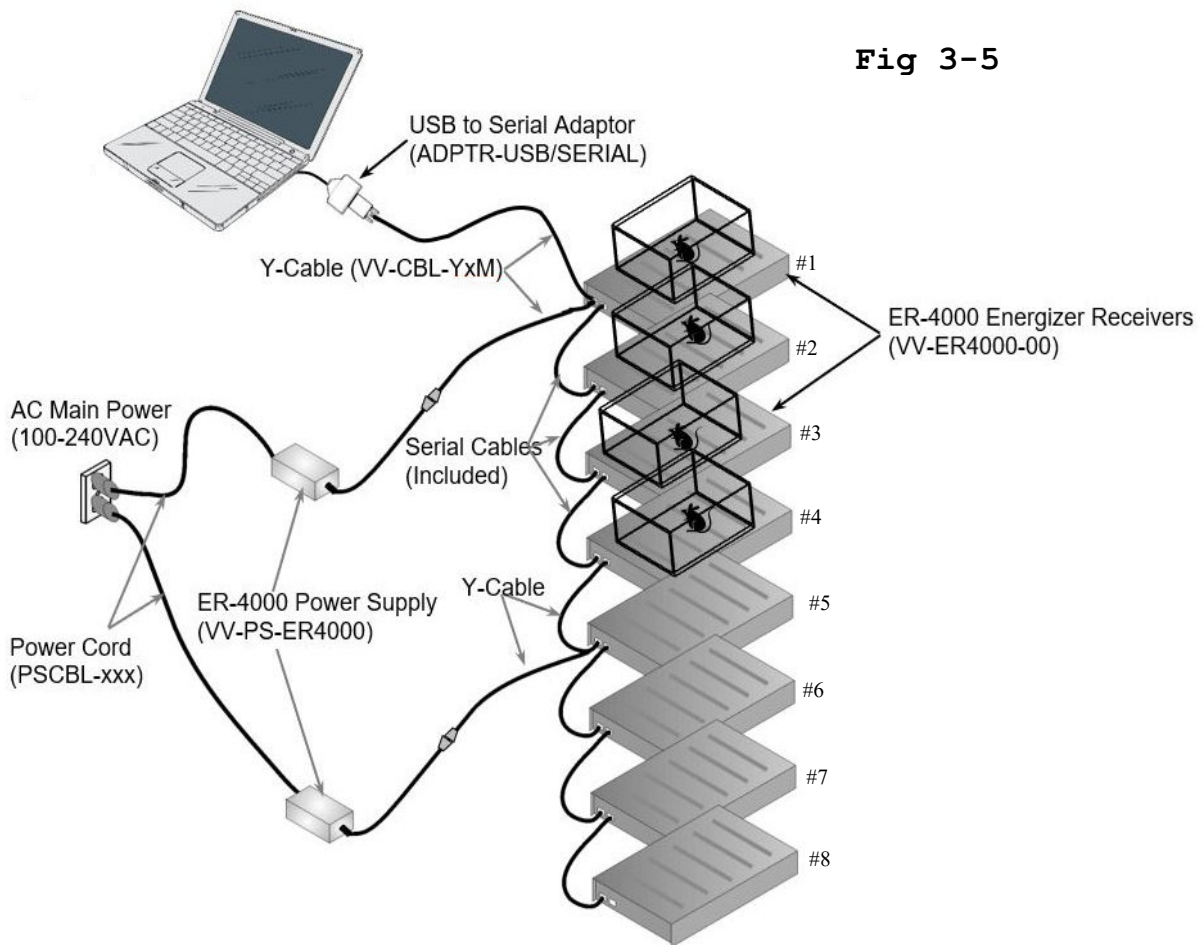
6. Assign new ID#
   I. Use the mouse curser to select the ID# in "ER4000 Detected" column (Fig 3-4)
   II. Enter the desired ID# (1-32) in the "Enter New ER4000 ID" field
   III. Click <u>Apply Change</u>
   - The ID# highlighted in the "ER4000 Detected" column should update to the new value

     Recommended - Attach a semi-permanent adhesive backed label with ID# to front of ER-4000

7. Assign subsequent ID#s
    I. Unplug power cord from wall or ER4000 Power Supply
    II. Unplug Y-Cable from previous ER4000
    III. Plug Y-Cable into next ER4000
    IV. Plug power cord back into wall or power supply
    V. Wait for green LED on ER4000 to turn on then off, red LED should continue blinking
    VI. Click Rescan

8. Repeat steps 6 & 7 for each ER4000 that will be attached in series

9. Attach all ER4000s in series to the PC (Fig 3-5)
    ◇ *Caution: DETACH ALL POWER CABLES FROM WALL POWER before proceeding*
    ◇ *Caution: The horizontal distance between ER4000 receivers must be 8" (20 cm) or greater.*
    ◇ *Caution: ER4000 receivers should NOT be placed near other electronic equipment such as computers, televisions, electronic power supplies, etc.*

Fig 3-5

USB to Serial Adaptor
(ADPTR-USB/SERIAL)

Y-Cable (VV-CBL-YxM)

ER-4000 Energizer Receivers
(VV-ER4000-00)

AC Main Power
(100-240VAC)

Serial Cables
(Included)

Power Cord
(PSCBL-xxx)

ER-4000 Power Supply
(VV-PS-ER4000)

Y-Cable

#1
#2
#3
#4
#5
#6
#7
#8

I. Physically arrange ER4000s in your lab
  - *Note: It is recommended to physically connect ER4000s in order of ascending ID# to avoid confusion later but it is not necessary*

II. Use a Y-Cable between the computer and the 1st ER4000 (Fig 3-5)
  - Secure all connections with captive screws to prevent damage to ER4000s

III. Connect the next 3 X ER4000s in series using the Serial Cables included with each ER4000
  - Each ER4000 Power Supply can power up to 4 x ER4000s. Use a Y-Cable between ER4000s 4 & 5, 8 & 9, 12 & 13, 16 & 17, 20 & 21, 24 & 25, 28 & 29
  - Use Serial Cables to make remaining connections

10. Attach all Y-Cables to power supplies using Circular 5-Pin Connectors

11. Plug each Power Cord into each Power Supply and wall outlet
  - When power is applied the green LED on each ER4000s should turn on momentarily then turn off, the red LED should continue blinking
  - If the green LED on any ER4000 continues to flicker frequently for no apparent reason this is due to electromagnetic interference (EMI) in the environment. Increase separation between ER4000s and any other electronic equipment

12. Run VitalView software - *Restart if necessary*.
 I. Click <u>Settings</u> → ER4000 tab
    - ID#s for all ER-4000s should appear in the "ER4000 Detected" column
    - If not click <u>Rescan</u>
  II. Click "System" Tab
  III. Click the <u>Save Config</u> button in the lower right corner
      i. Name file, E.g. "InitialConfig"

4. Activity Hardware Setup (DP1224)

The DataPort1224 (DP1224) provides USB connectivity for Starr's running wheels and cage-top infrared motion sensors. VitalView Software can support up to 4 X DP1224s connected directly to your PC or through standard powered USB hubs. The example in Figure 4-1 is for illustrative purposes. Your setup will depend on equipment purchased and the layout of your lab.

Note: DP1224s can be located anywhere in your lab that you can run a wire to. For more information contact Starr Life Sciences.

Fig 4-1
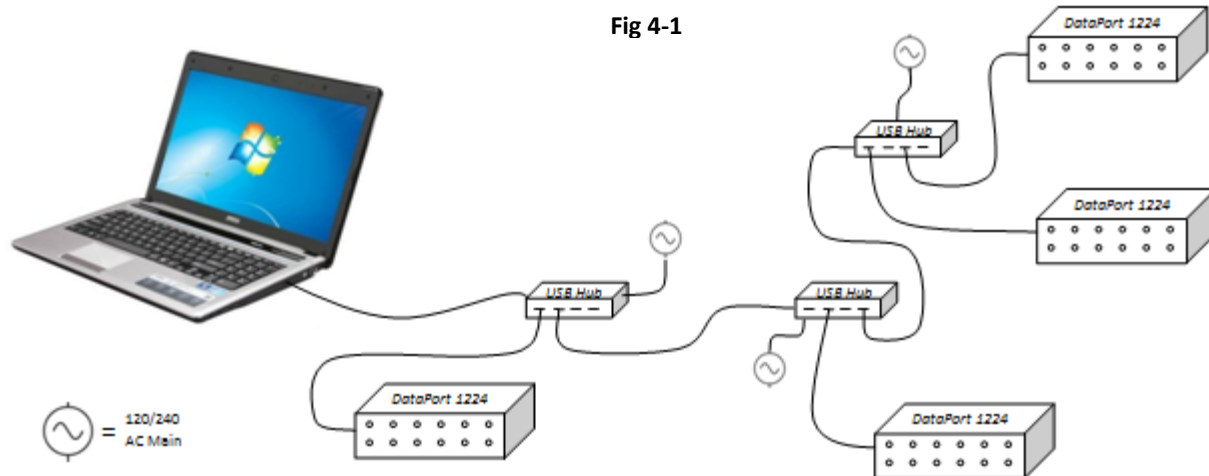
1. Connect USB Hub(s) - *If Applicable*
   - Attach each hub one at a time. Before connecting the next hub wait a few seconds until Windows recognizes and installs device drivers
2. Connect DP1224s
   - Attach each DP1224 one at a time, to any available USB port on your PC or hub(s).
   - Before connecting the next DP1224 wait until the bottom green LED on the side of the DP1224 stops blinking and the top LED turns solid green (Fig 4-2) (*NOTE: it may take a few minutes.)*
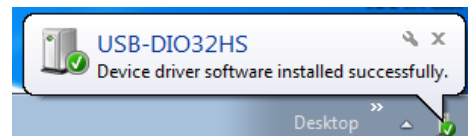

Fig 4-2

Fig 4-3

   - Depending on your Windows settings, the message shown in Fig 4-3 may appear at the bottom right corner of your Windows desktop

3. Run Instacal Software - *After all DP1224s have been attached, run Instacal® software*
   - Instacal found at Windows Start→ Measurement Computing
   - Figure 4-4 should appear. The number of items and their serial number(s) will be different depending on your equipment.

