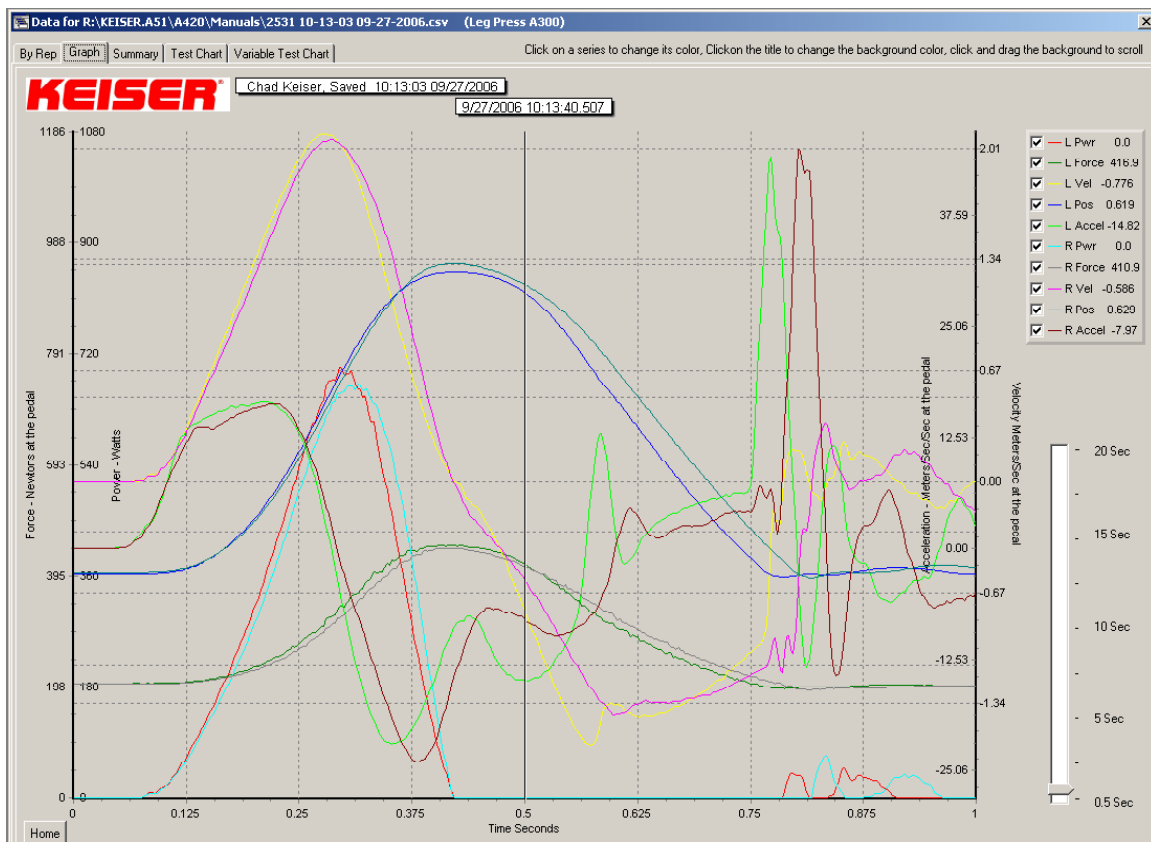


# KEISER® *aj*420

## Operations and Maintenance Manual Rev X



**Release 9.3.5 Software Package**

# Contents

Illustrations Index	3
Prerequisites	4
Introduction	5
Installation and Setup	7
Embedded Software Versions for Release 9.3	8
Operation	15
Live Data Display Screen	25
Notes on Units of Measure and Displayed Values	25
Translated Data File Format	30
Power Tests	32
Notes on use with a rack	39
Notes on Range of Motion required to count a rep	39
Calibration	41
Theory of Operation	45
Firmware Update Procedure	50
Setting the Model	54
Troubleshooting and Error Indications	55
Upgrading from a Previous Version, Re-installing	65
Installing the High Speed Serial Card and Drivers	67
Notes on At the Handle Position and Force Conversions	69
Future Revisions	75
Contact Data / Service	75

# Illustrations

Figure 1 Calibration Blocks	8
Figure 2 Data and Time Chips	8
Figure 3 Connections to the Machine	10
Figure 4 Connections to the PC	11
Figure 5 New Style Power Adapter	12
Figure 6 Original One-Hole Adapter	12
Figure 7 Machine Status Screen	14
Figure 8 Calibration and Diagnostics Screen	14
Figure 9 User Display	16
Figure 10 User Display Rack	17
Figure 11 Name Assignment Window	18
Figure 12 Toolbar Buttons	20
Figure 13 Default Chart Options	20
Figure 14 User Index Screen	21
Figure 15 Live Data Screen	27
Figure 16 File Browser Window	28
Figure 17 Graph Screen, By Rep Tab	28
Figure 18 Graph Screen, Graph Tab	29
Figure 19 Graph Screen, Summary Tab	29
Figure 20 Graph data added by the six-rep test	36
Figure 21 Graph data added by the ten-rep test	36
Figure 22 By Rep Graph With Reaction Time Data From a Ten-Rep Test	37
Figure 23 Rack Chart	37
Figure 24 Variable Test Chart Controls	38
Figure 25 Short Side of 995011 Calibration Block	42
Figure 26 Short Side of 995010 Calibration Block	42
Figure 27 Calibration Dialog Box	43
Figure 28 Calibration Dialog box	43
Figure 29 Long Side of 995011 Calibration Block	43
Figure 30 Long Side of 995010 Calibration Block	43
Figure 31 Control Box, Three Valve	47
Figure 32 Control Box Four Valve Quiet	48
Figure 33 Third Generation Control Box	49
Figure 34 Main Processor Circuit Board	50
Figure 35 Flash Program Select Dialog Box	51
Figure 36 Machine Address Prompt	52
Figure 37 Pressure Program Select	53
Figure 38 Pressure Circuit Board Select	53
Figure 39 Plus Minus Push Buttons	54
Figure 40 Wiring Diagram 3 Valve	56
Figure 41 Wiring Diagram 4 Valve	57
Figure 42 Third Generation Four Valve Wiring Diagram	58
Figure 43 Third Generation Four-Valve with simplified wiring	59
Figure 44 Dual 3 Valve Air Hose Diagram	60
Figure 45 Single 3 Valve Air Hose Diagram	61
Figure 46 Dual 4 valve Air Hose Diagram	62
Figure 47 Single 4 Valve Air Hose Diagram	63
Figure 48 Third Generation Air Hose Diagram	64

## **Prerequisites**

- A420 installations require a supply of dry compressed air, 100 to 125 PSIG. Keiser manufactures a line of air compressors designed for this purpose. Ask your sales representative.
- This installation requires three utility ac power outlets, one each for the power supply, the PC, and its monitor. These three items are rated for international voltages and frequencies and will work off utility main voltage anywhere in the world. The proper AC line cords for each are shipped with your order.
- All documentation and manuals are available in US English only as are all messages that display on the PC software screens.
- It is assumed that you are familiar with the basics of using Microsoft Windows operating systems.
- Should you require support, an Internet connection to the PC will be necessary. Having a means of communicating by telephone near the PC is also helpful in the case of support issues. As of Release 9.3.0 and later, automatic updates to the software require an Internet connection to function.



## **Introduction**

The Keiser A420 is the latest in a series of exercise machines developed for the purpose of research. This manual includes updates related to release 9.3 software. This series differs from its predecessors in many ways. It is designed to produce accurate position, velocity, power, and acceleration information throughout the exercise range of motion. Its predecessors, the A400 and A410, measure power as an average over an entire exercise repetition, whereas the A420 is capable of measuring power and velocity at any instant throughout the range of motion. The A420 is fully compatible with the Keiser Chip System and can share data with it. The A420 series is designed to be easily ported to any existing Keiser Chip System machine. The second release software differs from the original software in automation of user operations and large improvements in download speed. Many operations that the operator was required to perform manually on the original software release have been automated in release two. The second release also allows the graphical screens to be printed to a user-supplied printer. Graphs from exercise sets collected at different times may be graphed side by side for comparison. Data collected by older release software may also be graphed and printed by any newer release. The primary changes in the third release are bug fixes and the release of position and velocity information at the handle on the graph screens for selected machine models. The fourth release repairs bugs that were introduced with the third release in some of the at the handle translations. The fourth release also makes many subtle improvements in the operation of the PC software. The fifth release adds acceleration data, a quasi-real time screen and many more models of at the handle translation. Note that the hardware shipped with the fifth release or later produces much less noise when operational than earlier models. The fifth release is fully compatible with earlier hardware and will operate properly with it. The sixth release repairs a bug in the software which would cause it to fail if used with any PC with its time zone set to any value where the offset value from GMT was the opposite of that in the USA. This would affect operation of the software anywhere east of Greenwich or west of the International Date Line. Note that any data collected with any earlier release software will display correctly if displayed with this release of the software. The errors that have been corrected deal primarily with the values displayed on the detailed graphs for velocity at the handle. Power data is correct in all cases. The PC shipped with new models includes a CD writer to provide for an easy way to archive collected data or send samples back to the factory for analysis when a problem occurs. The seventh release makes the power tests available to all users. See the section on power testing. This release also improves printing of the graph screens. Each new release adds several more models to the at the handle translation list and makes other incremental improvements in the operation of the system. Release 7.6 fixes several bugs including errors that would occur in work totals when the total work exceeded 6536 joules and adds the ability to save at the handle translated data to a file. As of release 7.6, the PC portion of the software becomes much more modular and portions may be replaced without replacing the entire package. This is being done to allow updates to the chip system portion of the software without changing the entire package. Release 7.7 introduces an installer program to make installation of the software easier. Release 7.8 corrects a bug that would cause reps to be missed on one side of a dual cylinder machine under certain conditions. This bug appears to affect the model 2531 leg press more than other models. This release also corrects an incorrect constant in

the calculation of values on the Resistance display only when set to display in SI units (Newtons). This error caused the display on the machine to read low by a factor of 29152 / 29375 or about 0.76%. This bug affects the Resistance display on the machine only when used in the SI units (Newtons) mode and does not affect the accuracy of the collected data. Release 7.8 also corrects a bug that would cause a machine that was placed in the Six Rep Test mode to remain in that mode after the key was removed. Release 7.9 adds at the handle translation for rack models and version tracking in the data file. Also included is improved graphing of data in the ten rep test mode. Release 8.0 makes the software more compatible with Windows XP and makes the ten-rep test function independently for both sides of a dual cylinder machine. Release 8.0 also adds outlier controls to the ten-rep test chart. As of release 8.0, we drop support for Windows NT. Release 8.1 makes changes to the look and feel of many of the graph windows to improve compatibility with various versions of Windows. Release 8.2 improves support for operation with internationalization settings for number format other than US English and adds a new power test graph. Release 8.2.2 makes only small changes to the PC portion of the software. Keyboard shortcut operation is improved and operation of the peak locating software is updated slightly. Documentation of the peak data on the summary data screen is improved, see page 20. Changes from releases 8.2.2 up to 9.3.0 include:

- Improved tests for memory failure (8.2.3)
- Improved timeout for reading large data sets (8.2.3)
- Fixed errors on changing colors of some test charts (8.2.4)
- Fixed overrun error on some machines (8.2.4)
- More friendly to restricted users on Windows (8.2.4)
- Fixed scale factor error on acceleration. (8.2.4)
- Fixed a hang when double clicking on minimized machine data window (8.2.4)
- Fixed a hardware compatibility issue between some red keys and dongle (8.2.5)
- Adds file drag and drop open (8.3.0)
- Manual updated (8.3.0)
- Improves valve cycling at power up (8.3.2)
- Compatibility with Chip system updates (8.3.3)
- Data window positioning improved (8.3.3)
- Improved Units tags on graph screens (8.3.4)
- Support for blue and green time keys on chip system only (8.3.6)
- Adds units text on various screens
- Fixes a problem with ten rep test starting on the wrong rep (8.3.6)
- Release 9.0.0 now installs and works on Window Vista
- Support for rack models
- Major changes to rep counting software
- Acceleration data are now low pass filtered
- Firmware update program is more user friendly
- Corrupt chip update firmware introduced
- Saves Graph options in Windows registry
- The exercise machine counts reps and displays power without a key (9.3)
- Machine displayed power numbers match those of our other machines (9.3)

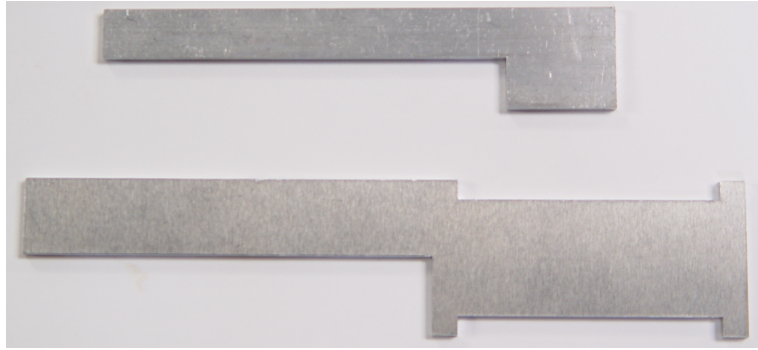
- Software updates to the machine are automatically installed (9.3)
- Software updates to the whole package download from the internet (9.3)
- External flag input option added (9.3.5)
- Minimum resistance reduced on models 2531 and 3020

## **Installation and Setup**

The A420 package consists of:

- A. One or more A420 equipped Keiser exercise machines and a power/data cable for each; Power/data cable is the blue cable in Figure 5 and Figure 6.
- B. One or more Power supplies and power adapters, and one PC data cable (Figure 6);
- C. Chip reader adapter (attached to PC);
- D. Personal computer with software and extra hardware pre-installed;
- E. Monitor
- F. Calibration blocks, Keiser PN 995010 & 995011 (Figure 1);
- G. Data chips (red) (Figure 2);
- H. Time set chip (black), only if Keiser Chip System is also in use (Figure 2);
- I. One or more Keiser air compressor(s) to provide dry compressed air for the system to operate on;

Note: As of November 2008 the chip system time set keys have changed. This version of the software that runs on the PC supports the new time set keys, however they are not needed or used with the A420. See the Chip System manual for more information.