   I.   Click <u>OK</u> - *Figure 4-5 should appear*
   II. Click on <u>X</u> in upper right corner to close screen
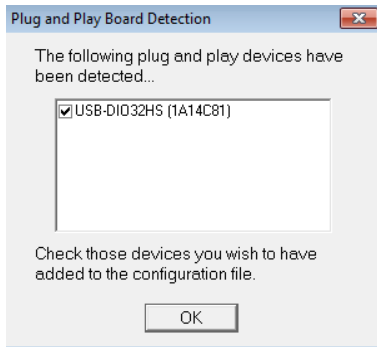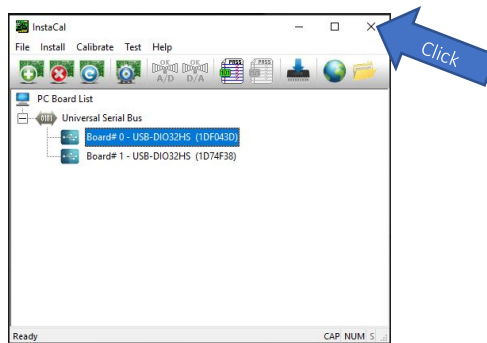   III. RESTART COMPUTER

Fig 4-4

Fig 4-5

Note: If you unplug a DP1224 from the computer at any time you will need to rerun Instacal software if/when you reattach the DP1224

4. Run/Restart VitalView Software
   I.   Click <u>Settings</u> → DP1224 tab
      - If DP1224 tab (Fig 4-6) is not visible:
         ▫ Make sure Hardware Dongle (Fig 2-3) is inserted into any USB port on the PC or USB hub
         ▫ Make sure Activity software module was successfully activated. See "VitalView Software Installation"
      - If any DP1224(s) are not listed under "DP1224s Detected"
         ▫ Check all connections
         ▫ Make sure USB hubs have power
         ▫ Click <u>Rescan</u>

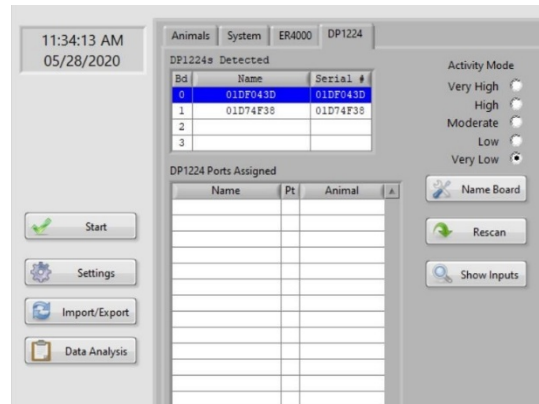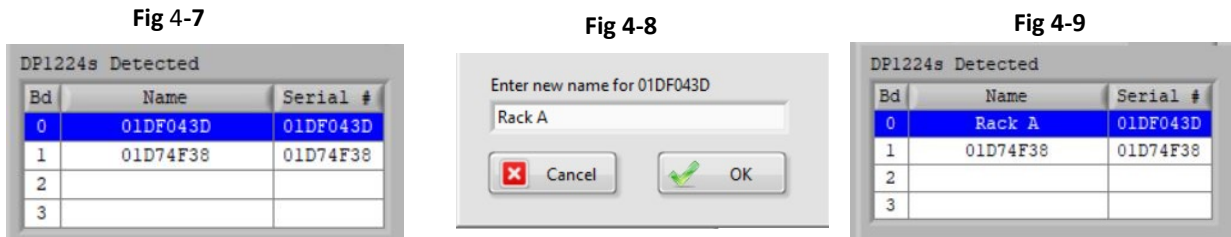Fig 4-6

II. Optional - Assign Names to DP1224s
  i) Select a DP1224 from "DP1224 Detected" field using the mouse cursor (Fig 4-7)
  ii) Click Name Board - *Fig 4-8 should appear*
  iii) Enter Name
  iv) Click OK - *Name should appear in list (Fig 4-9)*

Fig 4-**7**

Bd	Name	Serial #
0	01DF043D	01DF043D
1	01D74F38	01D74F38
2		
3		

DP1224s Detected

Fig 4-8

Enter new name for 01DF043D

Rack A

❌ Cancel   ✔ OK

Fig 4-9

| Bd	Name	Serial #
0	Rack A	01DF043D
1	01D74F38	01D74F38
2		
3		

DP1224s Detected

Recommended - Affix semi-permanent adhesive backed label with assigned name to DP1224

5. Test/Align sensors

While VitalView software is running but not actively acquiring data, 2 different visual indicators are provided to help you confirm running wheel sensor connectivity and alignment.

1. The red LED on the side of any attached DP1224 will turn on when a magnetic sensor is exposed to a magnet. (Fig 4-10)
2. The Input Display Panel can be activated from the DP1224 tab by selecting a DP1224 from the "DP1224s Detected" list then clicking the Show Inputs button (Fig 4-11)

Fig 4-10

Fig 4-11
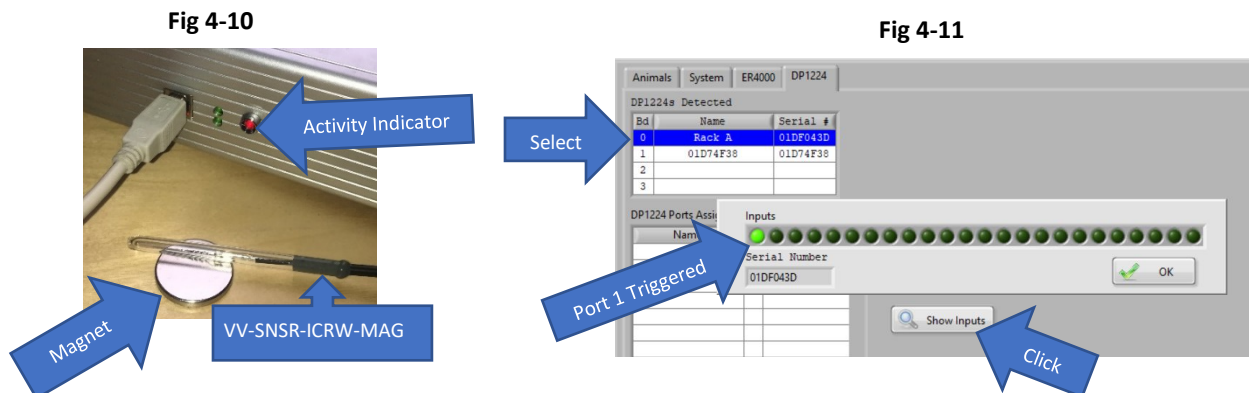
I. Assemble any running wheels and/or cage top infrared motion sensors per the instructions included with each device
II. Attach each device to an open port on a DP1224
  i. Push connector in until it clicks
  ii. For best wheel turn accuracy align magnetic sensors with the magnet attached to each wheel according to the instructions included with each wheel

5. Software Setup

Overview

In this section you will first setup basic system parameters such as sample rate, default file path/location, etc. Parameters that only apply to E-Mitter/ER4000 or DP1224 hardware are marked accordingly. Subsequent sections go through the setup of E-Mitter/ER4000 and DP1224 separately in more detail.

Setting up System Parameters

Click on Settings → System tab (Fig 5-1 should appear)

Adjust each setting according to the detailed descriptions on the following pages

- **System Sampling Interval** – *For initial system testing set to 5 seconds*
  - o Sets the sample period for recording all data channels to the raw data file
  - o Determines the rate at which the real-time data displays update
  - o Determines maximum data resolution available for viewing, export and analysis.
  - o The smallest interval allowed is 1 second. Larger Sample Intervals result in smaller data files for a given period of time. (To calculate file size, see Appendix C).
  - o When selecting a sampling interval, consider the data resolution you will require when reporting data. It is recommended that you sample twice as often as your reporting requirements to allow for some missed samples. (E.g. If you intend to report summary data at an interval of 5 minutes, set system sample interval no higher than 150 seconds)
  - o For more detail see Appendix D – VitalView Terminology

- **File Time Limit** – *Check box to turn on*
  - o Defines time period from start of recording when VitalView automatically closes the current data file and creates a new one with the same Data File Name (different time code).
  - o Using this function to limit individual file size can make it easier when you use the Basic Analysis functions to open and view data. Very large files can take a long time to load into computer memory.
  - o Individual files can easily be joined together in the Import/Export→ Data screen
    - ▪ Select multiple files from the list then Click Combine Files

- **Heart Rate and Temperature Oversample Buffers (ER4000 tab)** – *For initial system test set to 5 seconds*

  Each ER4000 has a Hardware Sample Rate of 1 sample/sec for Heart Rate and Temperature data. This can't be changed by the user. The "Oversample Buffer" is a moving average of this raw data intended to eliminate the effects of random systemic noise. The moving average window is N samples = N sec, where N = the value entered.

Note: When you start data acquisition the initial values of temperature and heart rate data will not appear until the buffer is filled, e.g. Oversample Buffer = 120 = 120 second initial delay

Note: System Sample Interval determines the rate at which samples are taken from the Oversample Buffer and recorded to the raw data file

  - o Recommended settings
    - ▪ Initial System Test – Set to 20 seconds
    - ▪ Short term experiments (< 1 day) – Set to 30 seconds. Allows you to see instantaneous changes but may allow more random noise detection
    - ▪ Long term experiments (> 1 day) – Set to 120 seconds
    - ▪ You can turn off the Oversample Buffer by entering a value of 1
    - ▪ It is highly recommended this not be set to less than 20 seconds.
  - o For more detail see Appendix D – VitalView Terminology

- **System Log Retention**
  - Enter the number of days over which Windows System Log Files are kept.
  - Files can be useful for troubleshooting if problems occur.
  - To view Windows System Log data click the View System Log button at the bottom of the System tab

- **Configure Location**
  Specify where VitalView configuration files are stored on your computer. These files contain the information entered on the Settings and Animal tabs. You can create/save multiple configurations and reload them at a later time. Examples are: Initial Configuration, E-Mitter Cal, Full Setup, Long Term Study, Short Term Study, Surgical Procedure.

- **Data Location**
  Specify where data acquisition files are stored on your computer. Files can be very large depending on number of data channels, System Sample Interval and duration of recording. See Appendix C regarding disk space requirements

- **Import/Export Location**
  - Specify where exported data files are stored on your computer. These files can be very large.
  - Data and configuration files generated by earlier versions of VitalView can be placed in this location to be imported and converted

- **Unlock Options**
  VitalView Software is modular. Each module can be purchased separately from Starr Life Sciences. Click on this button to enter software license keys. Refer to VitalView Software Installation section for more detail.

- **Enable Events [check box]**
  If "Events" software module has been purchased and activated the "Enable Events" check box will be visible at the top of the System tab. Events are enabled by default when the software is activated. Disabling Events turns off all previously configured Events. This can be useful when you are changing System Configurations and performing short test recordings or when using the VitalView Heart Monitor during implantation of E-Mitters

- **Temperature Units**
  Select Celsius or Fahrenheit display for core body temp from E-Mitter(s). Raw data files are stored as Celsius.

- **Activity Mode** (DP1224 tab)
  The Activity Mode determines the hardware sample rate of all DP1224(s). Higher settings may be necessary to accurately record the number of running wheel revolutions. Higher settings may adversely affect Windows system performance. See "Hardware Sample Rate" in Appendix D of this User Manual for more detail.

- **Distance Units**
  - Default units of length for distance/velocity displayed for running wheels (in, ft, m, km)
  - Distance is displayed on the Activity Monitoring screen and Data Analysis Graphs
  - Distance = Rev(π)(ID)
    - Rev = Revolutions = Wheel Turns = Activity Counts
    - ID = Inner Diameter of running wheel
    - π = 3.14159
  - Linear Velocity = Distance/time

- <u>**Save Config**</u>
  - Saves all Hardware/System/Animal configuration information to a file.
  - Click this button often while setting up system configurations to avoid loss of progress
  - You can create/save multiple configurations and reload them at a later time. Examples are: Initial Configuration, Full Setup, Long Term Study, Short Term Study, Surgical Procedure. Last used configuration is loaded by default when restarting VitalView.

- <u>**Load Config**</u>
  Last Configuration File is loaded by default unless you specify otherwise. Files are found at Configure Location specified on Settings →System tab.

  Note: Last configuration used is loaded by default when restarting VitalView.

Telemetry Software Setup (ER4000) - *Skip If not using ER4000s*

To configure each new subject, you will need to assign a name to the "Animal", specify the ID# of an ER4000 and enter serial number and calibration values for the E-Mitter that will be implanted in the subject. There are optional settings available for organization of subjects and display of data.

Configure Animals

1. Click Settings→ Animals tab – Figure 5-1 should appear
2. Click New at bottom left corner of screen. Figure 5-2 should appear
3. Enter a name and click OK.
   - The new name should appear on the Animal list on the left and in the Default Group list on the right (Fig 5-1).
4. Optional: Create Group - type a new Group name into the "Group" field and click Save.
   - The current Animal will appear under the new Group name on the Group list at the right.
   - The new Group label will be available in the pull-down menu for use with subsequent animals.
5. Click on the "Device" field and select ER4000 from the pull-down options.
   - *Activity, Temperature and Heart Rate fields should appear (Fig 5-2)*
   - Check boxes next to each parameter to turn data acquisition On/Off
   - If using an E-Mitter without heart rate leads always deselect the Heart Rate parameter.
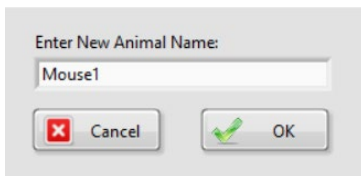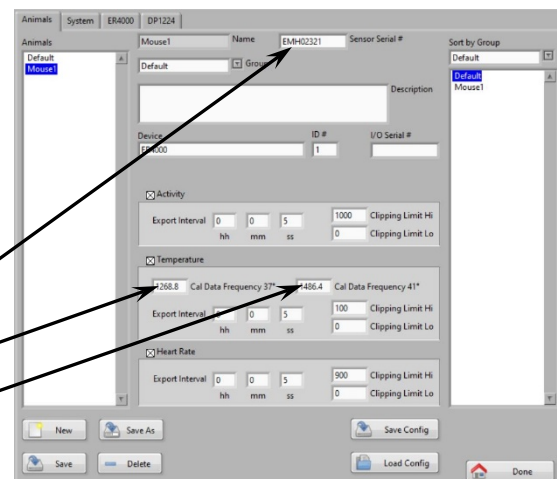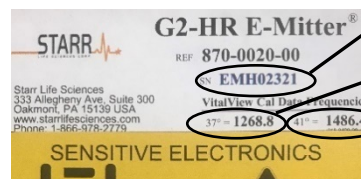
Fig 5-2

Fig 5-1

Fig 5-3

6. Enter theER4000 ID# (1-32) into "ID#" field
7. Obtain the E-Mitter that will be used with the ER-4000 ID#.
   - Make sure the serial number on the E-Mitter matches the serial number printed on the plastic case that accompanies it.
   - Enter the Serial Number (SN) and "VitalView Cal Data Frequencies" from the E-Mitter case into the proper VitalView fields (Fig 5-1 & 5-3)
8. Optional - Text entered into "Description" field will appear in Zoom/Detail views of data channels and exported data files

9. Optional - Enter serial number from bottom of ER4000 into I/O Serial # field

10. Optional - Set "Export Interval" for each parameter - *(Default = System Sampling Interval)*
   - Can be used as a channel specific Export Sample Interval later when exporting data
   - It is highly recommended to use only multiples of the System Sampling Interval

11. Optional - Set Clipping Limits for each parameter
   - Accept default values or see VitalView Terminology in Appendix D for more detail

12. Click Save

   Note: Always click "Save" before starting a New Animal

Repeat Steps 2 → 12 for each new Animal

When finished, all Animals names should appear on the ER4000 tab in left column alongside ER4000 ID#s

Activity Software Setup (DP1224) *– Skip if not using DP1224s*

To configure each new subject, you will need to assign a name to the "Animal", specify the type of device being used and select which DP1224 and Port# the device is attached to. There are optional settings available for organization of subjects and display of data.

Configure Animals

1. Click Settings →Animals tab

2. Click New at bottom left corner of screen. Figure 5-4 should appear

3. Enter a name and click OK.
   - The new name should appear on the Animal list on the left and in the Default Group list on the right (Fig 5-5).
   - Optional: To create a new Group label and assign it to the current (highlighted) Animal, type a new Group name into the "Group" field and click Save. The current Animal will appear under the new Group name on the Group list at the right. The new Group label will be available in the pull-down menu for use with subsequent animals.

Fig 5-4

Fig 5-5

4. Click on the "Device" field and select appropriate running wheel/IR sensor (ICRW, IRMOT, etc)
   - Fields shown in (Fig 5-5) should become visible.

- Check box next to Activity turns data acquisition/display On/Off

5. Select which DP1224(if using multiple DP1224s) from the "Name" pull-down menu
6. Enter the Port # (1-12 or 1-24) on the DP1224 that the Device is plugged into
7. Optional - Enter an "Equipment ID" number (if any) associated with the sensor/running wheel
8. Optional - Text entered into "Description" field will appear in Zoom/Detail views of data channels and exported data files
9. Optional - Set "Export Interval" for each parameter - *(Default = System Sampling Interval)*
   - Can be used as a channel specific Export Sample Interval later when exporting data
   - It is highly recommended to use only multiples of the System Sampling Interval
10. Optional - Set Clipping Limits for each parameter
    - Accept default values or see VitalView Terminology in Appendix E for more detail
11. Click Save
    Note: Always click "Save" before starting a New Animal

Repeat Steps 2 → 11 to configure each new Animal

When finished, all Animals names should appear on the DP1224 tab on the "DP1224 Ports Assigned" column

6. Monitor/Collect Data

Once your hardware and software are installed and configured it is recommended that you perform a short test run to ensure that data is being collected/recorded as expected before you perform actual studies.

For a test run set System Sampling Interval and Temperature/Oversample buffer to 5 seconds. This will allow you to easily observe changes to inputs

Record for a short period of time then use the steps in the Import/Export/View Data section to open/view the resulting data files. Make sure you are logging data as expected.

Start Data Acquisition

1. Click the <u>Start</u> button on the left side of the VitalView main screen.
   - The screen shown in Fig 6-1 should appear (column data will reflect previous user entries)
   - All Animals configured for Telemetry (ER4000) are listed in left column, all Animals assigned to DP1224 ports appear in right hand column

   Note: If you want to omit any Animal/Input from data collection, go to the Animal configuration and change the "Device" to "Unused" then click <u>Save</u>

Fig 6-1
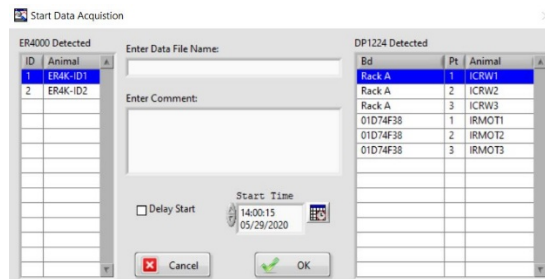
2. Optional - Enter Data File Name
   - If left blank the File Name will be created from a Windows System Time/Date code

3. Optional - Enter Comment
   - Text entered will be included in exported data files. *-No character restrictions*

4. Optional – Enter start time
   - Skip if you want to start immediately
   - To set a start time use the mouse pointer to select the [icon] button and enter the start time and day
   - Click the "Delay Start" box before proceeding

5. Click <u>OK</u>,
   - The message shown in Figure 6-2 should appear
   - "On-Line" indicator at top right will blink green (Fig 6-3)
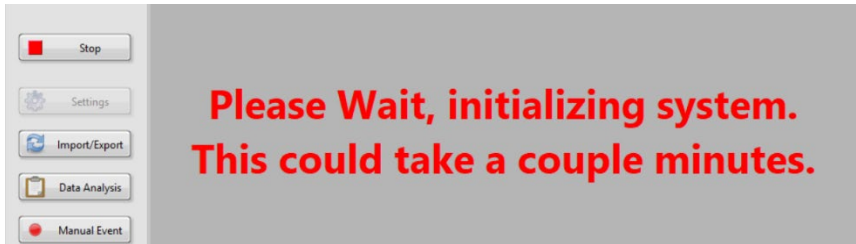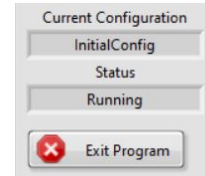   - Data Collection Status field at bottom left should display "Running" (Fig 6-4)

Fig 6-2

Note: Green LEDs on ER4000s may flicker excessively during system initialization

Fig 6-3

Fig 6-4

Monitor Real-Time Data Acquisition from DP1224s – *Skip if not using DP1224s*

1. Click <u>Mon Activity</u> on left side of VitalView main screen
   - If multiple DP1224s are connected choose from the "Monitor Select" pull down menu (Fig 6-5)
   - A list of data channels should be visible (Fig 6-6)
   - Click anywhere on a display line (Fig 6-6) to open a detail/zoom view (Fig 6-7)
     - Zoom window shows last 100 data points. The time period shown is determined by the System Sample Interval and is displayed at the bottom of the screen.
     - To view detail of entire recording use Export →Graph →View -or- Data Analysis →View Graph/Multigraph
     - Click <u>Done</u> in lower right corner to exit detail/zoom screen

2. To test connectivity and channel assignment, manually trigger each sensor. I.e. spin running wheel or, move hand in front of infrared sensor (IRMOT)
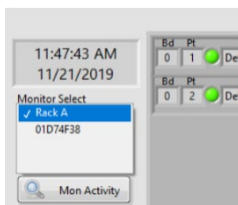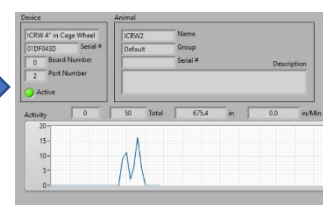