**Figure 1 Calibration Blocks**



**Figure 2 Data and Time Chips**

### **Embedded Software Versions for Release 9.3.5**

3.32 3F3D7706 E5F6 = Processor version  
3.04 3F3D7E8F 7BF2 = Position version  
1.57 3EF67C8C E155 = Display version

For those with the Build 2.01 pressure control circuit board and the newer quiet valve block (4 valve block):

3.17 3D2D5A69 891A = Pressure version

Please note that there are two versions of the 4-valve block. Both operate with the same software.

For those with the Build 2.01 Pressure control circuit board and the older 3-valve block:

2.13 3A984CA8 B4BA = Pressure version

And for those with the original Build 1.01 Pressure control circuit board and the older 3-valve block.

1.13 3A984B93 7494 = Pressure version

Release 9.3.4 PC software will report version 6.0.4.3 or greater. This release breaks the PC portion of the software up into several small modules to allow for updating portions of the functionality of the package without replacing the whole thing. Many of these modules are common with other Keiser products. The “Help About” menu item will report the version of the main program as well as versions of other included modules. As of this time the other module versions reported are:

**ChipLib**      **Build 2.4.16.1**  
**Translate**    **Build 2.7.0.1**  
**Trig**          **Build 2.2.0.1**  
**Time**          **Build 2.4.0.5**

The updated embedded software implements new features in the PC software and improves operation of several parts of the machine. The air control subsystem has been completely redesigned to run much quieter than the original. With the correct software versions installed, this release will operate correctly on all A420 machines. An improvement has been made to the embedded code that is capturing the peak power values to avoid false captures on bouncing exercise arms. It has been discovered that if a user were to let the exercise arm return on a very heavy force repetition very quickly, the arms will bounce from the rubber stops far and fast enough to appear to be valid data. The version of software in the fourth release and later can detect this condition and avoid collecting this false data. This version of the pressure and position software has been modified to be able to see data just before the beginning of the repetition. This causes the detailed graphs to look better as there is some data collected just before motion is detected. These are the minimum versions of the embedded software required to operate version 6.0.4.3 of the PC software. Older versions of the PC software should operate correctly with these versions of the embedded software, however operating in this mode is not tested or guaranteed. You must update the embedded software to make use of this latest version of the PC software. Older versions of the embedded software will not operate properly with this version of the PC software. As of release 8, the PC software will check each machine to see that it has the current version of the appropriate software and display a warning with outdated software in the exercise machine. As of release 8.2 the PC software will also check the validity of the software loaded into the modules of the exercise machine by computing a cyclic redundancy check on the code and issue a warning if it differs from that required. Releases 9.3 and newer automate updates from the Internet.

The power/data cable shipped with each machine is 25 feet long, which sets the maximum distance the exercise machines may be placed from each other and from the computer. This cable is a standard PC network cable and is available at most computer or electronic supply stores. **WARNING! Never connect the A420 cabling to any other system.** If it is necessary to use a longer cable, contact the factory for information before doing so. As of the fifth release, one personal computer can run up to 25 A420 equipped exercise machines at the same time. However, the limits of the power supply are much lower. Two sizes of power supplies are available, a 72-watt and a 100-watt. The 72-watt power supply can run a maximum of 8 exercise machines, and the 100-watt power supply can run a maximum of 11 exercise machines equipped with A420 electronics. As of the Sixth release, we are using the 100-watt power supply on all installations. There are also limits on the number of machines that may be daisy chained from a single jack on the power adapter module. Using 25-foot cables (the factory provided length), a maximum of 4 machines may be connected to a single jack on the power adapter module. Using 15-foot cables, a maximum of 6 machines may be daisy chained. Three models of the power adapter boxes are available, one model with a single jack for connection to exercise machines, and two models with three jacks. Installations with more than 6 machines will need one of the 3-jack versions to divide the machines between the jacks. The limiting factor is the amount of power lost in the first and second lengths of cable from the power adapter box to the first machine and from the first to the second machine. The 3-jack power adapter box that is colored black allows more than one power adapter box to be used in the system to deal with long cable runs. Only one of the bare aluminum colored power adapter boxes may be used in a system. It is possible to use as many of the black colored power adapter boxes as necessary. The newer black box will replace either of the older aluminum colored boxes. By keeping the first and second cables short, it is possible to obtain different spacing of the machines. If assistance in laying out your installation is needed, contact the factory. The power/data cable connects the power adapter to the first machine in a chain of machines that will be controlled by a single personal computer. Plug the cable into one of the modular connectors on the power adapter and into either of the two jacks labeled 'Power' on the control box on the machine (blue wires in Figure 3).

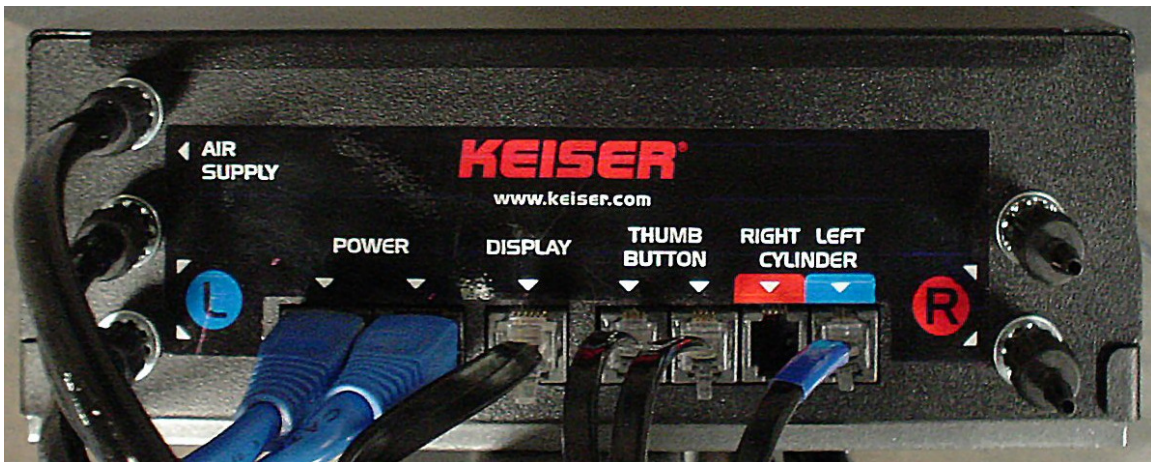
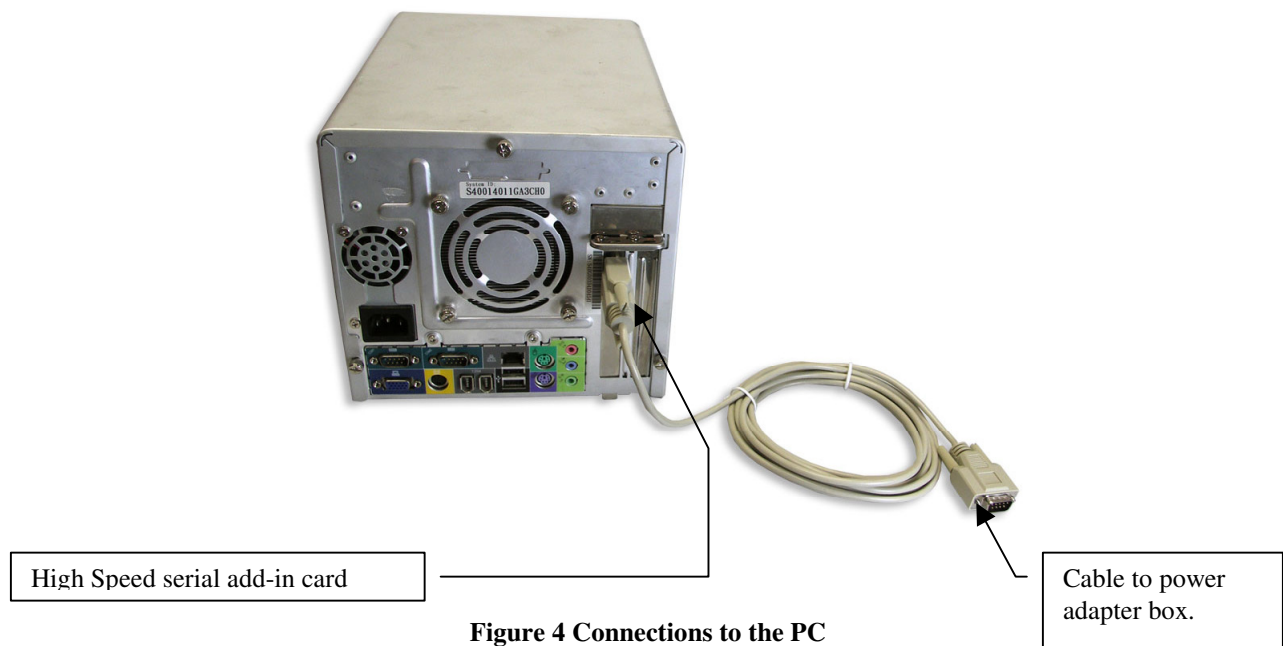


Figure 3 Connections to the machine

When more than one machine is being controlled by a single PC, the power/data cable for the second machine will run from the second 'Power' jack on the control box of the first machine to either 'Power' jack on the second machine. The operation of the power supply and wiring to the machines has been simplified with the fifth release hardware. Keiser Service will determine the layout of your wiring and power supplies at installation time. Air lines will need to be connected from the machines to the air supply at this time. If this has not already been done, contact the Keiser Service Department for details on setting up the air supply plumbing. The area where the personal computer is to be installed will require three wall power plugs, one each for the personal computer, its monitor and the power supply. If additional power supplies are connected, they will each require a wall plug for power also. The power supply has been sized for your installation. Do not replace it with any other model of power supply. If the power supply requires replacement, contact Keiser Service. Connect the serial data cable from the power adapter box (Figure 5) to the COMM connector on the high-speed add-in serial card installed in the PC (Figure 4). If you are adding a new machine to an existing installation, see the section on upgrading. This photo is a typical XPC as shipped with A420 machines. Yours may have the plugs in slightly different locations. As of the seventh release, the chip reader dongle may be supplied as either a USB device or a serial device. Other than plugging into a different jack on the PC, they operate the same. Refer to documentation, which shipped with your PC, and that supplied with the iButton TMEX drivers on the install CD.







**Figure 5 New Style Power Adapter**



**Figure 6 Original One-Hole Adapter**

Once the exercise machines are in place and the power/data cables and air supplies have been connected, plug the power cables into the power supply, the computer and the monitor. The personal computers delivered with the machines at the time this manual was written are shipped with Windows XP sp3 pre-installed. We are no longer supporting Windows NT 4 because Microsoft has dropped support for this operating



system. If you are running an older PC with Windows NT installed, you must upgrade to Windows 2000 or Windows XP to use this software. The latest necessary Microsoft service packs and patches were installed on your new PC before it shipped. The A420 program has a startup shortcut installed on the desktop of the PC. When the power supply is connected to the power outlet, the machines will start operating immediately, the personal computer does not need to be running. The liquid crystal displays on the exercise machine will display version of the display module and model information for a short time and then switch directly to the operating mode. If air pressure is available, each machine will fill to the pressure it was last set to before being powered down. Starting with release 7.6, machines with any 4-valve block will go through a pressure cycling operation when the power is first applied. The purpose of this operation is to cycle the exhaust valves with a considerable amount of pressure in the system to free any sticking lubricant within the valves. Start the A420 program on the PC. After dismissing the copyright notice, the program starts by displaying the machine status window (Figure 7). This sample shows a PC connected to seventeen machines programmed to addresses 1 through 16 and 21. The order of machines shown in this window and the line they display on will be determined by the address set when the firmware in each machine is flashed. This order may be changed by following the procedures outlined in the section on Firmware Update Procedure. Users upgrading first release machines will need to perform a software flash update on their existing machines before they will communicate with the PC software. The first release firmware delivered in first release machines must be upgraded to work with second or subsequent release machines in the same setting. This procedure is automated within the flash update program. Working machines will populate lines on the Machine Status screen as soon as they are connected to the PC. The diagnostic and calibration screen (Figure 8) for each machine may be opened by double clicking on the model number of the machine in the status window. The calibration window is used to re-calibrate the position transducers and set the time on the machine. The calibration procedure is only necessary when a component of the system has been replaced. The time should be set on each exercise machine when they are first installed and periodically thereafter. The time keeping mechanism in each exercise machine is very similar to that in a wristwatch and will have about the same accuracy and drift characteristics. The time and time zone must be properly set on the PC before setting the time on the exercise machines. PC software newer than version 3.8 sets the time on the exercise machine automatically when the program is first started. The large window in the calibration screen displays the response of the exercise machine to commands issued by clicking on buttons on the left side of the window. Every response by the exercise machine in the large window is written to a log file. The log file will be located in the same directory as the program (c:\a420). The log file name will include the address of the machine and be named "callog\*.txt" where the \* character is replaced by the address of the machine. For example, all calibrations done on the machine with address 7 are saved in callog7.txt. Log files are maintained to help diagnose problems. Should a problem arise, the Keiser Service Department may request that you send a copy of this log file to the factory for analysis.

Machine Status

Double Click Model for calibration. User for Real Time Data. SetPoint to change force

Address	Model	User	Start Time	Duration	Left Reps	Right Reps	Set Point	Display Power	Status	Seat
1	1335								No Data	
2	1335								No Data	
3	1335								No Data	
4	1335								No Data	
5*	1335								No Data	
6	1335								No Data	
7	1335								No Data	
8	1335								No Data	
9	1335								No Data	
10	1335								No Data	
11	1335								No Data	
12	1335								No Data	
13	1335								No Data	
14	1335								No Data	
15	1335								No Data	
16	1335								No Data	
17										
18										
19										
20										
21	1931	19 TEST	12:03:10 06/29/2004		0	0	111	0	In Use	....
22										

Figure 7 Machine Status Screen

Machine Calibration and diagnostics

Address = 4 This window will automatically close in 55 seconds

Zero Pressure

Zero Position

Calibrate Left

Calibrate Right

Calibrate Pressure

Log Processor Version

Log Position Version

Log Display Version

Log Pressure Version

Log Info

Log Supply Voltage

Read Time from machine

Set Time to PC Time

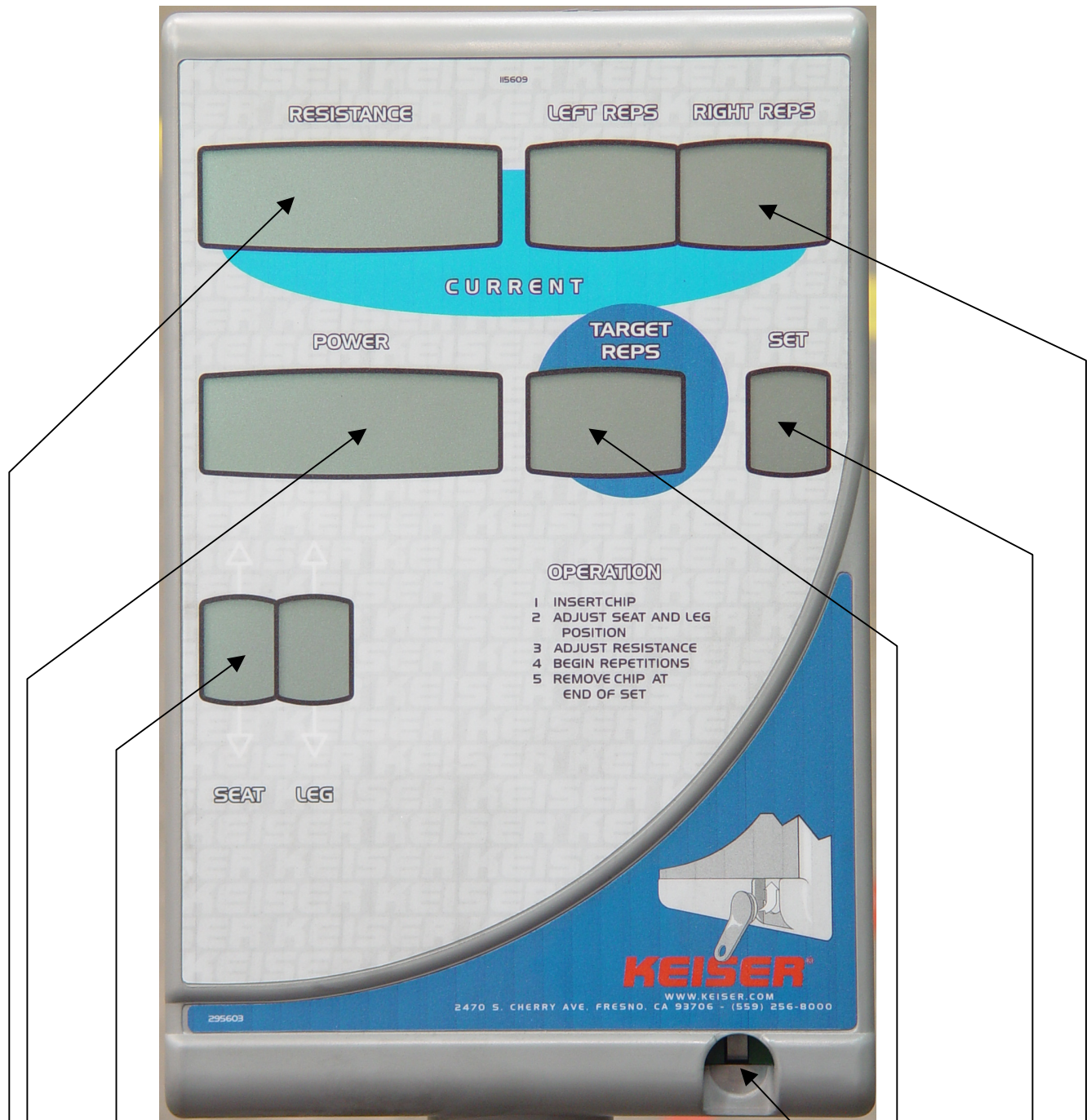
Issue a Manual Command

Close This Window

Figure 8 Calibration and Diagnostics Screen

## Operation

The user display has several data areas as shown in Figure 9. The “Resistance” value displayed in the upper left window is a number that represents the force that a user will exert somewhere in the exercise stroke. This number is designed to match the number displayed on a standard Keiser production model with a digital display. Pressing the thumb buttons located on the user handles of the exercise machine will change this number. Starting with the seventh release, the increase and decrease buttons may optionally appear on the face of the user display unit above the resistance window and are marked with a “+” and “-“. Use the button marked with a “+” to increase and the one marked with a “-” to decrease. If you should make a false start and wish to start over collecting data, press and hold both thumb buttons until the message “CLR” appears and release immediately. The reps count will be reset and all data collected since the key was inserted will be deleted. The clear function may be delayed as evidenced by the appearance of the message “PA 17” appearing in the resistance display. The digits (17 in this example) will count down and when they reach zero, the clear function will occur. This pause delay will only occur if an attempt is made to clear too soon after the exercise arm has moved. We added this delay to reduce the risk of losing valuable data when a subject inadvertently presses both buttons at the wrong moment. The upper right pair of windows displays the number of repetitions the user has completed for each limb. In the case of a single sided machine, only the left side will display. The window labeled “Power” shows a running average of the peak power achieved following the most recent repetition. This number is designed to motivate the user and is not useable for research purposes. As of Release 9.3.0, we change the data in this window to show the sum of the peak power for both limbs combined. The window labeled “Target Reps” displays the number of repetitions achieved in the corresponding set of the previous visit and the “Set” window displays the set currently being logged. A visit is defined as a set of exercises, which occur within a four-hour time frame. Visits and sets are calculated from the time the chip was inserted. This time is stored in the chip only for an exercise set that produces three or more repetitions. The lower left window or windows show the adjustment settings for this model of machine that have been stored in the chip. These settings may be altered after the chip has been inserted and before exercise has begun by pressing the increase and decrease buttons above and below each position window. The adjustment settings for each model of machine are the same for all sets and visits. Some models require that the data in these windows be set correctly to provide correct ‘at the handle’ translations. The 1122 Leg Extension with range limiter is an example of this situation. This caveat applies to all Keiser machines with the rotary range limiter device installed. In the case of Rack models, it is necessary to enter the amount of iron weight being lifted into this window. The data saved within the chip is the same as that saved by the Keiser Chip System and is fully compatible with it, with the exception that the A420 does not store power test data within the chip. The PC saves much more accurate power test data in the A420 power test system than the Keiser Chip does, and because of this limitation we do not save the power test data in the chip with the A420.



**Figure 9 User Display**

Seat Position /Iron weight Display and Adjustments

Chip Insertion Area

Target Repetitions

Current Set

Power

Repetitions Display

Resistance



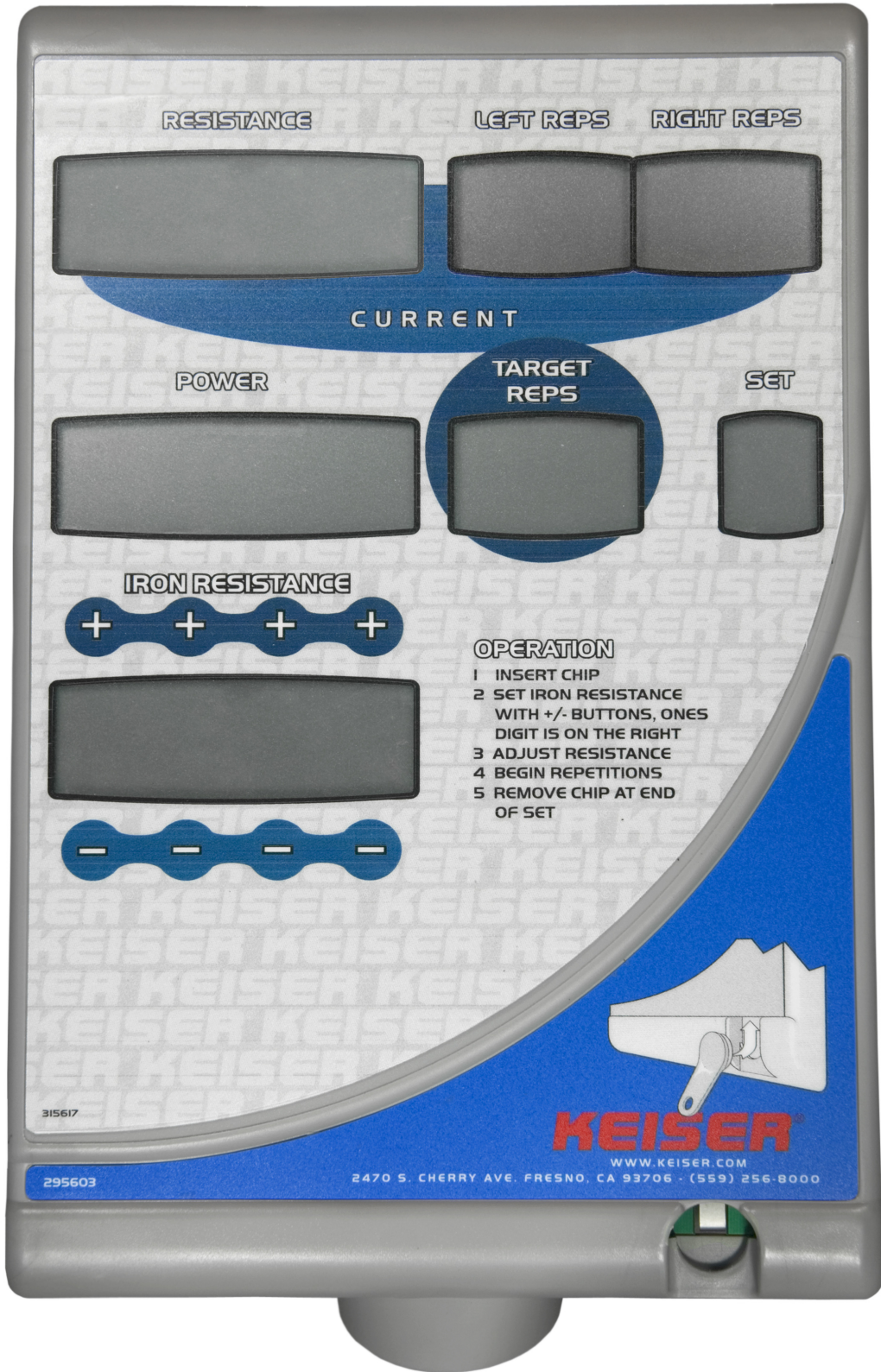
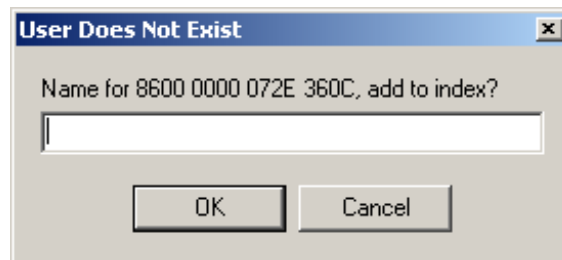


Figure 10 User Display (Rack)

The machine will count reps and save research data only while a chip is inserted into the chip slot. When the chip is first inserted, the machine will adjust the resistance to the value set on the corresponding set of the previous visit stored in the chip. Once the chip is inserted, the resistance may be changed to any value desired with the thumb buttons on the handles of the exercise machine, or in the case of those machines with the display panel resistance option by depressing the + or – buttons above the resistance window on the display. The resistance may be altered by double clicking on the displayed resistance for the machine in question on the machine status screen, only when a chip is inserted. If you double click on the resistance value on the machine status screen, a small window will open up which will allow you to change the resistance on the selected machine. As a safety feature, the software in the machine will not allow the resistance to be changed for several seconds after the exercise arm has been in motion. While the machine is making adjustments to the amount of resistance on each side, the corresponding repetition indicator for that side may flash. It may also flash during or after an exercise to indicate that the machine is making adjustments. This is a normal situation. If the repetition indicators should continue to flash for a long period of time (several minutes) after making a change, this is an indication of a problem and needs to be addressed. The resistance display will flash when the air supply from the compressor drops below 90 PSIG. This can happen for a short period of time after making a large increase in the resistance on a machine, or if another machine sharing a long piece of air supply line makes a large increase. If the resistance display continues to flash for a long period of time when no adjustments have been made, check the compressor and supply lines for problems. Once the chip has been inserted, and the resistance and adjustment positions have been set and adjusted into the machine, the user may begin the test exercises. There is no need for the user to see the screen on the personal computer as the data is displayed only after the exercise is complete. The software tracks users by a serial number stored inside each individual chip. It is necessary to assign a chip to each individual user for whom data will be saved. Different users cannot easily share chips. As soon as the chip is removed from the machine, the data collected while the chip was inserted is downloaded to the PC and removed from the exercise machine. On previous versions of the A420 PC software, if the chip had never been assigned to a user, a small window would open on the PC screen prompting for the name of the user to associate with this chip.



**Figure 11 Name Assignment Window**

Note that this process has been changed on the fourth release and later software. An unnamed chip will save data to a directory named with the chip's serial number and will not stop operation of the main program as it did in previous versions. The best way to deal with assigning user names to chips is to insert the chip into the chip reader adapter

attached to the PC before using it in a machine. If the chip has never been used before, the name assignment window shown in Figure 11 will appear. Once a name is assigned, each time this chip is used in any machine connected to this PC in the future, data will be saved in a directory named by this user's name. It is not possible to assign more than one chip to the same user name. It is possible to re-assign a chip to a different user. To do so, click on the Manage Users button on the toolbar portion of the main screen (Figure 12). If the chip you wish to re-assign is connected to the chip reader dongle when you click on the Users button, the assign users window will open with the chip in question highlighted. Double click on the highlighted line or press the enter key to change the name of the user assigned to this chip. If you know which user a chip is assigned to, you may locate and change the name without attaching the chip to the reader. If you intend to use a single chip for many users and rename it between each use, be cautious about the capitalization of the name and the number of spaces. If a chip has been changed to a different user and you wish to change back to an original user, the name needs to be entered exactly the way it was the first time. User names need to be formatted in such a way that Windows may use them as the name of a directory (folder). Punctuation in names is not allowed. The fourth release software now sorts chips by name. Previous versions would leave the list in the order the chip was first used. Currently there is no way to delete a chip from the list. If a chip is lost or defective, we suggest naming it something that begins with 'Z' so it ends up at the end of the list.

The third and later releases of the A420 software make the copy button and menu items function. They did not operate in previous versions. When any graph or summary screen is visible and has focus, clicking on the copy button will copy the graph or highlighted text in the summary box to the system clipboard, allowing the graph or text to be embedded into another document by pasting from the clipboard. Text in the summary box may be highlighted with a left click and drag operation as is standard for Windows text boxes. A pair of new options check boxes appears in this version. The "Graph With Metric Units" check box will cause the data in the graph window to be graphed in SI units when checked or in Imperial units when unchecked for those machines for which at the handle translation has been developed. The status of this box will be remembered from one session of the program to the next as of the fourth release. See the section on translation near the end of this document. The check boxes have an effect only as the data file for a test session is being opened. It is possible to open a graph window for a user data session and display the data in SI units in one window, then change the check box and open the same data in another window in Imperial units at the same time. The "Dongle Disconnected" message seen at the right side of the window will result if the chip reader dongle has been disconnected from the PC. The only way to reset this message once it is displayed is to re-connect the dongle and then stop and restart the program.