Fig 6-5

Fig 6-6

Fig 6-7

Monitor Real-Time Data Acquisition from ER4000s – *Skip if not using ER4000s*

1. Click Mon Telemetry on left side of VitalView main screen
   - You should see a listing of Telemetry data channels (Fig 6-8)
   - If you have more than 16 ER4000s attached, click the "Monitor Select" field in the upper left corner to access ER4000 ID#s 17-32
   - Click anywhere on a display line (Fig 6-9) to open a detail/zoom view (Fig 6-10)
     - Zoom window shows last 100 data points. The time period shown is determined by the System Sample Interval and is displayed at the bottom of the screen.
     - To view detail of entire recording use Export →Graph →View -or- Data Analysis →View Graph/Multigraph
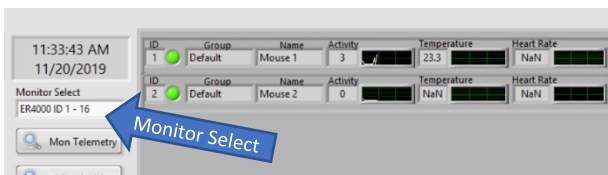   - Click Done in lower right corner to exit detail/zoom screen
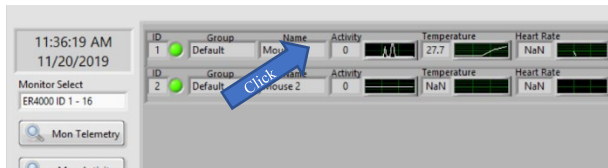

Fig 6-8

Fig 6-9
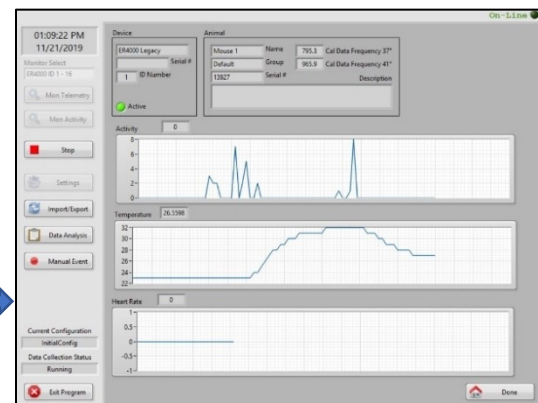
Fig 6-10

2. To test E-Mitter connectivity place an E-Mitter onto an ER4000 and move it around until the green LED on the front of the ER4000 stays on.
   - If no E-Mitter is present in the charging field of each ER4000 then the data fields should contain 0 (zero) or NaN (Not a Number)
   - Activity counts and room temperature (if Cal Data Frequencies have been entered) should be displayed
   - Moving the E-Mitter across the top surface of the ER4000 triggers activity which is indicated by the green LED on the front of each ER4000 turning on/off
   - If you close your hand around the E-Mitter and hold it above the ER-4000 so the green LED is lit, the measured temperature will rise (Fig 6-9/10)

7. Import/Export

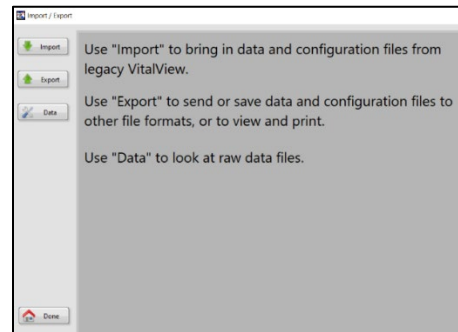Click the Import/Export button on the left side of the VitalView main screen to access tools for working with VitalView data files. (Fig 7-1 should appear)

Fig 7-1

Import button

The Import tool allows you to import experimental data and configuration files created with older versions of VitalView and VitalView Activity.

Use Windows Explorer to copy your old files into the Import/Export folder location specified in – VitalView → Settings →System tab →Import/Export Location

To Import data from Previous versions of VitalView (Versions 4,5 & 5.1)

Older versions of VitalView created 5 types of files. Each type of file has the same "filename" but a different extension.

- o logfile = filename.log
- o data files = filename.001, filename.002, etc.
- o configuration file = filename.cfg
- o calibration file = filename.cal
- o Event files = filename.evn – (Not compatible with VitalView 6. Do not import)

To import experimental data the logfile and data files are required. Configuration and calibration files are optional.

To import data from "VitalView Activity" software (Versions 1.0 – 1.5)

"VitalView Activity" software created 3 types of files. Each type of file has the same "filename" but a different extension.

- o Configuration file = filename.xml
- o Data file = filename.csv
- o Secondary data file = dm_filename.csv (Do not import)

To import experimental data the data file is required. The configuration file is optional. Disregard the "DM" file.

1. Click the <u>Import</u> button on the left side of the Import/Export screen (Fig 7-2 should appear)
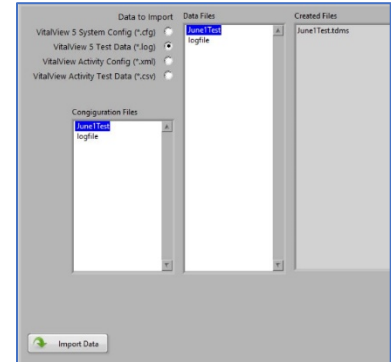   - Compatible files will appear in the appropriate columns

   Fig 7-2

2. Select the radio button for the type of Data to Import
   - VitalView 5 System Config (*.cfg)

     Select if you want to import a system configuration and E-Mitter calibration values (if available) for use in future data collection sessions

   - VitalView 5 Test Data (*.log)

     Select if you want to convert experimental data collected using older versions of VitalView to the current format. If the configuration file is available it will appear in "Configuration Files" column. Select both the data file and configuration file before you click <u>Import Data</u>.

   - VitalView Activity Config (*.xml)

     Select if you want to import a system configuration from VitalView Activity Versions 1.0 to 1.5 for use in future data collection sessions

   - VitalView Activity Test Data (*.csv)

     Select if you want to convert data collected using VitalView Activity versions 1.0 to 1.5 to the current data format.

3. Select the file you wish to import from the "Data Files" column
   - If you select a Data type file to import, the "configuration Files" column will appear below the "Data Files" column (Fig 7-2)
   - Select the correct configuration file (if available) that is associated with the data file. Configuration data will be embedded in the data file when imported

4. Click the <u>Import</u> button
   - New files appear in the "Created Files" column
   - Config and Calibration are combined into "filename.ini" which is created in the VitalView/Configure folder. You can load this into VitalView by clicking the <u>Load Config</u> button on the System or Animals tab
   - Log, data, config and calibration files are combined into "filename.tdms" that is created in VitalView/Data folder

Export button

Experimental and system configuration data can be exported from an active data monitoring session or any previously saved file. Data can be exported to the Windows Clipboard, Viewer and default printer or to a number of different file formats such as Excel, ASCII and legacy VitalView formats

1. Click the Export button on the left side of the Import/Export screen (Fig 7-3 should appear)

Fig 7-3
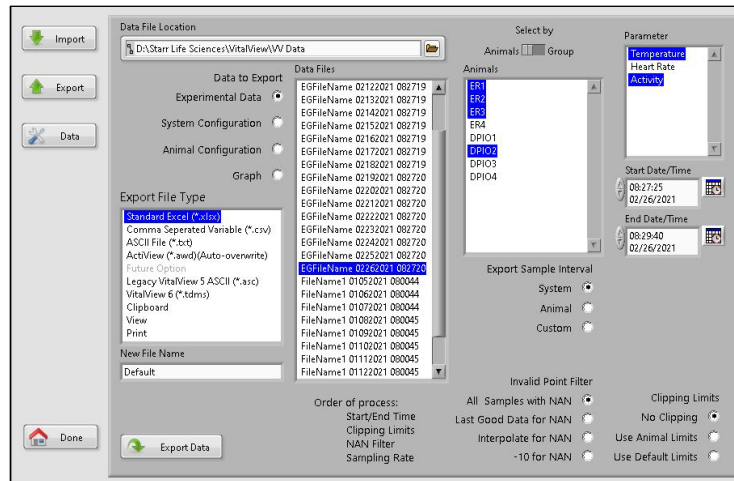
2. Select the type of "Data to Export" radio button

- **"System Configuration" or "Animal Configuration"**
  I. Select the Configuration File that you want to export from the column on the right
  II. Select "Export File Type" to be created
  - Excel - creates an Excel file with each Subject/Animal data in a separate tab
  - Clipboard - creates a space delimited data table on the Windows clipboard which can be Pasted directly into most Windows applications
  - View - displays a space delimited data table which can be printed to your computers default printer
  - Print - sends a space delimited text file directly to your computers default printer
  III. Enter a name for the file to be created in the "New File Name" field
  - Output files will be created in the location specified in Settings → System tab → Export Location
  IV. Click Export

- **"Experimental Data" or "Graph"**
  I. Select the Data File that you want to export from the "Data Files" column
  Note: You can export data from an active monitoring session by selecting the file name listed in the top border of the VitalView Monitor screen.
  - The Animals and Parameters available in the selected data file appear in the "Animals" and "Parameters" columns respectively

II. Select the Animal(s) and Parameter(s) to be exported

Note: Hold down the Ctrl key while making selections to highlight multiple separate items

Note: Hold down the Shift key while making selections to highlight a continuous list of items

III. Optional - Specify the time span of data to be loaded
- The entire data file will be loaded by default into the Start/End input fields (Fig 7-4)
- To load data from a shorter time span within the file, click on the Start Time and End Time fields and manually enter desired Start/End points

Fig 7-4

Start Date/Time
2:03:07.898 PM
4/2/2020

End Date/Time
2:12:34.793 PM
4/2/2020
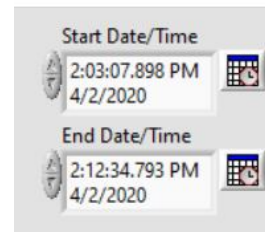
IV. Select the "Export File Type" to be created

All file types except Clipboard, View or Print will result in the creation of a new file in the location specified in Settings → System tab → Import/Export Location

- Clipboard - will create a space delimited tabular text file on the Windows clipboard which can be Pasted directly into most Windows applications
- View – will display a space delimited tabular list of the file data which can be printed to your computers default printer
- Print – will send a space delimited tabular text file directly to your computers default printer

V. Select Export Sample Interval radio button
- System – All data channels will be exported using the System Sample Interval that was set at the time of the recording in Settings →System tab.
- Animal – Each data channel is exported using the Display Interval set for each Animal at the time of recording
- Custom – All data will be exported using a specified Sample Interval
  - It is highly recommended that you choose an interval that is a multiple of the System Sampling Interval to prevent reporting inconsistencies
  - Activity – count values from adjacent sample periods will be periodically combined.
  - Temperature and Heart Rate – ongoing Export Sample Intervals that don't align with the ongoing System Sampling Interval will contain the closest preceding data point.