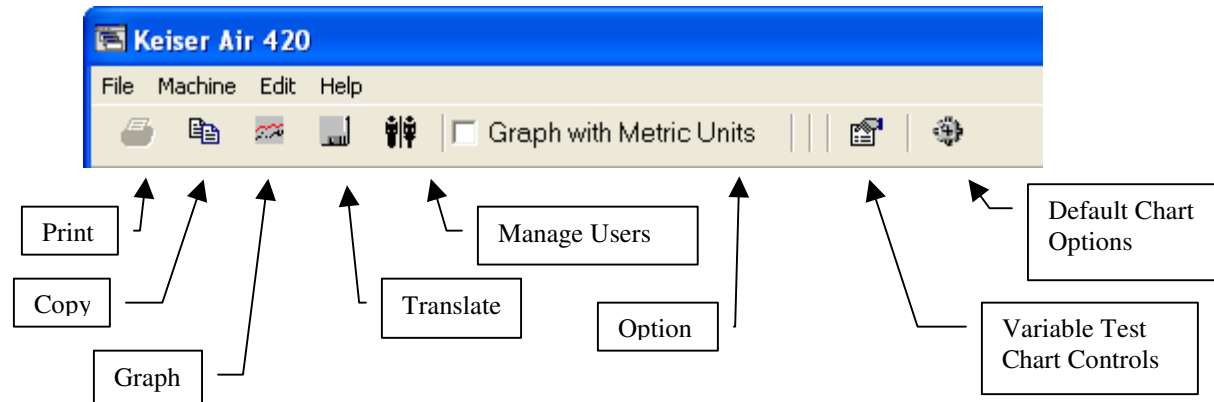


Figure 12 Toolbar Buttons

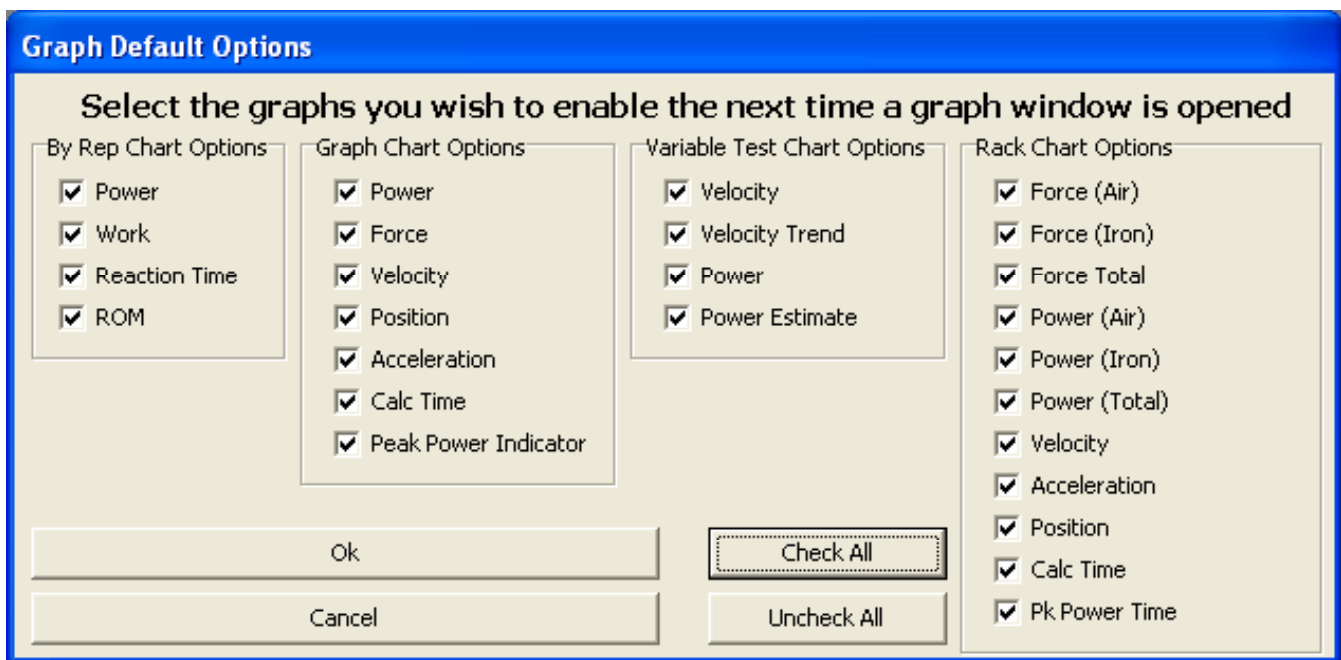


Figure 13 Default Chart Options



User Index			
Double Click a line to change the name			Close this window
Index	Key Number	Name	Last Chip Save
1	1100 0000 072D 910C	Key One	21:46:32 04/04/2003
2	8600 0000 072E 360C	New Key	20:34:49 01/25/2003
3	8000 0000 072F 1A0C	Key Two	16:42:45 03/24/2003
4	0D00 0000 072B 350C	Test Key Three	00:00:00 01/01/1970
5	8700 0000 072B CE0C	Test Key Four	00:00:00 01/01/1970
6	0B00 0000 0724 870C	Test Key Five	20:19:00 01/25/2003
7	1200 0000 072A 480C	Test Key Seven	00:00:00 01/01/1970
8	F100 0000 072A 010C	Test Key Eight	00:00:00 01/01/1970
9	C400 0000 072C 450C	Test Key Nine	00:00:00 01/01/1970
10	D800 0000 0725 660C	Test Key Ten	00:00:00 01/01/1970
11	DC00 0000 0729 EC0C	Test Key Eleven	00:00:00 01/01/1970
12	E900 0000 072D 9A0C	Test Key Twelve	12:24:35 06/20/2002

Figure 14 User Index Screen

Once a chip has been assigned to record data for a user, simply insert the chip into the machine for which data collection is desired. Set the seat positions and resistance then perform the workout. In the case of a rack, enter the weight of the iron including the bar into Iron weight area (seat position on other machines). When the workout is complete, remove the chip. The PC will download the data from the workout as soon as the chip is removed. If for some reason, the PC is not running when the chip is removed, the data will be retained as long as power to the machines is not interrupted. As soon as the PC is running the A420 program again, it will download the data. There are limits on how much data can be collected while the PC is off line. The limits are:

1. A maximum of 16 user sets.
2. A maximum of 256 repetitions on either side shared by all users.
3. A maximum of 327 seconds of data collected while the exercise arm is moving.

The data download process is fully automated and requires no user intervention. The download process operates at about 10 times the speed that it did in the first release of the A420 product. Once the data is downloaded to the PC it is saved in a file within a directory, which is named with the users name that was assigned to the chip in use. The users name directory will be located at C:\A420\DATA (Windows 2000 - XP). If the users name had been entered as "John Doe" for example, John's data files will be saved in "C:\A420\DATA\John Doe". The saved data files have a naming convention that allows the operator to find data from a particular test easily. The saved files all have an extension of ".csv" which allows them to be opened by Microsoft Excel or any other program that can deal with "comma separated values" type files. Beginning with release 7.6, the software offers an option that allows the data file to be saved in a format that shows values at the handle of the exercise machine. The graph button on the A420 PC software will open these files and display the contents in a graphical format. The translate button will not only open the file for display, it will also save a translated version to a file with the same primary name as the original and with an extension of ".translated.csv". This file will save in the same location as the original by default, however you may choose to relocate it during the save process. These files may be opened by any piece of software that can deal with "comma separated values files". See the section on Translated File Format for details. The A420 software cannot open the translated version of the file, and an attempt to do so will produce an error message. Beginning with release 8.3, file drag and drop has been implemented. Any data file may be opened by dragging the file from any Windows Explorer window and dropping it onto the A420 program window. A maximum of 10 files may be opened at one time with this feature. The first four characters of the file name are the Keiser model number of the machine that the exercise was done on, followed by a space character. The next 8 characters of the file name are the time of day the data was saved formatted as hh-mm-ss where hh is the hours portion of time in 24 hour format, mm is the minutes, and ss is the seconds, followed by another space character. The final 10 characters of the file name are the date on which the data was saved formatted as mm-dd-yyyy where mm is the number of the month, dd is the number of the day, and yyyy is the year. An example file name would be "1931 15-55-00 03-25-2003.csv". This example would have been data collected on a model 1931 (triceps) machine at 55 minutes, 0 seconds after 3 pm on March 25, 2003. Note the time is in 24-hour format. We know which user this data is for by its location. To view data for a particular user, click on the Graph Button on the toolbar (Figure 12). A file browse

window (Figure 16) will open. The example shown was taken on a Windows 2000 system. The window will look slightly different on those machines running Windows XP, however they have the same functionality. Note that the folder names shown are all users for which data has been collected on this system. To view data for a particular user, select the corresponding directory by double clicking on it, and the display will change to show all the data files saved for this particular user. Select one and open it by double clicking on its name. A Graph Screen will open with the by rep tab showing (Figure 17). This view shows the peak power for each repetition for the left and right side as well as the amount of work done for each repetition for each side. The work data is new for the fifth release. The graph may be scrolled to the left or the right by clicking and dragging on the background of the graph. The graph may be returned to its original scroll position by clicking on the Home button in the lower left corner. The color of each of the bars may be changed by clicking on the bar itself, and the background color may be changed by clicking on the title. Either of the graph bars may be turned on or off by changing the check box next to its legend in the upper right corner. The graph may be printed to a user-supplied printer by clicking on the print button on the tool bar (Figure 12). If a color printer is installed the bar colors will print; however the background color does not print. Caution, if you change the background color to black and any of the graph bars to white, when the graph is printed the white bar will not be visible in the printout. By clicking on the Graph tab, it is possible to change to the detailed graph view screen (Figure 18). This graph shows activity on the exercise machine on a detailed basis. Like the by reps graph this graph may be scrolled by clicking and dragging the background. Clicking on any of the graph lines will change the line colors. The slider control in the lower right corner may be used to vary the time scale resolution. The time scale defaults to displaying data over a one-second interval. The values for force, position, and velocity are referred to the working end of the cylinder on the exercise machine. The third and subsequent releases of this software will be able to display these values at the user exercise handle for certain models of machine. It is possible to display values in either SI or Imperial units for those models with translation enabled. The selection of units is controlled by a check box on the top of the main program screen. Checking the "No Translation" box at the top of the screen will cause the graph to display values at the cylinder, as had been the case in previous versions. Release 9.1.0 adds two new items to this graph. First it fattens the position graph line for the portion of the rep used to calculate averages. Second, a square dot is placed on the position line at the point at which peak power occurs.

In the case of those models of machine for which at the handle translation has not been completed, all graphs will always be in SI units at the cylinder. As the graph is scrolled to the left or the right by left clicking and dragging on the background of the graph, the values of the data at the cursor in the center of the graph are displayed on the legend in the upper right corner for each respective curve. The time that the data was captured is displayed directly above the cursor in the center of the top of the graph. The exercise machine only collects data when the velocity is in excess of a small minimum. This prevents the graph from having large sections of no data, however, it can cause pauses in the exercise to be compressed in the graph view. The third release software or later will leave a blank area in the graph during these gaps. Clicking on the print button on the tool bar while this screen is active will print this screen. Clicking on the summary tab will display the summary screen (Figure 19). The summary screen contains summary data

about this set of data. Release 8.2 adds another section to this screen. The first line in this section records the peak range of motion seen for the entire exercise. The second line displays the settings of the outlier control for the Variable Test Chart. The remaining lines in this section contains on a line for each side and each rep respectively:

1. The time data for this rep starts being processed.
2. The time data for this rep ends being processed.
3. The Peak Velocity seen between these times for this rep.
4. The Peak force seen between these times for this rep.
5. The Peak power seen between these times for this rep.
6. The Peak Acceleration seen between these times for this rep.
7. The average velocity over this time interval.
8. The average force over this time interval.
9. The average power over this time interval.
10. The peak velocity at peak power in this time interval.
11. The peak force at peak power in this time interval.
12. The peak range of motion in this time interval.
13. If this rep / side is an outlier, the word "Outlier".

Note that the averages allow a small percentage of the data at each end of the reps time window to be excluded from the calculation. This allows for uncertainties at the ends of the rep to be left out of the average calculations. The amount of exclusion can be adjusted from the Variable Test Chart Controls (see figure 24). Note that item 6 (acceleration) above was added in release 8.2.2. This value was fixed at 5% in release 8.2.1. In Release 8.2.1 the capture of the peak values (items 3,4,5, & 6 above) were limited to being captured during the non-excluded portion of the rep. As of Release 8.2.2 we change the software to not exclude any of the rep when searching for peaks. The exclusion area is used only for calculation of averages now.

This screen, like the graph screens, may be printed or copied to the clipboard. To copy the text data on this screen to the clipboard, simply press control C on the keyboard or select the copy item on the menu bar. Operation of the copy operation is simplified with release 8.2.2. Each time any machine connected to the PC saves data an entry is made into a file named Userlog.csv located in the C:\A420\DATA\ directory. This file is a comma separated value file that may be opened with Microsoft Excel or any other program that understands comma separated value files. The columns of data saved in this file are:

1. Chip serial number
2. User name data was saved under
3. Time and date data were saved
4. Length of time the chip was left in the machine
5. Left repetitions
6. Right repetitions
7. Power value displayed on the user interface when the chip was removed
8. Resistance setting on the machine when the chip was removed
9. Keiser model number of the machine
10. The four adjustment position settings or a "." where nothing was set.

This file keeps a record of every data set saved by the PC program. There is no screen built in to the program to display or analyze this file as of this version. This file can be opened and viewed by Excel with no caveats like the per-exercise data files have.