VI. Select Invalid Point Filter radio button
   VitalView uses error checking algorithms to flag errors caused by occasional systemic noise. These "Invalid Points" are recorded as NAN (Not A Number) in the original experimental data file. Selections here determine how invalid points are handled during viewing, analysis and export.

- All Samples with NAN:
  - Invalid points exported as text value "NAN" to CSV, ASCII, Clipboard, View and Print
  - Exported as blank/empty value to Excel and graphic formats (Graph, Bitmap, eps, emf)

- Last Good Data for NAN - Last valid data point is substituted for invalid points until the next valid data point is encountered
- Interpolate for NAN - Invalid points replaced with values calculated by linear interpolation between the last valid data point and next valid data point
- -10 for NAN - Number (-10) is substituted in place of invalid points. This is useful for making the prevalence of invalid points easily visible when displayed but skews statistical calculations performed on the data

VII.   Select Clipping Limits radio button

See "Clipping Limits" in Appendix D, VitalView Terminology

- No Clipping –   No clipping boundaries are applied to exported data.
- Use Animal Limits – Applies Clipping Limits specified for each Animal at time of recording on the Settings→ Animal tab
- Use Default Limits – Applies Clipping Limits associated with the Default Animal to all exported data

VIII.   Click Export Data
- The new file will be created at the location specified in Settings →System tab→ Import/Export Location

IX. Click Done button at lower left corner of screen

Data button

The Data button opens access to VitalView data utility tools. Select a single file from the list and click View Raw Data to quickly browse the file data. Click multiple files from the list and click Combine Files to join them into a single file. After combining files select the name of the newly created file and click Defragment to clean up the file stored on your computer hard drive.

Click the Data button on the left side of the Import/Export screen (Fig 7-5 should appear)

Fig 7-5
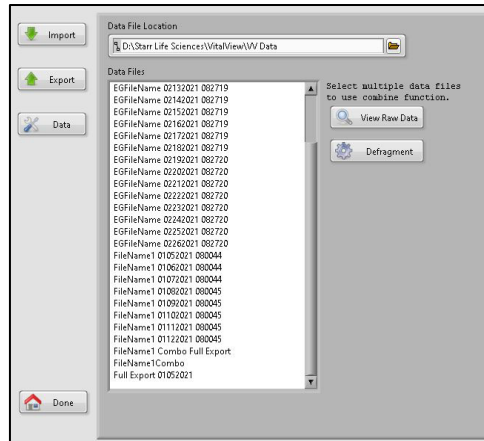
- **View Raw Data**
  I. Select a file from the "Data Files" list and Click the View Raw Data button (Fig 7-6 should appear)
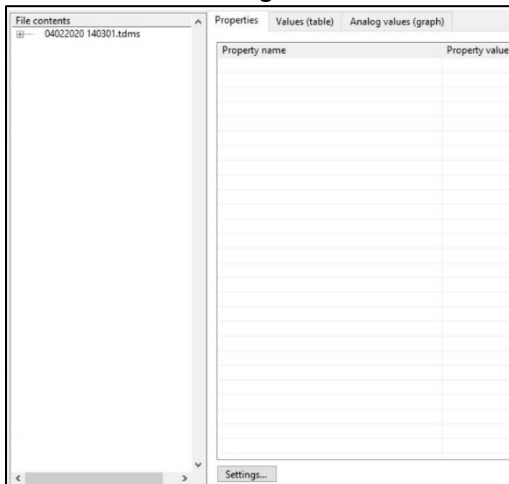
Fig 7-6   **Fig 7-7**
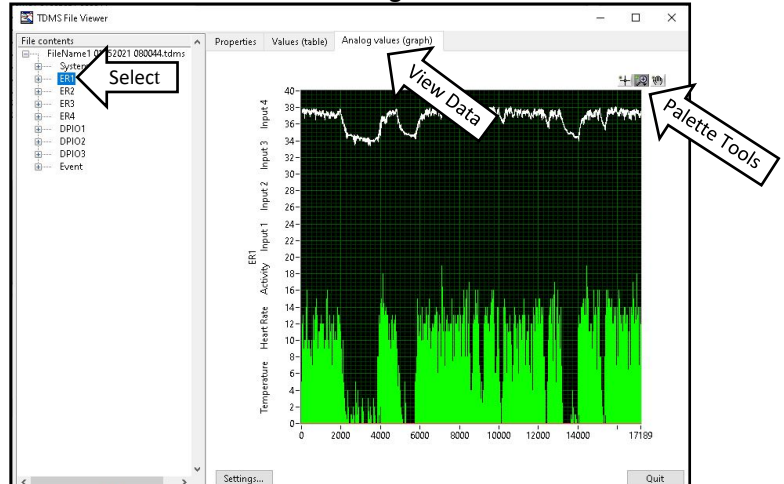
II. Select which Animal or Parameter you would like to view from the column on the left (Fig 7-7)
III. Select the tab across the top to view tabular or graphical display of data
IV. Use the "Palette Tools" on the Graph to change the vertical or horizontal scale or to zoom in on a particular area of interest

Note: To view large files click Settings and select "Load All Values"
Note: The default time axis labels will not be formatted correctly. Right Click on X-axis and select "Ignore Time Stamp" to show data file sample number

- **To combine files**
  I. When you select more than one file from the "Data Files" list the <u>Combine Files</u> button and "Data File Name" field should appear (Fig 7-8)

Fig 7-8

  II. Enter the name of the file to be created and click <u>Combine Files</u>
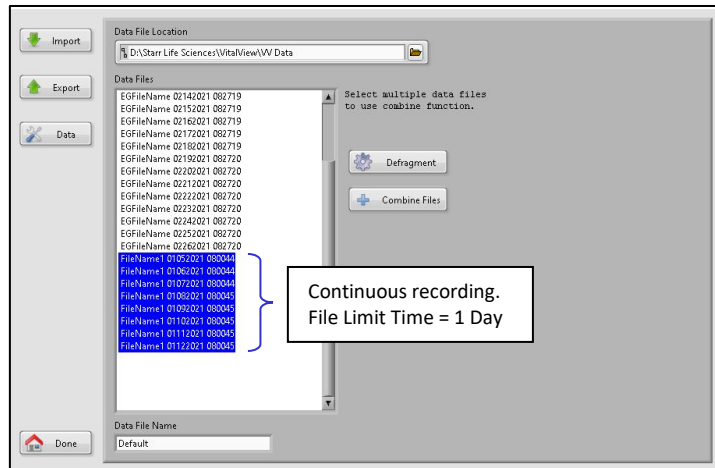   - Selected files will be combined sequentially along the same time axis using the timing data from each file
   - The new file is created at the location specified at <u>Settings</u> → System tab →Data Location and should appear in the list and

Note: The example above depicts the joining of sequential data files created during a single recording session over an eight-day period. File Time Limit setting = 1 day

Note: It is recommended to only join files that were created with the same data sample interval. Joining files with different sample intervals may cause irregularities in the way data is displayed in the combined file.

8. Data Analysis

- You can install VitalView and use the Data View/Analysis tools on multiple computers. These tools don't require the presence of a hardware dongle.
- It is strongly recommended against viewing data files on a computer that is actively acquiring data.

The Data Analysis screen contains tools for managing large data files, data filtering and statistical analysis. The tools allow you to compare multiple parameters from multiple subjects within a data file, quickly determine basic statistical values and export data with full or down-sampled resolution.
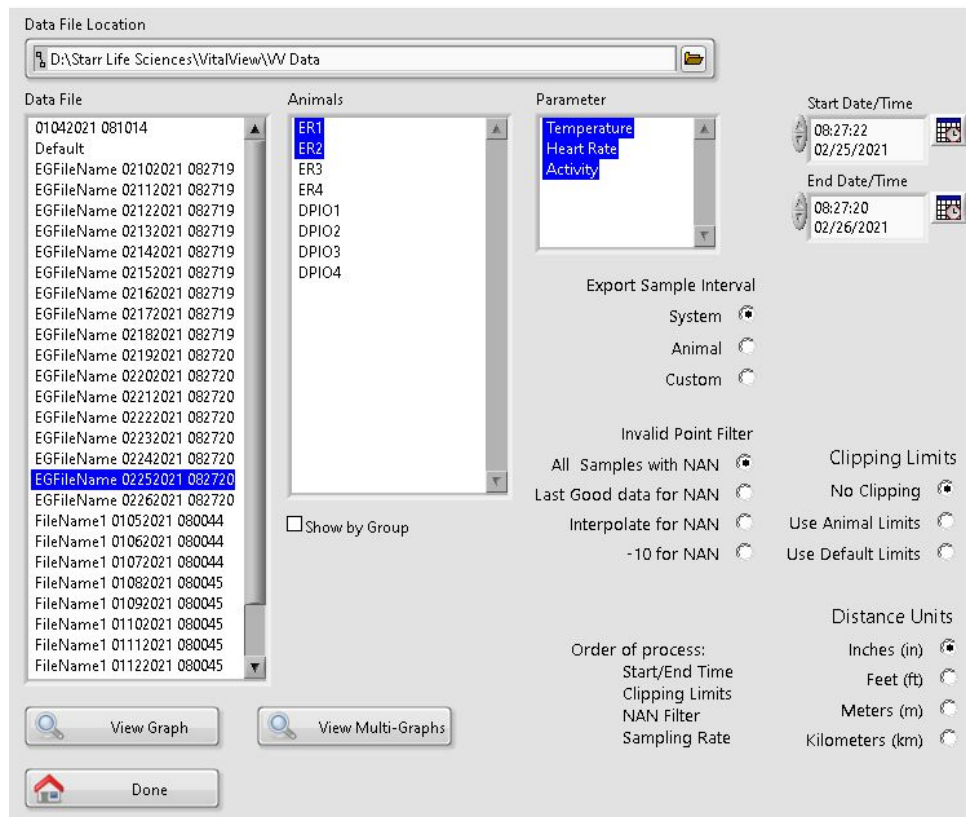
The process steps are:
- Select the data you want to manipulate
- Load a copy of the data into a buffer (View Graph)
- View, manipulate and filter the buffered data set
- Name/Export the buffered data set.