### **Live Data Display Screen**

The fifth release software and later includes a feature, which allows live data from a single machine connected to the pc to be displayed on the PC in graphical format. This window (see Figure 15) will display live data from the selected machine. The position (range of motion), force (resistance), power, velocity, and acceleration data for the left and right sides is displayed as a bar graph as well as numerically below the bar. The highest value seen for each of these values since the window was opened is captured and displayed numerically as well as a black tick across the bar. Clicking on the 'Clear Peak' button will reset these peak values. This window will only operate when a chip is inserted into the exercise machine. This window will close automatically when the chip is removed. Due to limitations of the Windows operating system, the live data seen on this screen does not capture every sample that the embedded software sees and saves in the detailed data files. The number displayed in the upper right corner of the screen (21 in this example) is the number of samples that were missed between updates of this screen. Since the embedded software captures data at a rate of 400 samples per second, this example is actually sampling at about 20 samples per second. Due to this relatively slow sample rate, the captured peak of a very quickly executed repetition may miss the exact peak of a data point. All the points are captured in the data files that are saved when the chip is removed and if there is a question, it is possible to analyze the captured data after the exercise is complete. This screen is useful to watch for the subject executing the full desired range of motion during an exercise, or any other usage you can imagine. In most cases the slow sample rate should not be a major limitation, as the eye would have difficulty following something that updated any faster. We do not recommend or support using the data displayed on this screen for research purposes.

### **Notes on Units of Measure and Displayed Values**

All values displayed on the liquid crystal displays on the machine are for the information of the person doing the exercise only. The resistance value displayed on the user interface will display the force felt by the user at some unspecified point in the range of motion. This value may be displayed in either Pounds of force, Kilograms of force, or Newtons of force depending on the setting of the machine model number. The machine model number set into the software will display in the resistance window during the power up sequence. For machines with software before the seventh release, if this value ends in a number the display is in pounds and if it ends in a letter, the force is displayed in kilograms. As of the seventh release, these machines have an option to display the force number in Pounds, Kilograms or Newtons. Machines are normally programmed to display this number in Pounds when they leave the factory, however this setting may be easily changed in the field (see the section on setting the model number). The value displayed in this window is designed to match the value that would be displayed in a stock Keiser exercise machine of the same model number. There is a caveat on dual cylinder (bilateral) machines, that the force curve will only match exactly when the stock machine is used in such a way that the limbs on both sides of the machine are moved at the same time. If only one side of the stock machine is moved the force will be lower.

This does not happen with the A420 machines. The number displayed in the force window on the user display is the number that needs to be used to match the force on a machine to a previously used value. The actual value of the number is of no value as research data as a force value. This number is usable to duplicate force settings on the machine from one use to another. In all cases, power is displayed in watts, no matter where displayed on this machine. Power displayed on all A420 machines is the peak power achieved by a single limb in a 1/400<sup>th</sup> second time window during a repetition. The power window on the exercise machine display is a running average of previous repetitions. This number has been designed to be motivational to the person exercising on the machine. The value displayed in this window is not useable as research data due to the averaging. The data displayed in the graph window(s) on the PC is the research quality data. On the first two releases of the software, all the data displayed on PC graphs is data referred to the cylinder. The force and velocity displayed are the force and velocity at the clevis of the air cylinder in SI units, where force is stated in Newtons and velocity is stated in Meters per second. No translation to force, position, and velocity at the end of the user handles was done with the first and second release software. Since power is the same no matter where measured in the system, the power displayed on the graph screens applies no matter where referenced. With the third release software selected models of machine have had the force, position and velocity measurements translated from 'at the cylinder values' to 'at the handle units'. Also for those models for which translation has been done, there is an option to display values on the graph screens in Imperial units by un-checking the "Graph with Metric Units" check box at the top of the screen before opening the graph. The graphs screens all have legends, which inform of the current measurement units. The data stored in the data file for each exercise is always stored in 'at the cylinder' format with SI units. Translation to 'at the handle' values occurs as the file is opened to be displayed only by this program. As of the seventh release, all supported models have data values at the handle displayed. Units of measure for Range of Motion are Inches or Meters. Units of force are either Pounds or Newtons. Velocity is displayed in units of Inches per second or Meters per second. Acceleration is displayed in units of Inches per second per second or Meters per second per second. Each of these units obeys the setting of the "Graph With Metric Units" check box at the time the window was opened. These machines and software will produce the best results at mid level force ranges. Using these machines at extremely low force levels near the minimum possible will produce noisy data where the desired data is masked by noise introduced by friction, and arithmetic rounding. If you need to do studies at extremely low resistance levels, consult the factory for information on ordering machines with a reduced diameter air cylinder. This modification will reduce the maximum available force on the machine and move the data collected up into a more suitable portion of the machine's dynamic range.