Note: The original data recording is unaltered

1. Click the <u>Data Analysis</u> button– the screen shown in Figure 8-1 should appear.

Fig 8-1

2. Select a file from the "Data File" column
   - The items listed in Animals, Parameter, and Date/Time fields will update to reflect the contents of the Data File selected
   - Data Files are stored in the Windows folder specified in the VitalView Settings →System tab→ Data Location
3. Select one or more items from the Animals column
   - You can select multiple items by holding down the Shift or Ctrl key while making selections
4. Select one or more items from the Parameter column
   - You can select multiple items by holding down the Shift or Ctrl key while making selections
5. Optional - Specify the time span of data to be loaded
   - The entire data file will be loaded by default
   - Use the mouse cursor to click on the calendar or time fields (Fig 8-2) to manually specify different Start/End times

Fig 8-2

Start Date/Time
2:03:07.898 PM
4/2/2020

End Date/Time
2:12:34.793 PM
4/2/2020
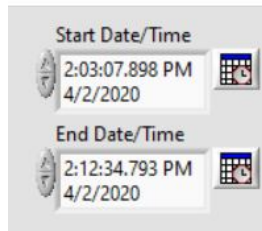
6. Select Export Sample Interval radio button
   - System – All data channels will be exported to graphs using the System Sample Interval that was set at the time of the recording in <u>Settings</u> →System tab.
   - Animal – Each data channel is exported to the graphs using the Display Interval set for each Animal at the time of recording
   - Custom – All data will be exported to the graphs using a specified Sample Interval
     - o It is highly recommended that you choose an interval that is a multiple of the System Sampling Interval to prevent reporting inconsistencies
       - ▪ Activity – count values from adjacent sample periods will be periodically combined.
       - ▪ Temperature and Heart Rate – ongoing Export Sample Intervals that don't align with the ongoing System Sampling Interval will contain the closest preceding data point.

7. Select Invalid Point Filter radio button

VitalView uses error checking algorithms to flag errors caused by occasional systemic noise. These "Invalid Points" are recorded as NAN (Not A Number) in the original experimental data file. Selections here determine how invalid points are handled during viewing, analysis and export.

- All Samples with NAN:
    - o Invalid points exported as text value "NAN" to CSV, ASCII, Clipboard, View and Print
    - o Exported as blank/empty value to Excel and graphic formats (Graph, Bitmap, eps, emf)
- Last Good Data for NAN - Last valid data point is substituted for invalid points until the next valid data point is encountered
- Interpolate for NAN - Invalid points replaced with values calculated by linear interpolation between the last valid data point and next valid data point
- -10 for NAN - Number (-10) is substituted in place of invalid points. This is useful for making the prevalence of invalid points easily visible when displayed but skews statistical calculations performed on the data

8. Select Clipping Limits radio button

See "Clipping Limits" in Appendix D, VitalView Terminology

- No Clipping – No clipping boundaries are applied to exported data.
- Use Animal Limits – Applies Clipping Limits specified for each Animal at time of recording on the Settings→ Animal tab
- Use Default Limits – Applies Clipping Limits associated with the Default Animal to all exported data

9. Select Distance Units
    - Unit of measure for distance run on running wheels.
    - Total distance run is displayed on individual graphs of Activity from running wheels only.
    - $Distance = Rev(\pi)(Dia)$; Rev = Activity Counts, Dia = ID running wheel

10. Click the <u>View Graph</u> or <u>View Multi-Graphs</u> button to copy the data into the buffer
    - <u>View Graph</u> (Fig 8-3 should appear)
        o Up to 14 parameters can be viewed together on a single graph
            ▪ E.g. 7 Animals X 2 Parameters/each = 14 Parameters total
        o Data series can be manipulated and exported together
        o Each parameter label consists of a parameter prefix and the Animal name
            ▪ Prefix: T = Temperature, H = Heart Rate, A = Activity
        o Left Click the outer limit of the X or Y axis and manually enter a value to change scale

Fig 8-3
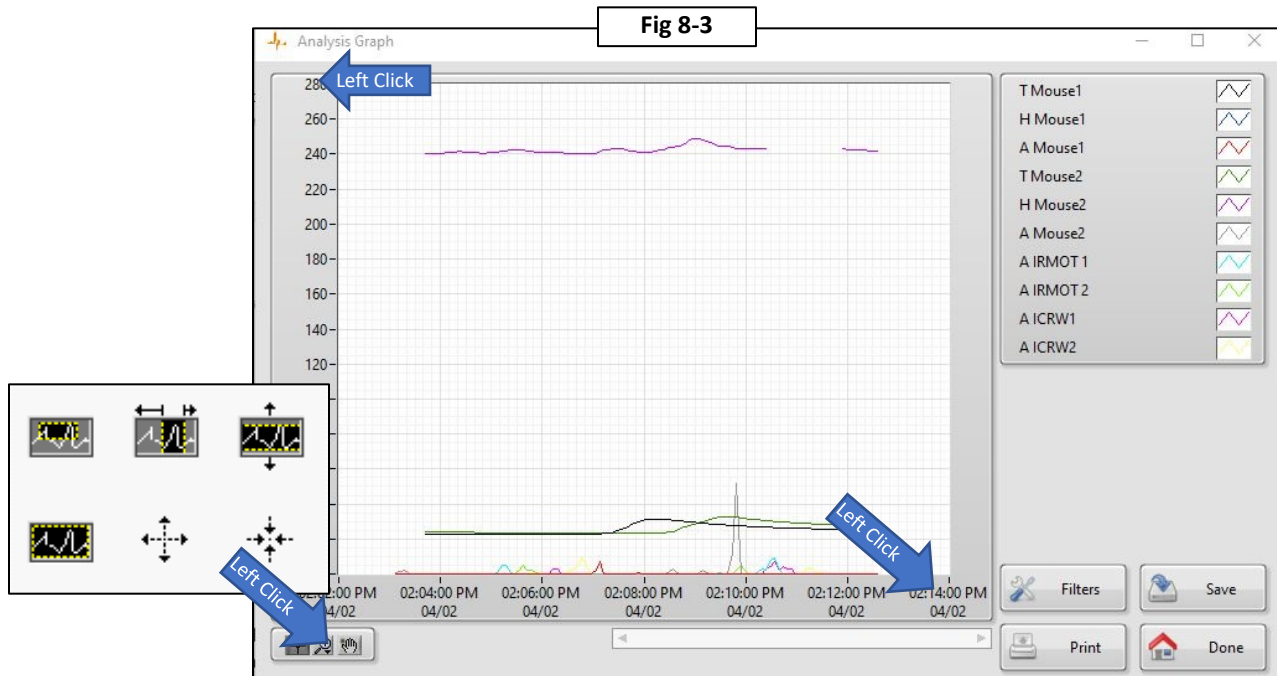
- <u>View Multi-Graphs</u> -*Available if more than 1 parameter is selected*
    o Each data series is plotted on a separate graph
    o Unlimited parameters can be viewed
    o Statistical information for each data series is calculated and displayed
    o Mean, St Dev and Variance are not calculated if data set contains NAN values
- Only Parameters that were set active for each Animal at the time of the original recording in the Settings →Animal tab will be displayed

11. Click the <u>Filters</u> button on any Graph
    - Single data series graph - Fig 8-4 should appear
    - Multiple data series graph - Fig 8-5 should appear
        o Select a data series to filter from the "Plots Available" column
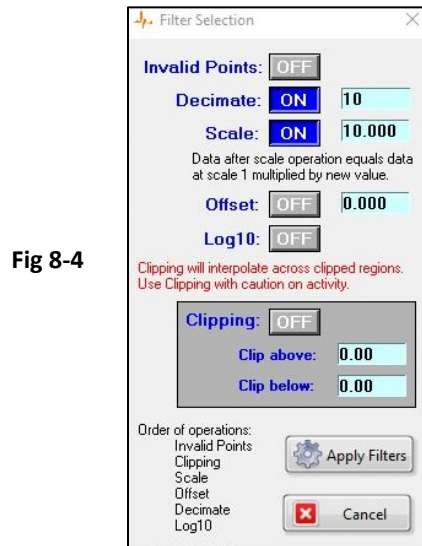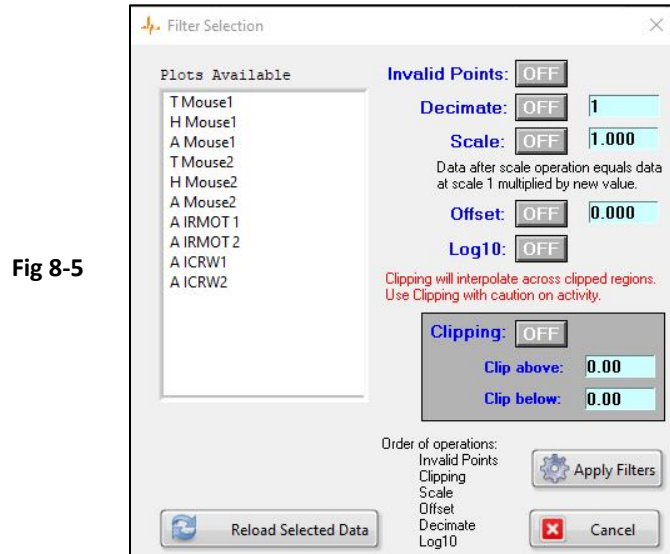
Fig 8-4

Fig 8-5

12. Input filter values
    - Click <u>OFF→ON</u> buttons for each filter you want to apply
        o See Decimate and Scale in Fig 8-4
    - Invalid Points
        o Data loaded into the Graph/buffer with NAN=NAN will show gaps in data
        o Turning on the Invalid Points filter and applying to a data set will substitute the Last Good Data value for each NAN value.
    - Decimate (bin average). Periodic series average based on a defined number of samples (bin size)
        o Enter the number(N) of consecutive data points to be averaged per "bin"
        o Applying this filter will result in a data series with 1/N samples
        o Each new sample is assigned the time value from the last sample in each bin.
    - Scale – All values in a data series are multiplied by the scale factor.
        o Useful for converting a bin averaged <u>Activity</u> data series into a cumulative interval series.
            ▪ Scale data series by bin size N
        o Also useful for scaling parameters with dissimilar magnitudes so they can be viewed alongside one another on the same graph.
            ▪ Multiply body temperature(~37 C) by 10 to view alongside heart rate (~400 BPM)
    - Offset – Value entered is added to all data points of selected data series.
    - Log10 - Converts the Y-Axis of selected data series to a logarithmic scale.
    - Clipping Above/Below
        o Eliminates data points outside of the set Clipping limits

- o Last Good Data value is substituted in place of clipped data
- o Value entered in "Clip Above" field must be greater than the value entered in the "Clip Below" field

13. Click <u>Apply Filters</u>
- Graph should update immediately.
- You can continue applying filters to data series.
- If you want undo filter operations on one or more data series currently loaded in the buffer, select the series you want to reset and click Reload Selected Data

14. Save/Export data in the analysis buffer
- Click the <u>Save</u> button on any graph to export all data series depicted on the graph
- Choose ASCII, CSV or AWD (Actiview)