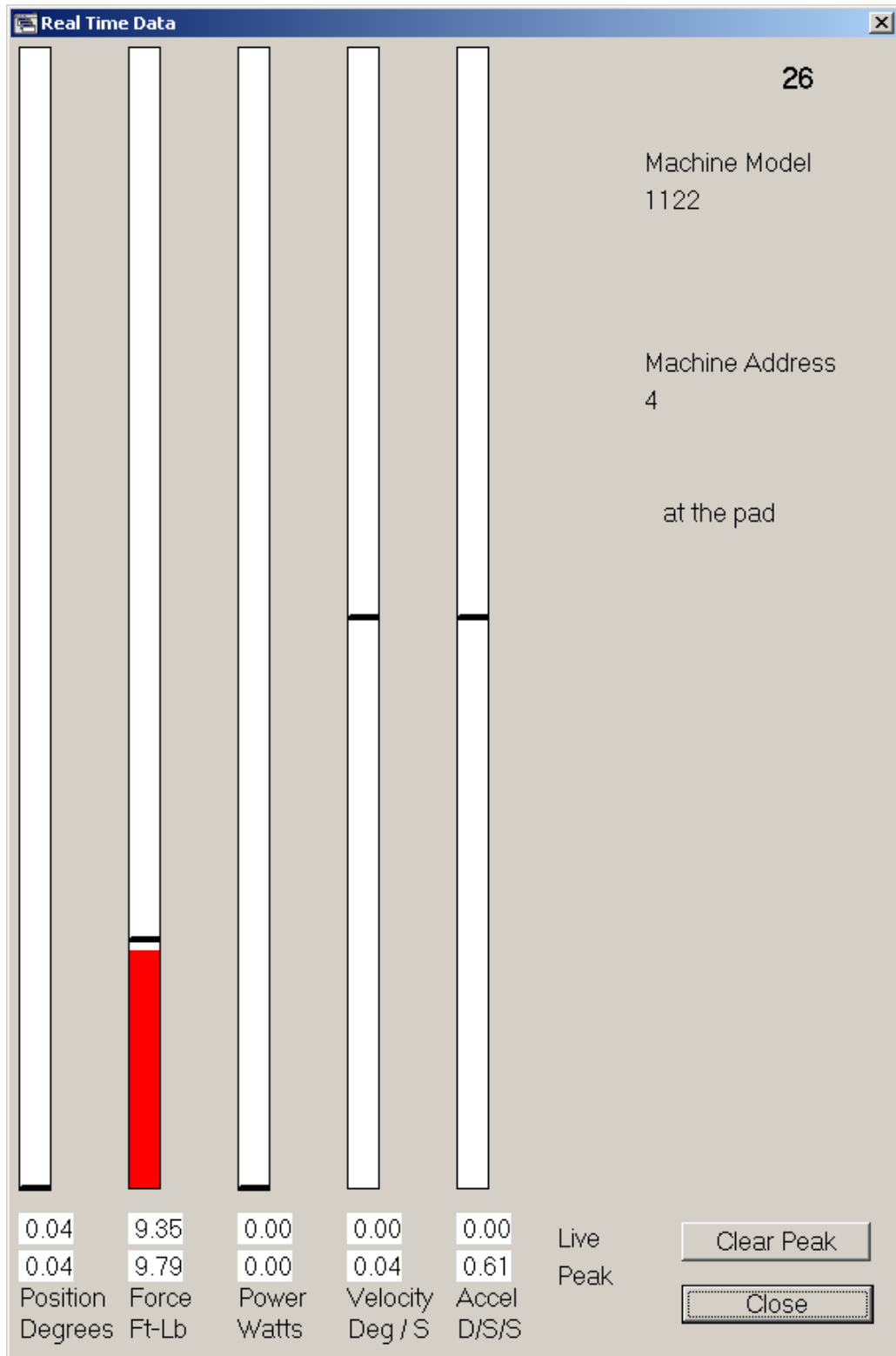


Figure 15 Live Data Screen

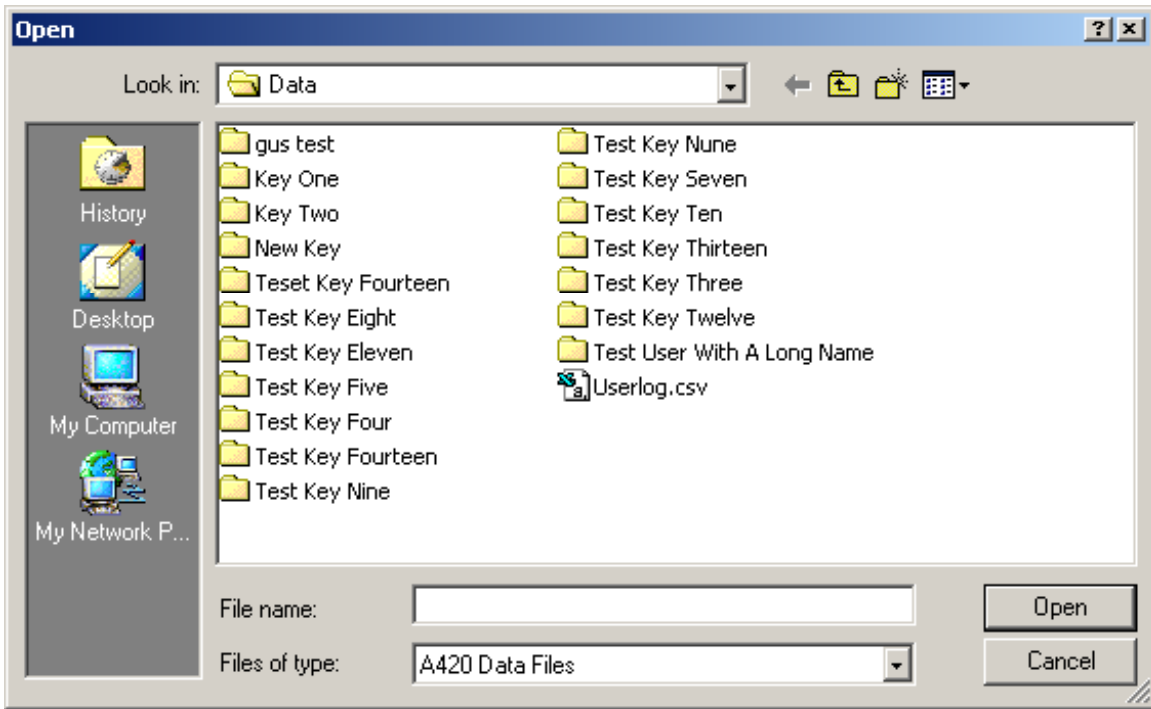


Figure 16 File Browse Window

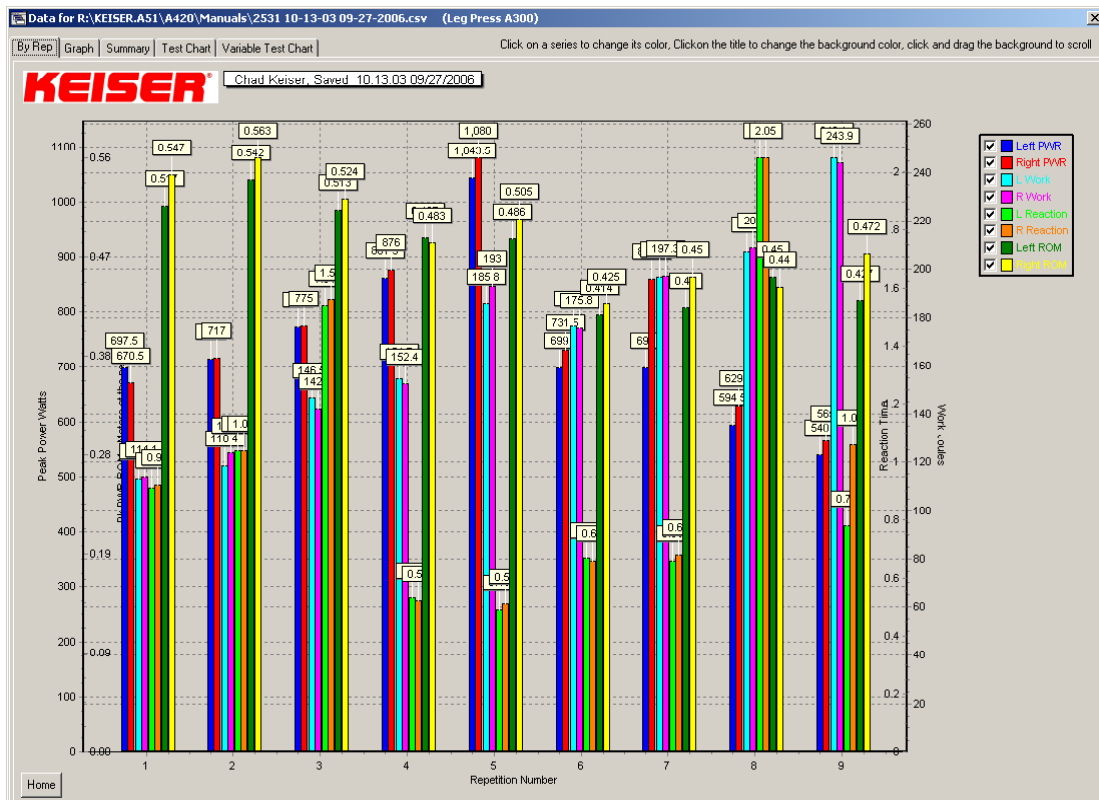


Figure Graph Screen, By Rep Tab



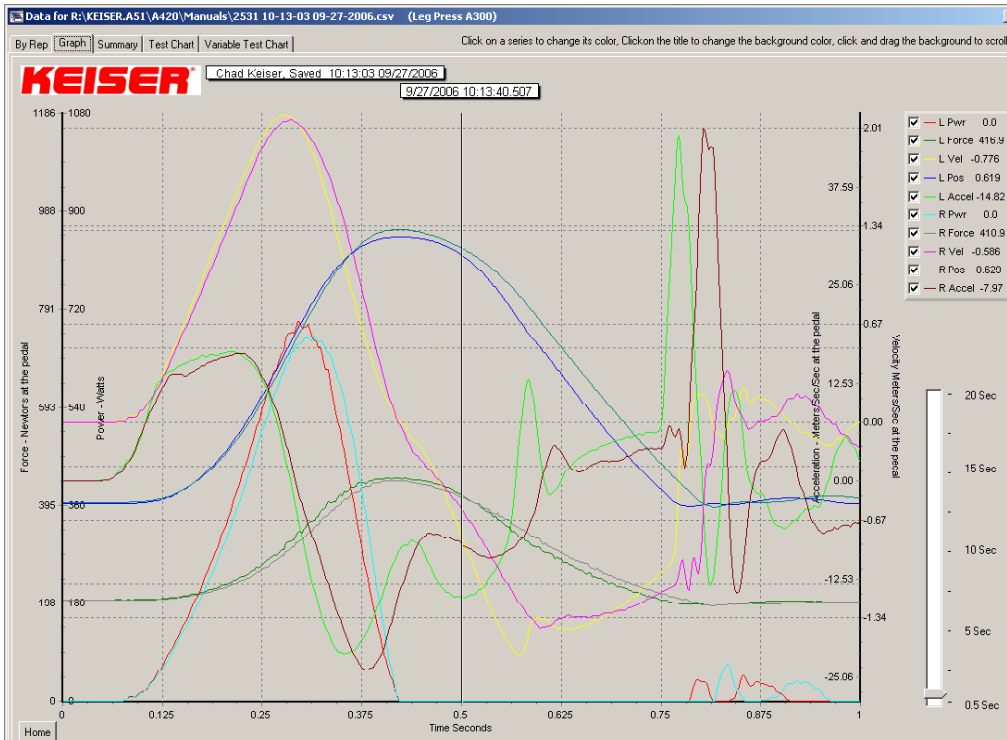


Figure 18 Graph Screen, Graph Tab

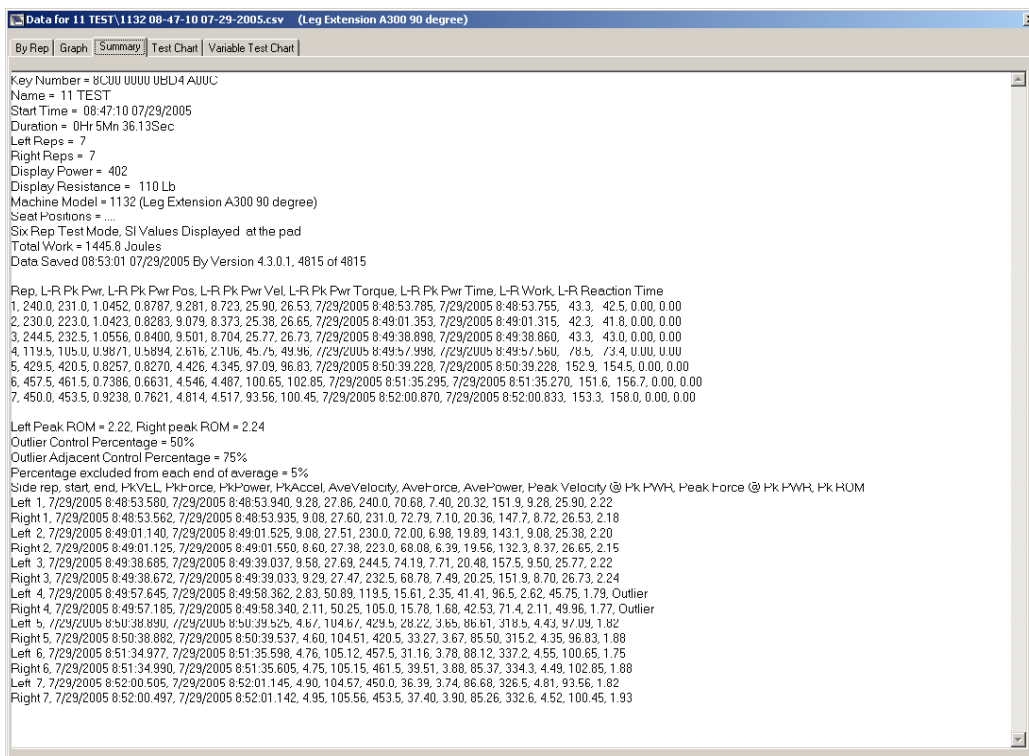


Figure 19 Graph Screen, Summary Tab

## **Translated Data File Format**

The data saved in the translated data files (\*.translated.csv) is in comma separated values format and may be opened or analyzed by any software that understands this format. The first line consists of titles describing the data within the second line. The data in the columns of the second line is as follows

- 1 Key Number. This is the serial number of the chip used
- 2 Name. The user name that was assigned to the key when the exercise was completed.
- 3 The time the key was inserted into the machine as hh:mm:ss m/d/y.
- 4 Duration, the length of time the key was in the machine.
- 5 Left Reps
- 6 Right Reps
- 7 Display Power. The value displayed on the face of the machine for power when the key was removed.
- 8 Setpoint. The resistance setting that was displayed when the key was removed.
- 9 Machine Model.
- 10 Seat Positions.
- 11 Flags, for internal use.
- 12 Total Work, the sum of all the work done.
- 13 Channel number this machine is set to.

The third line of data notes when the data was saved, the version of the software on the PC that saved the data and the number of records saved.

The fourth line is blank.

Line 5 describes the translation done.

The sixth line is blank.

Line 7 is a title line for the per rep data that follows. The columns of data in per rep data are as follows

- 1 Rep number
- 2 Left peak power in watts.
- 3 Right peak power in watts.
- 4 Left peak power ROM. The ROM at which the left peak power occurred.
- 5 Right peak power ROM. Ditto right
- 6 Left peak power velocity. The velocity at which the left peak power occurred.
- 7 Right peak power velocity. Ditto right.
- 8 Left peak power force. The force at which the left peak power occurred.
- 9 Right peak power force. Ditto right.
- 10 Left peak power time. The time the left peak power record occurred.
- 11 Right peak power time. Ditto. Search in the detailed data for this time to find the record that corresponds to this point.
- 12 Left Work in Joules.
- 13 Right Work in Joules.
- 14 Left reaction time. Data resulting from the 10 rep test if used.
- 15 Right Reaction time. Ditto right.

The final rep is followed by a blank line.

Column titles for the detailed data that follows. All detailed data in this file is in at the handle units.

- 1 Time. Time is specified as a floating-point number with a resolution of 2.5 milliseconds. The beginning of time is 1-1-1970. Time is always recorded in GMT. To find the time relative to any two points in the detailed data records, simply subtract the two time values. Consider the time number of the first detailed data as record zero time.
- 2 Left Force.
- 3 Left Position.
- 4 Left Velocity.
- 5 Left Power.
- 6 Right Force.
- 7 Right Position.
- 8 Right Velocity.
- 9 Right Power.
- 10 Left Acceleration.
- 11 Right Acceleration.
- 12 Left external data flag, True or False
- 13 Right external data flag, True of False

Units of measure will be the units (Metric / Imperial) selected on the screen just before the translation was initiated.

## Power Tests

The Seventh release software package provides two tests for peak power on the A420. U.S. and foreign patents are pending on these tests. These tests are designed to help determine the resistance at which a user would need to work out with to achieve maximum power. We refer to these two tests as the six-rep test and the ten-rep test. Both of these tests are based on the principal that as resistance increases, the maximum possible velocity will decrease at a relatively linear rate. With a very low resistance, a person is capable of their maximum velocity. As the resistance is increased, the velocity will ultimately reach zero when the resistance is high enough that the user can no longer move the exercise arm. Since power is the product of velocity and force, very little power will be produced at the two extremes. The maximum achievable power will be produced at a point between these two extremes. These tests estimate the shape of the force vs. velocity curve without the need to make a very large number of measurements.

The six rep test functions by measuring the velocity the user produces when doing a set of three repetitions at extremely low resistance while attempting to produce maximum concentric speed. The user then increases the resistance to a much higher setting, preferably near their one repetition maximum (1RM) and again does three individual repetitions focusing on maximum speed through the concentric contraction. When the data in this set is downloaded to the PC, the software in the PC selects the best repetition of the 3 low resistance repetitions and the best of the high resistance repetitions and calculates a graph of predicted power and velocity for the user. See Figure 20. The user selects the resistance at which to test. The results of the test will vary somewhat, and an experienced subject or test supervisor produces best results.

To use the six-rep test, the subject must first insert the chip into the display and then depress and hold both the increase and decrease thumb buttons at the same time (the test will only function when a chip is inserted into the display). If a message such as "PA 13" appears, the machine is asking you to wait for the number of seconds displayed, which will count down. This feature was added to make it more difficult for a subject to accidentally clear valuable data by pressing both buttons inadvertently. The message will only appear if both buttons are pressed too soon after moving the exercise arm. In a few seconds the resistance display will change to display "CLER", and in a few more seconds "Er". The subject must release the thumb buttons as soon as the "Er" message appears. The subject then sets the resistance to a very low value and does three individual repetitions with the goal of achieving the maximum possible speed through the concentric phase for each of these repetitions. There is no time limit for this test, and it is desirable that the subject rests between each of these repetitions. After the third repetition, the subject needs to increase the resistance to a much higher value, preferable near their 1RM. The subject then does three more individual repetitions at this higher resistance setting, again with the goal of achieving maximum concentric speed. There is no limit on the actual number of repetitions done as the software actually analyzes only the first three repetitions done at the low resistance and the last three repetitions done at a higher resistance. This allows a subject that is unsure of their 1RM strength to experiment with the resistance before completing the final three repetitions at a high resistance.

Setting the machine into the six-rep test mode does not change the way the exercise machine operates. The six-rep mode only informs the software in the PC to analyze the data as a six-rep test and to add the extra graphical display on a tab titled “Test Chart”. The test chart graph displays data that consists of a point, which is the best power value of the first three repetitions, and a second point, which is the best power value of the last three repetitions. The software calculates 2 curves, one of which is a straight line that extends through these two points to the x and y intercepts. See Figure 20. The other curve is the power that would be produced from that combination of force and velocity. The data displayed to the right of the graph shows the slope of the velocity – force line, the x intercept as Fmax (projected maximum force at an isometric contraction) and the y intercept as Vmax (projected maximum velocity at zero resistance). The Pmax value is the peak power the user should be capable of, which will occur at the center of the force – velocity line.

The ten-rep test was originally designed to operate with twenty repetitions, however we have found through testing that good results can be obtained with ten repetitions thus reducing the amount of time the test takes to run. The ten-rep test operates by automatically selecting the resistance at which the user is to perform each repetition of the test. The subject or trainer needs to estimate the subject’s 1RM strength during the setup portion of the test. The software within the A420 machine then adjusts the resistance for each repetition and prompts the user for time to do each repetition. The resistance for the first repetition will be a very low value determined for the machine model number and the subject’s 1RM estimate and will be increased for each subsequent repetition until the estimated 1RM resistance is reached on the tenth repetition.

The rest time between repetitions is increased for each repetition to avoid fatiguing the subject. Since we are prompting the user for time to do each repetition, this test also can be used to test the reaction time of the subject. We have found that subjects have difficulty achieving maximum power and best reaction time on the same test so we recommend concentrating on one or the other when running this test. This test will produce a graph very similar to that produced by the six-rep test, see Figure 21. The primary difference is that all repetitions are used to produce the chart. On dual sided machines, the data for each repetition is the mean of the values obtained for the two sides. As of Release 8, this graph is changed to display independent data for each side of the body on dual cylinder machines.

Reaction time data is added to the chart on the tab labeled “By Rep”. Note that the subject in the test shown in this sample anticipated the time on the right arm and was very slow on the left arm on the first repetition. On the second repetition both limbs were late and on the remainder a reasonable reaction time was observed. The times are given in seconds. The first repetition shown in this sample is well beyond the maximum value the data can store and thus shows the maximum of about 0.5 seconds of anticipation and 1.6 seconds of delay.

As of release 8, we add data for the ROM at which peak power is achieved to the “By Rep” graph. This data is applicable whether or not the test is being run. This data is actually collected by older versions of the software; only at release 8 do we display it on one of the graphs.

To use the ten-rep test, the subject must insert the chip into the display and then depress and hold both the increase and decrease thumb buttons at the same time. If a message such as “PA 13” appears, the machine is asking you to wait for the number of seconds displayed, which will count down. This feature was added to make it more difficult for a subject to accidentally clear valuable data by pressing both buttons inadvertently. The message will only appear if both buttons are pressed too soon after moving the exercise arm. In a few seconds the resistance display will change to display “CLR”, and in a few more seconds “6 r”. After yet a few more seconds the display will then change to display “10r”. At this point the subject must release the thumb buttons to enter the ten-rep test mode. If the ten-rep test is being performed on a model 2531 leg press, please be sure that the subject is starting with the pedals resting on the outer movable stops. Once in the ten-rep test mode the display will show an estimated 1RM value in the resistance window. The subject will use the “+” and “-“ thumb buttons to increase or decrease this value to their estimated 1RM. If the estimate is too low, the test will take more than ten repetitions, and if the estimate is too high, the test will complete in less than ten repetitions. This does not affect the results, although it is better to estimate low than high, because more repetitions will give more reliable data. As of release 7.8.9, the ten rep test has been altered to ignore data collected from the first two repetitions done after the test is initiated. The timeout and resistance values will not change during the first two repetitions and once the second repetition has completed, the reps counters will reset and data collected to that point will be deleted. The reps displays show negative numbers during these warm up reps to signify that they are only warm up reps. The power value achieved during the warm up period will remain on the display after the warm up reps. Once the 1RM has been set and the thumb buttons have not been pressed for a short period of time, the test will begin by counting down the time in the “Target Reps” window on the user display. When this value reaches zero, the subject will do a single repetition with the goal of achieving the maximum possible velocity through the concentric contraction phase. The eccentric phase is ignored and should be performed at a normal speed. The machine will automatically adjust the resistance upwards and start timing to the next repetition. The time between repetitions begins quite short and increases as the resistance increases. After the first repetition, remaining time less than 5 seconds displays as a dash “—“ in the “Target Reps” window to prevent the subject from anticipating the time. The system measures the amount of time after the time value displays “0” until the exercise arm moves. This allows for a measure of the subjects reaction time at the low resistances, and their reaction time plus their rate of force development at the higher resistances. As previously stated, it is very difficult for the subject to concentrate on a quick reaction time and maximum speed through the concentric phase at the same time. Therefore, it is best to measure each in separate tests. In many sporting events it is essential that the athlete be able to concentrate on both reaction time and maximal speed at the same time, and therefore should be tested for these together. The test is complete when the subject can no longer move the exercise arm.

Release 8 also adds one more function to the test chart graph screen. We now have the ability to programmatically remove outliers from the data. The two tests used to remove outliers are:

1. If a repetition does not achieve the set percentage of the max ROM achieved, it is not used. ROM in this case is the ROM at which peak power is achieved. The default value for this test is 25%.
2. If a repetition does not achieve the set percentage of the peak power for the previous repetition, it is not used. The default value for this test is 50%.

Both of these settings can be changed by clicking on the Outlier controls Icon on the tool bar (see Figure 12). The change will take effect the next time a graph is opened. It is possible to have more than one view of a graph with different outlier controls by changing the settings between opening each view.

As of Release 8.2, a new chart has been added for the 6 and 10 rep tests. This chart is very similar to the current “Test Chart” for the 6 and 10 rep tests. The difference is that the source of the data may be altered. The existing test chart uses values for power, velocity and force that occur at the point in the repetition where the peak power occurs. The Variable Test Chart allows the source of the data to be varied before the chart is opened. This selection is made by clicking on the “Variable Test Chart Controls” button on the toolbar (See Figure 12 and Figure 24). The source of each of the three data components may be selected and outliers controlled from this screen. The outlier controls for this graph are slightly different in that the ROM required is a percentage of the maximum ROM achieved for all the reps in the data set. If “Value @ Peak Power” is selected as the source for all three data sets, the graph will be identical to the Test Chart graph. Because of this overlap in functionality, the Test Chart graph will be removed from a future version of the software. The outlier controls for the Test chart do not affect the Variable Test Chart and the outlier controls for the Variable Test Chart do not affect the Test Chart. As of release 9.1.0 we drop the first test chart, as the variable test chart can achieve all of its functionality. If you as a user of a previous version have a need for this chart, contact Keiser Service for a means of re-activating this chart.

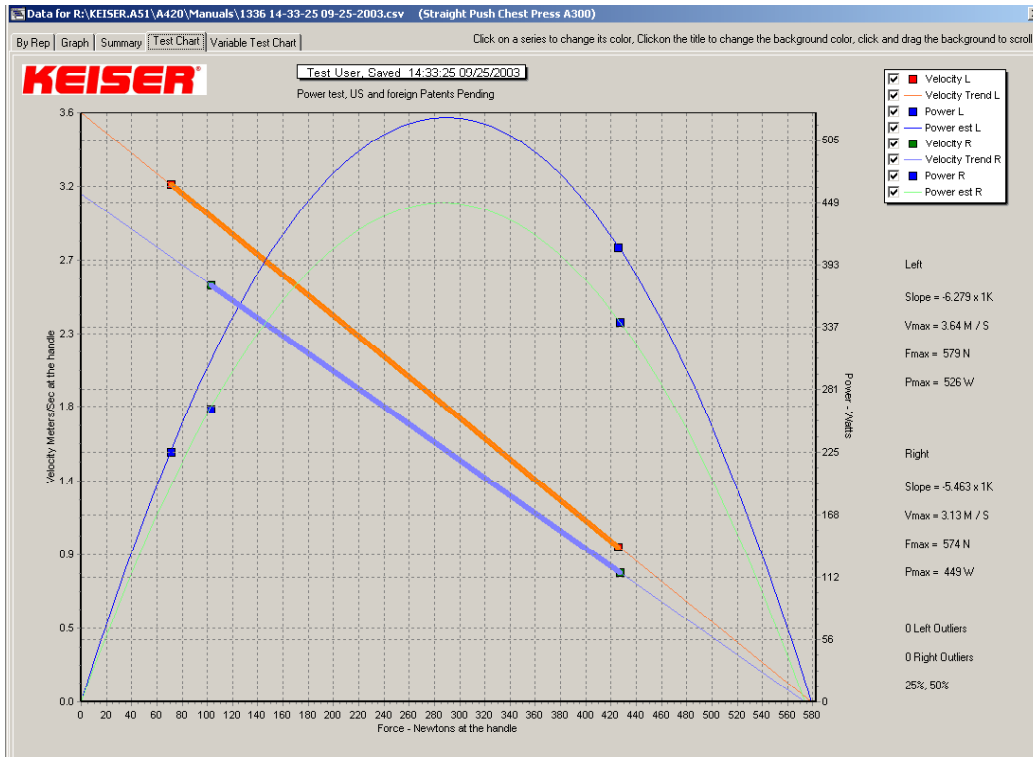


Figure 20 Graph data added by the six-rep test

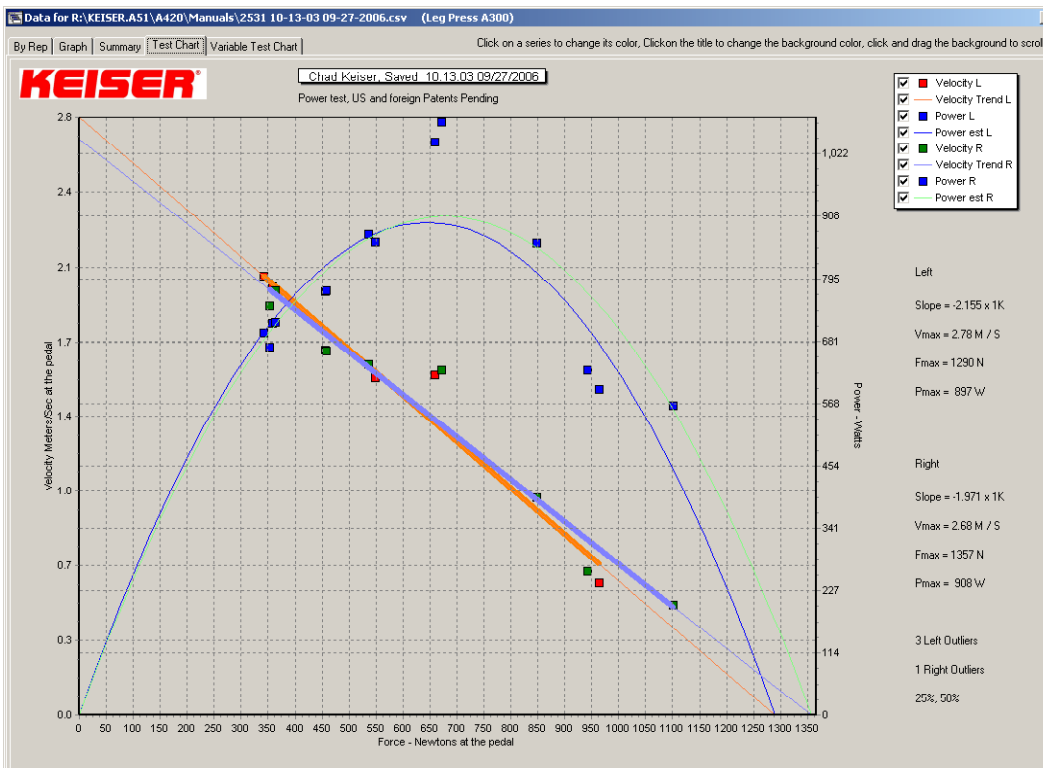


Figure 21 Graph data added by the Ten-Rep Test



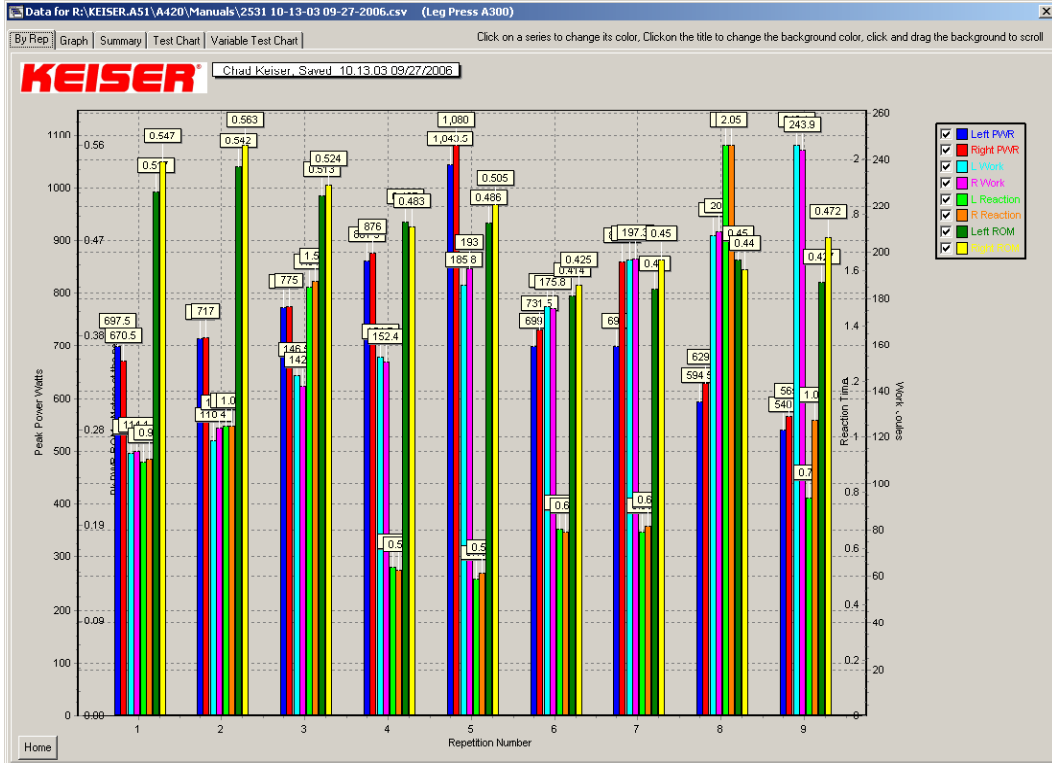


Figure 22 By Rep Graph With Reaction Time Data From a Ten-Rep Test

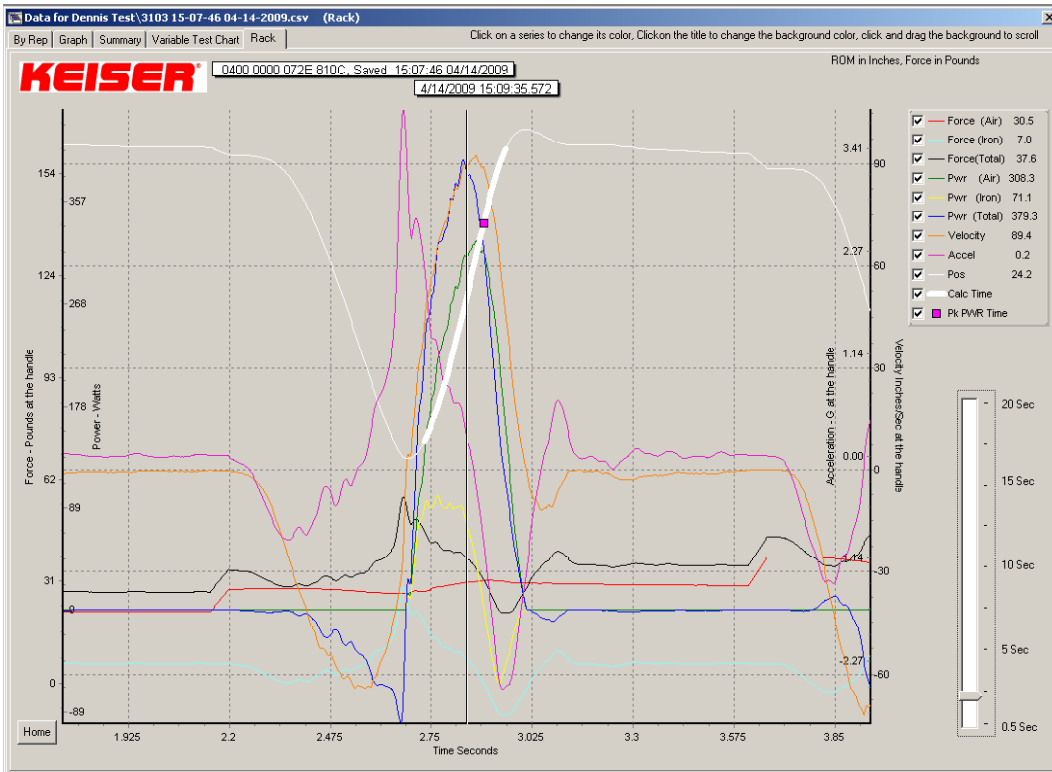


Figure 23 Rack Chart

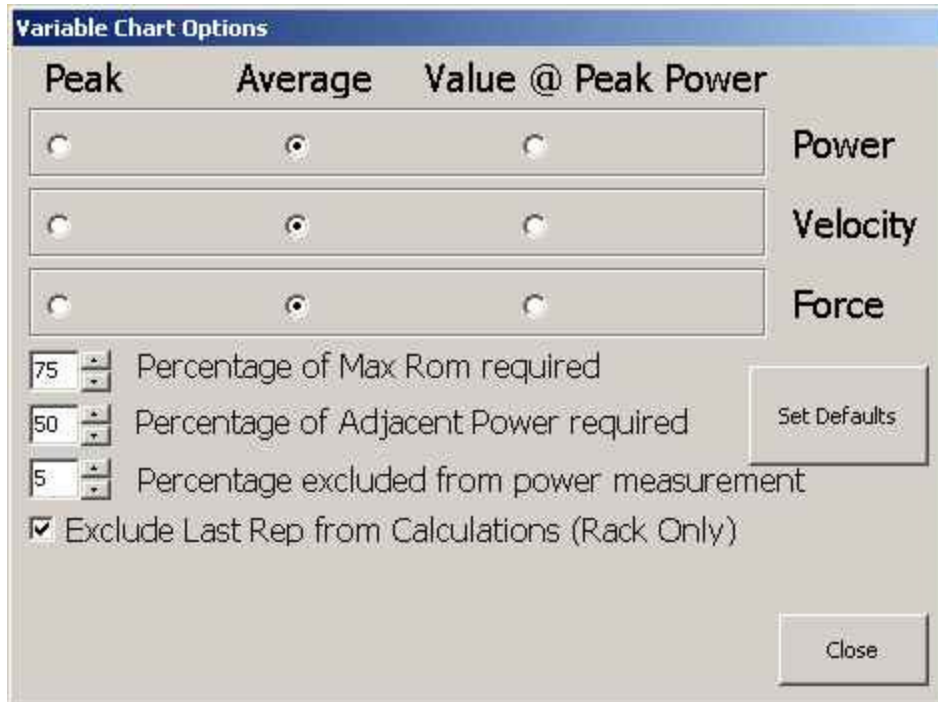


Figure 24 Variable Test Chart Controls

### Notes on use with a rack

When used with a rack, this version of the software adds features unique to the rack. The rack version of this software has the ability to calculate forces due to the acceleration of the mass of the weights and bar when those values are entered into the display before the set is started. Rep counting is altered on the rack models to insure that the reps counts for the two sides operate in unison. As of Release 9.3.4, rack software will function with only one side if necessary. When using a rack as a single side load, there is a restriction that data will not display correctly if one side is used and then later in the same exercise set before the key is removed, the other side is used. We recommend that if you need to do a one sided exercise with a rack, choose one side and always use that side. An additional tab (Figure 23) is displayed on data window for a rack machine that has the following traces

1. Force (Air), this is the combined force from the two sides
2. Force (Iron), calculated force from the average acceleration
3. Force (total), sum of above
4. Pwr (Air), total power from both sides due to air
5. Pwr (Iron), power generated by moving the iron
6. Pwr (total), sum of above
7. Velocity, average velocity of the sides
8. Accel, average acceleration of the sides
9. Pos, the average position of the sides
10. Calc time, This selection widens the Position trace over the interval averages are calculated from
11. Pk PWR time, a marker to the point at which peak power due to air only occurs.