Appendix A – Troubleshooting

- **Software**
    - Software not responding
        - Check that other VitalView screens/dialog boxes are open/active and hidden.
        - Close extra screens and dialog boxes
    - Start button greyed-out and unresponsive
        - No software is activated – See Software Installation section
        - Make sure Hardware Dongle is attached to a USB port on the computer or attached USB hub
    - VitalView Screens are missing fields/controls that are shown in the instructions
        - Make sure Hardware Dongle is installed and Software Modules are activated
    - Text on screens and controls appears clipped or distorted
        - Check Windows "Ease of Access" Display settings
        - Make sure text and display scaling are set to 100%
        - Restart VitalView software after any changes are made
    - VitalView software is "Running/On-Line" but no data is acquired
        - Make sure all ER-4000s and DP1224s attached to the computer show up on their respective Hardware tab
        - Check all connections – Click "Rescan"
        - Check each animal setting on the System → Animal tab.
            - Make sure a proper "Device" is selected and Port#/ID# is assigned
            - Make sure the box next to each parameter is checked
- **Telemetry/ER-4000/E-Mitter**
    - Red LED on front of ER-4000 does not blink
        - Check AC power outlet, switches on plug strips, breakers, etc.
        - Verify all Y-Cable connections. Use captive screws to prevent disconnect
        - Make sure you have no more than 4 x ER4000s for each power supply
    - Red LED is blinking on ER-4000(s) but does not appear on the Settings →Hardware tab
        - Verify all Y-Cable connections. Use captive screws to prevent disconnect
        - Make sure you have no more than 4 x ER4000s for each power supply
        - Verify that the COM Port shown on the ER4000 tab matches the COM Port shown in Windows Device Manager
        - Verify that no ER-4000s have duplicate ID#s - See Telemetry Hardware Setup
    - Temperature values are obviously inaccurate
        - Make sure "Cal Data Frequency" values are entered correctly for each Animal on the Settings/Animal tab. Make sure they match those printed on the plastic E-Mitter case with the corresponding serial number
    - Temperature/Activity/Pulse data is erratic

- Distortion of values can be the result of significant electromagnetic interference (EMI) in the immediate environment.
- Make sure minimum spacing between ER-4000s is 20 cm or greater
- Reduce/eliminate any sources of EMI. (Electric motors, mass spectrometers, diathermy machines, MRI devices, etc).
  - Turn off equipment or increase separation
- Use a Low-Band AM radio tuned to 500 KHz to identify possible sources of EMI. Place radio near ER-4000. If static is heard, move the radio around the room to find the source. Static will get louder as you move closer to sources
- Check cable routing.
  - Route cables away from each other, power cords, telephone cables, etc.
  - When signal cables must cross power cables, cross them at a 90º angle.
  - Red LED blinks but Green LED never turns on
    - Make sure implanted animal is in range. Adjust/center cage/animal on platform
    - Check if Green LED will light when a different E-Mitter is placed in the charging field
    - If green LED does not light but VitalView can recognize the E-Mitter and collect data, the LED is damaged. Contact Starr Life Sciences
- DP1224
  - Green LEDs on side not lit
    - Check all USB connections
    - Make sure any USB hubs in use are plugged into wall power
  - Green LED lit but DP1224 is not recognized by Instacal software
    - Reinstall Instacal and its drivers
  - Green LED is lit, DP1224 is recognized by Instacal, DP1224 not recognized by VitalView
    - Exit VitalView software and restart Windows
    - Run Instacal software to verify the DP1224 is recognized.
    - Restart VitalView Software
    - Click "Rescan" button under list of DP1224s Detected on the Settings → DP1224 tab
  - Running Wheels – missing wheel turn counts
    - Check alignment between the magnet attached to the wheel and the sensor
    - Pass a magnet over the sensor to simulate a wheel-turn count and verify connection
  - IR Sensor
    - Make sure all IR Motion Detectors have power supply attached. LED on front of sensor should light up when you pass your hand in front of it

If you are still unable to resolve your problem please contact Starr Life Science for technical support.

Appendix B - Heart Monitor

The VitalView Heart Monitor utility provides a display of the continuous cardiac waveform from HR E-Mitters (PDT-4000HR and G2 HR).

HR E-Mitters each have 2 biopotential leads. The waveform obtained is not a true ECG waveform. It is best described as the Q-T Segment with a broadened R wave. Heart rate is determined by counting the number of R wave pulses within a given time interval.

Accurate heart rate detection depends on proper surgical placement of the leads. The Heart Monitor utility is useful for confirming proper placement before closing the incision and transferring the animal to recovery. It is recommended to monitor the heart signal following surgery to make sure that the lead contact remains secure during recovery.

The following example depicts the use of the Heart Monitor with a human ECG Patient Simulator (Fig B-1) in place of an implanted animal. Detailed surgical implantation instructions are provided in "E-Mitter Implantation Procedure"
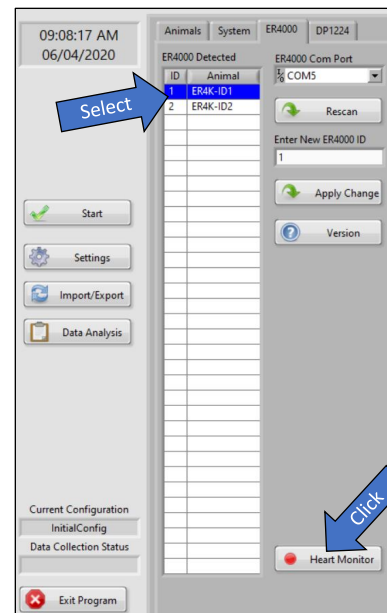
Fig B-1

The "Right Arm" and "Left Arm" test leads are attached to the E-Mitter leads.

Use "micro-grabber" test clips to minimize damage to leads

Fig B-2

The Heart Monitor can be used to view the waveform of any single HR E-Mitter/ER4000 detected by VitalView.

See ER4000/Telemetry Hardware and Software Setup for detailed setup instructions.

The VitalView "Heart Monitor" tool is found on the ER4000 tab (Fig B-2)

1. Run VitalView software but DO NOT start a monitoring session. VitalView must be "Off-Line"
2. Select the ER4000 you wish to monitor from the list on the ER4000 tab (Fig B-2)

3. Click the <u>Heart Monitor</u> button (Fig B-2) – the Heart Monitor screen should appear (Fig B-3)
   - Fig B-3: No E-Mitter in ER4000 charging field
   - Fig B-4: E-Mitter present, HR leads floating, no cardiac signal
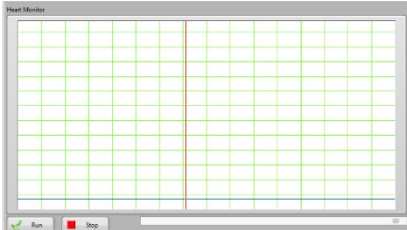   - Fig B-5: E-Mitter present, human Patient Simulator (240 BPM) attached to HR leads (Fig B-1)

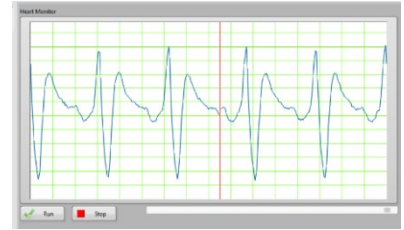
Fig B-3   **Fig B-4**   **Fig B-5**

4. To print the waveform to the system default printer click <u>Stop/Run</u> at the bottom of the screen, when you get a trace that you want to print then click "Print"

Implant Lead Quality

Fig B-6 shows a signal obtained from an E-Mitter implanted in a rat. This waveform shows characteristics that indicate good surgical placement of leads (well defined peaks that rise 1-1/2 to 2 gridlines above baseline)

Fig B-6
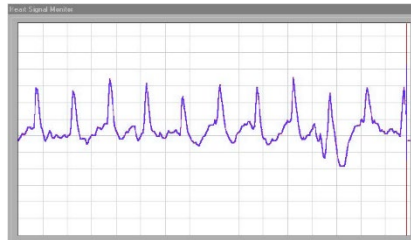
Conversely, if the peak is poorly defined, broadened, has low amplitude above the baseline, or spikes appear below the baseline, either the lead contact is poor or the subject is not well. Therefore, the investigator should try to achieve a lead contact that provides an R-wave with good definition.

When sutured appropriately into place, the lead contact should not degrade over time. In fact, the lead contact can often improve over a period of one to two days after surgery and remain constant afterward. It is wise to check the lead contact of each subject on a periodic basis, perhaps once per month or at least at the beginning of each sequential experiment.

Appendix C - Data File Size

The total file size of a recorded data file is approximately determined by the number of data channels, System Sampling Interval and duration.

$$Total\ Disk\ Space = 850 + (\#An * 800) + \left((\#Ch + 1) * \frac{t}{T} * 4.5\right) Bytes$$

System Overhead (850 bytes)

#An = number of animals (800 bytes / animal)

#Ch = number of data channels

- Running Wheel →DP1224 (1 Data Channel)
    - Activity
- IR sensor counts→DP1224 (1 Data Channel)
    - Activity
- Telemetry →ER4000 (3 Data Channels)
    - Activity
    - Temperature
    - Heart Rate
    - *Note: Each ER4000 records 3 data channels regardless of configuration*

t = time = duration of data acquisition/recording

T = System Sampling Interval = time between samples acquired. Set on Settings → System tab

Note: t and T must have same units i.e. sec/sec, min/min

24 Data Channels

System Sample Interval (sec): 5, 15, 60

96 Data Channels

System Sample Interval (sec): 5, 15, 60, 300
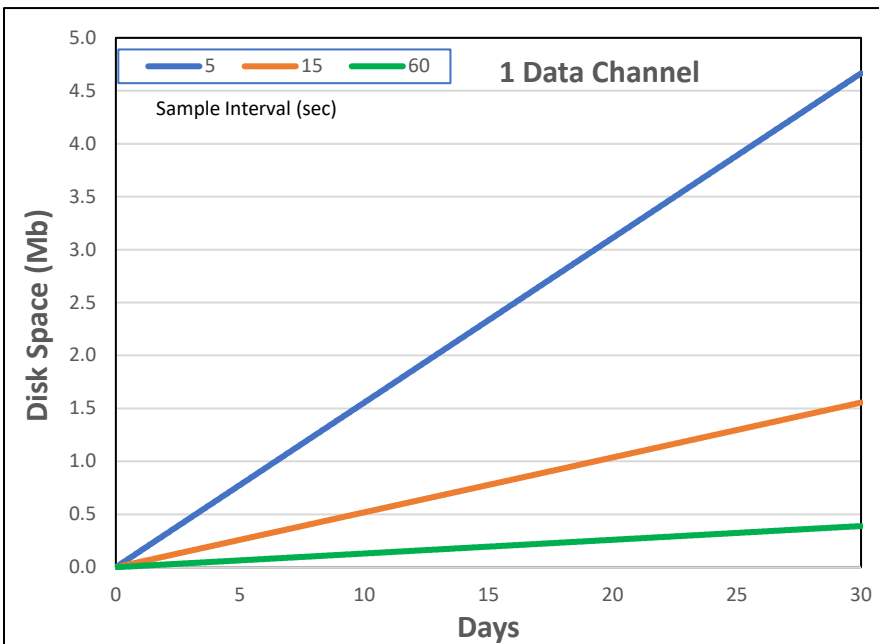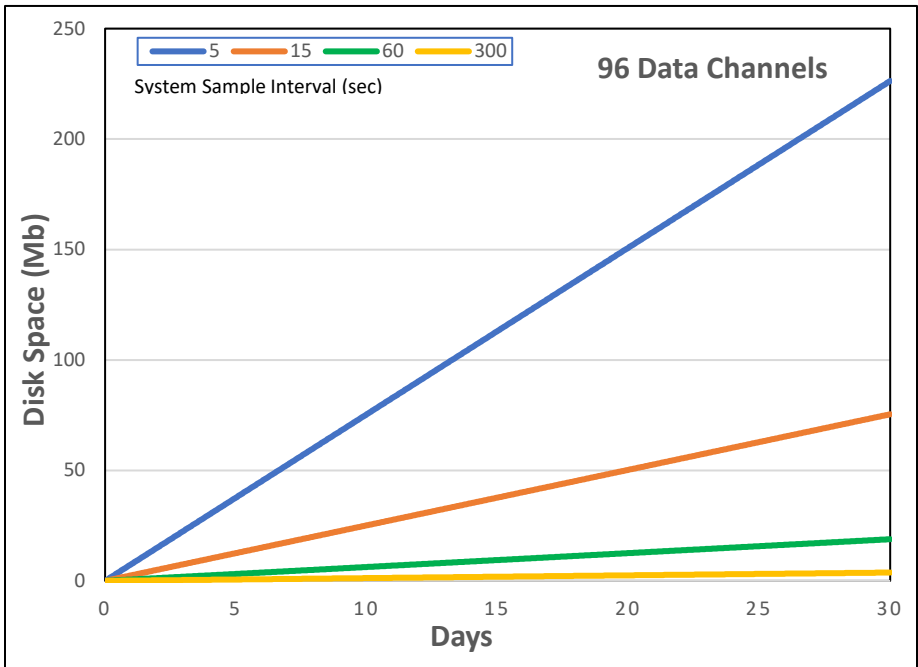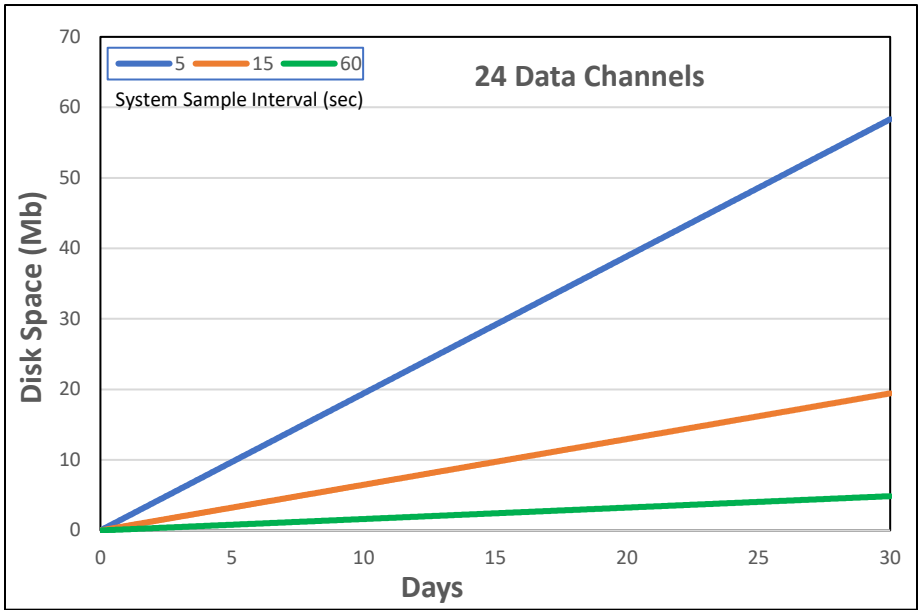
Appendix D – VitalView Terminology

Hardware Sample Rate

- The ER4000 internally samples temperature, heart rate and activity at 1 sample/sec. This is a system limit that determines maximum data resolution and is not adjustable by the user.
- The DP1224 hardware sample rate is set with the "Activity Mode" radio buttons found on the DP1224 tab. This setting is independent of System Sample Interval. Activity Mode determines the hardware's ability to resolve fast sensor inputs.

As a running wheel turns faster the DP1224 must sample faster to ensure accuracy. The table below shows the maximum revolutions per minute (RPM) that can be accurately resolved at each Activity Mode. Start by setting the Activity Mode at Very High to see if Windows system performance is adversely affected. You can estimate the maximum RPMs you will need by recording a typical subject running on a wheel with Activity Mode set to Very High then opening the data file and calculating the RPMs.

Note: Set Activity Mode to "Very Low" if you are only using IRMOT sensors

Activity Mode	Max Wheel Speed (RPM)	Equivalent Linear Velocity					
		ICRW - ID 4.5"		Small TP - ID 9"		Large TP - ID 13"	
		MPH	m/s	MPH	m/s	MPH	m/s
Very High	714	8.5	3.8	*19.1*	*8.5*	*27.6*	*12.3*
High	500	5.9	2.7	13.4	6.0	*19.3*	*8.6*
Moderate	250	3.0	1.3	6.7	3.0	9.7	4.3
Low	167	2.0	0.9	4.5	2.0	6.5	2.9
Very Low	100	1.2	0.5	2.7	1.2	3.9	1.7

Oversample Buffer

Temperature and heart rate are constantly sampled at 1 Hz by the ER4000 hardware and passed to "Oversample Buffers" in VitalView software. Each Oversample Buffer is a moving average with a window size determined by the value entered in the input fields on the Settings →System tab. You can set the buffer window size from 1 to 256 samples (1 sec/sample).

When first starting a data acquisition session the initial display of heart rate and temperature data will be delayed by buffer window length in seconds. You can eliminate the effect of the buffers by setting the value to 1.

For longer recording sessions (> 1 day) it is recommended to set this to 120. For short recording sessions (< 1 day) in which you want to observe instantaneous changes in your subject it is recommended to set this to 30 seconds. It is not recommended to enter a value < 20 seconds.

Raw Data

- "Raw data means any laboratory worksheets, records, memoranda, notes, or exact copies thereof, that are the result of original observations and activities of a nonclinical laboratory." CFR 21 Pt 58

    VitalView attaches a time/date code to the file names of raw data at the time of acquisition. The Export and Save functions allow you to save copies and subsets of data with a filename that does not include the time/date code. The time/date codes incorporated into the names of the raw data files can serve to differentiate raw data sets from modified data sets.

System Sampling Interval

- *ER4000 Temperature and Heart Rate* – System Sampling Interval determines the rate at which data points are taken from the oversample buffers and recorded to file. This rate is independent of the oversample settings. The minimum System Sample Interval is 1 sample/sec.

- *ER4000 Activity* – The System Sampling Interval defines the shortest time interval, or "bin", over which counts are accumulated. I.e., If System Sampling Interval is set to 10 seconds the data in the original recording data file will be reported as total counts per each 10 second interval (bin). You can combine bins in a data series for the purpose of analysis, display and export by a using a larger "export interval" in the Export and/or Data Analysis sections of the VitalView software.

- *DP1224* - The System Sampling Interval defines the shortest time interval, or "bin", over which counts are accumulated. I.e., If System Sampling Interval is set to 10 seconds the data in the original recording data file will be reported as total counts per each 10 second interval (bin). You can combine bins in a data series for the purpose of analysis, display and export by using a larger "export interval" in the Export and/or Data Analysis sections of the VitalView software.

Activity Counts

Counts are the number of logic state changes output by a sensor that measures switch closures. The frequency of counts is proportional to the parameter being measured. Activity Counts are proportional to gross motor activity of a subject.

The ER4000 records activity counts as an implanted subject moves in the X, Y and Z axis and changes orientation in the charging field above the ER4000 platform. The green LED on the front of the ER4000 provides a visual indicator of activity counts.

DP1224 – Running Wheels - Activity counts are recorded as the magnet mounted on a running wheel passes by the magnetic sensor mounted on the wheel frame. If Activity Mode is set sufficiently high to accurately capture all counts then counts can be considered equal to wheel turns. Wheel turns can be converted to distance traveled using the equation: Distance = (Counts) (Pi) (ID). Otherwise counts are proportional to gross motor activity.

DP1224 - IR Cage-Top Motion Sensor (IRMOT) - An activity count is recorded when motion is detected and the red LED on the front of the sensor turns on. If the sensor detects sustained motion it will continuously generate a count every 3 seconds until activity stops.

Export Interval

When exporting data, to a new file or to the Data Analysis buffer, you can choose to export the data using an "Export Interval" that is different from the System Sampling Interval. This can be useful for compressing very large files. A unique Export Interval can be set for each data channel from the System→ Animal tab or you can select a "Custom" Export Interval for the entire file at the time of export.

It is strongly recommended that export intervals be a multiple of the System Sampling Interval to avoid periodic inconsistencies in data reporting.

- ER4000 Temperature and Heart Rate

Export Interval = System Sampling Interval	No change
Export Interval = 2 X System Sampling Interval	Every other sample is exported
Export Interval = 10 X System Sampling Interval	Every 10th sample is exported

- Activity Counts

Export Interval = System Sampling Interval	No change
Export Interval = 2 X System Sampling Interval	Every 2 bin values are added
Export Interval = 10 X System Sampling Interval	Every 10 bin values are added

Decimate

The term Decimate as it is used in the VitalView Data Analysis Filter section means that a data series will be compressed by a decimation factor N. Each subsequent set of N samples in the original data series will be summed, divided by N, replaced with this value and assigned the time value associated with the last data sample from the original series of N samples. The resulting data series will contain 1/N samples and will have a sample interval of N * (original sample interval). This is often referred to as bin averaging.

When applying the Decimate function to a data series containing Activity Count data, the resulting data series values will be the average counts per data bin within each decimation interval from the original series. If you multiply (Scale) the data series by the Decimation Factor N the resulting data series values will be the cumulative counts for each decimation interval.

Clipping Limits

Hi/Lo Clipping Limits are user defined boundaries outside of which data is marked as Invalid Points. The purpose of Clipping Limits is to allow the user to eliminate data from display during post-process analysis that the user considers to be "outliers". Data points that are "Clipped" and the resulting gaps in data are handled according to the "Invalid Point Filter "settings.

 It is up to the user to determine valid criteria for defining outliers. All data is maintained in the original data recording.

Clipping Limits can be applied when post processing data sets using the tools in the Basic Analysis menu. They do not clip data values from the real-time display during data acquisition.