This tab functions very much like the Graph tab, which still displays for the rack. The rack version of the A420 will run the 10 rep test, however we recommend that this test be run with only the weight of a bar, preferably a light weight bar. Adding iron defeats the purpose of the test. **We strongly recommend having a spotter during the running of the test, as the final rep will be a failure rep.**

When using A420 software with a rack, we recommend getting the bar set up and in position before inserting the user key.

When doing very slow repetitions (outgoing stroke in excess of 1 second), the motion will appear to be somewhat erratic. This is caused by the stretching of the very long rope in the mechanism of the rack interacting with friction of the air cylinder. We recommend using the averaged data available on the summary tab if you must test with very slow reps on a rack.

### Notes on Range of Motion required to count a rep

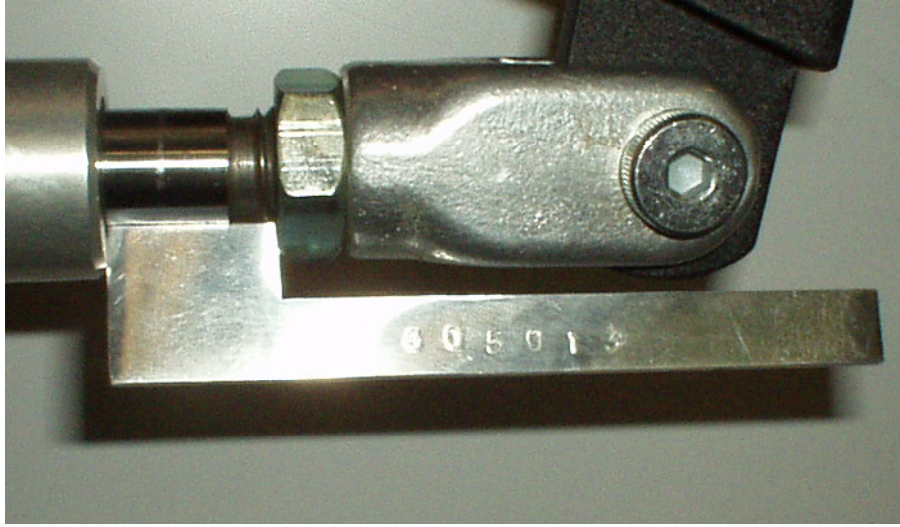
The range of motion necessary to count a rep is preset for each model of machine at the factory. If you are testing subjects who have a limited range of motion, which is short

and is missing some reps, contact Keiser service for information on changing the default range of motion. This ability is new to the release 9.1 software package.

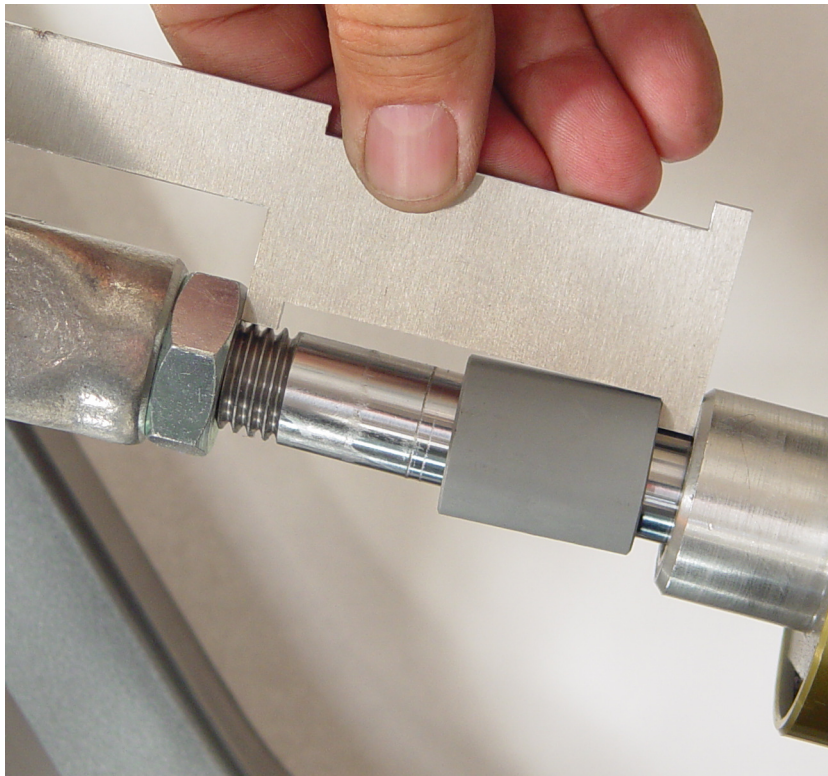
## Calibration

Field calibration consists of three items. Setting the zero point of the pressure transducers, setting the zero point of the position transducers, and setting the span of the position transducers. A fourth calibration procedure, setting the span of the pressure transducers can only be done at the factory. The calibration of the pressure transducers is not expected to drift significantly over the life of the machine. Each calibration procedure will log the results of its operation in a text file in the same directory as the program as well as display its results in the calibration window. The file will be named CalLog0.txt, where the character 0 will be replaced by the numerical address of the machine in question. Calibration frequency is up to the user. Frequent calibration is not necessary to keep the machine operating, and probably need only be done to confirm accuracy or when components have been replaced for service. To begin the calibration process, open the calibration window for a machine by double clicking on its model number in the machine status window (Figure 7). The calibration window (Figure 8) also allows the time in the machine to be synchronized with the time in the personal computer and log the version of the software in the four computers within the machine control box. Before setting the time in the machine, insure that the time and time zone in the personal computer are set correctly. To read the time from a machine, click on the *Get Time* button. The time and time zone information will be read from the exercise machine and displayed in the window. Every thing that displays in the window will also be logged to the calibration log file. To set the time to that of the PC, simply click on the *Set Time to PC Time* button. The clock device in the exercise machine has accuracy approximately equal to that of a wristwatch. To set the pressure zero point, first reduce the resistance of the machine to its minimum value. Next disconnect the air supply hose at the compressor to prevent injury from a loose air hose. All air hoses (Figure 3) need to be disconnected from the outside of the box before proceeding. Once all hoses are disconnected, click on the *Zero Pressure* button. The zero pressure sequence takes about  $\frac{3}{4}$  second to complete. Once it is complete, connect all the air hoses back to their original fittings. Note that there are two left hoses and on dual cylinder machines, two right hoses. On machines produced in 2003 and later, these hoses are color coded to help get them connected back to the correct fitting. The left hoses are blue and the right hoses are red. When the air hoses have been re-connected, increase the resistance setting enough to insure that the exercise arm is securely against its position stop. In the case of a leg press with dual position stops, it is important that the exercise arm be against the outer stop before starting the position zero procedure. To initiate the position zero sequence, click on the *Zero Position* button. Both sides will be zeroed at the same time. This takes about  $\frac{3}{4}$  second to complete, and it is important that the exercise arms remain solidly against the stops during this time. The position span calibration procedure requires a Calibration block, Keiser PN 995010 or 995011 (Figure 1). Before proceeding, lower the resistance to its minimum setting. In most cases it will require 2 people to complete this procedure, so get help before starting. We will step through the process for the left side. The procedure for the right side is the same. Click on the *Calibrate Left* button. A dialog box asking you to insert the short side of the block will appear (Figure 25, 26). Two different calibration blocks have been provided. Use the longer (part number 995010) block for machines with 12-inch stroke length cylinders and for machines with a plastic limiter

collar on the shaft of the cylinder. Use the shorter (part number 995010, previously 605013) block for those machines that have the 7-inch stroke cylinders

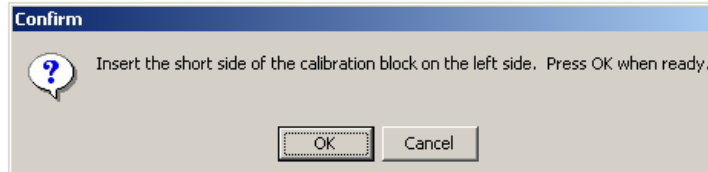


**Figure 25 Short Side of 995011 Calibration Block**



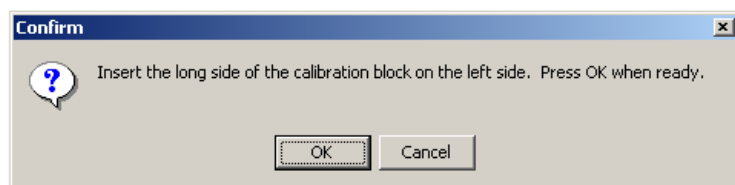
**Figure 26 Short Side of 995010 Calibration Block**

Place the block as shown in Figure 25 or Figure 26 and have your assistant hold the exercise arm to keep pressure on the block.



**Figure 27 Calibration Dialog Box**

Click on the *Ok* button to proceed. The exercise arm must keep force holding the calibration block in place for at least  $\frac{3}{4}$  second while the position is measured. You will be prompted to insert the long side of the block (Figure 28).



**Figure 28 Calibration Dialog Box**

Insert the block as shown in Figure 29 or 30 and have the assistant hold pressure on the exercise arm to hold it in place.



**Figure 29 Long side of 995011 Calibration Block**



**Figure 30 Long Side of 995010 Calibration Block**



Click on the *Ok* button and insure that the block and cylinder remain stationary for at least  $\frac{3}{4}$  second or more. The calibration blocks are machined such that the steps are exactly 100 millimeters different in length. When you click on *Ok* during the calibration process, the computers in the machine measure the length of the cylinder 256 times, average those readings and temporarily store the results. Once both long and short readings have been taken, the machine calculates the multiplier that will be needed to produce an exact 100-mm output reading based on the difference between the two averages. This scale factor is the number that is recorded at the end of this procedure.

Note that a *Calibrate Pressure* button exists. This button is password protected to prevent accidental operation. Calibrating the pressure for span requires an accurate source of 50 PSIG air, which is available at the factory and calibration is done on all machines before they ship. Experience with thousands of these pressure transducers over time has shown that they are more likely to fail completely than to drift and that the field failure rate is very low. As of the seventh release, the pressure span calibration procedure sets the machine serial number, which is stored into a data chip when an exercise set data is stored into the chip. This data is of value only to an installation with more than one machine with the same model number, and the lack of a stored serial number will not detract from the operation of previous versions of the software.



## **Theory of Operation**

The Keiser A420 series of machines was designed to accurately measure the velocity and force of the piston in the air cylinder. Position is measured by a resistive position transducer and converted to numbers with a resolution of one part in 16 million 400 times per second. The absolute accuracy of the position measurement is dependent on the linearity of the transducer itself, which is specified to be better than 1% by the manufacturer. The very high resolution is necessary to directly measure velocity without resorting to curve fitting or interpolation. Force is calculated by directly measuring the gauge air pressure at the air cylinder and multiplying by the area of the piston. The manufacturer of the pressure transducer specifies its accuracy at 1% or better. Since the system also controls the air pressure in the cylinders, it needs to know the absolute pressure as well as the gauge pressure in each cylinder. To achieve this, a barometric pressure sensor is included in the electronics. The control box contains four electronic circuit boards each with its own microprocessor (Figures 31, 32 and 33). The four circuit boards and their respective duties are:

**Position** - This circuit board is responsible for measuring position, calculating velocity, and acceleration and setting the master sample rate for the entire system. The position processor communicates directly with the control processor via a high-speed serial link and sends position and velocity information to the pressure processor via an IIC or SMBus link. Versions later than 2.00 of this software also calculate the acceleration. Version 3.03 reduces the bandwidth of the acceleration data to keep mechanical artifacts from hiding the part of the data we want to see. This was done to improve operation with the racks.

**Pressure** - The pressure processor samples the barometric pressure, the supply pressure, and the pressures of the two sides of the machine. It solves the universal gas law equation ten times per second to decide whether to add or remove air from each side to keep it at the desired resistance. The proportional valve control versions (V3.xx and later) raise the sample rate to 40 times per second. During and for a short while after a large movement, the allowable error band in pressure control is widened to allow for swings in pressure caused by thermodynamic effects. The pressure processor communicates directly with the control processor via a high-speed serial link and receives position, velocity, and timing information from the position processor via an IIC or SMBus link.

**Display** - The display processor communicates with the user display and has all the circuitry necessary to read and write the Keiser chip. It also contains the time of day clock and logic necessary to control the resistance set by the user or chip. The information necessary to change models of Keiser exercise machine is kept within this board, and in fact the model change buttons are on this board. A battery backs up volatile data and the time of day. The projected battery life is a minimum of ten years. The battery is not field replaceable.

**Processor** - The master processor circuit board coordinates communications with the other three circuit boards and the personal computer. It has the memory necessary to save user data until it is requested by the PC. The computer chip on this board is more powerful than the other three and does the majority of the repeated calculations necessary

to come up with the data requested by the PC. Data stored within this board is raw scaled data from the other boards. It is scaled to useable data just before being transmitted to the PC. All data sent from the embedded software to the PC is scaled in SI engineering units and represents data at the cylinder. All the handle translation is done by software running on the PC after the fact. This is done to make more efficient use of the memory available. The size of the memory available on this circuit board sets the limits on the amount of data that can be cached.

The program memory on all four circuit boards is implemented with flash technology and as such may be updated to new software from the PC without changing any parts.

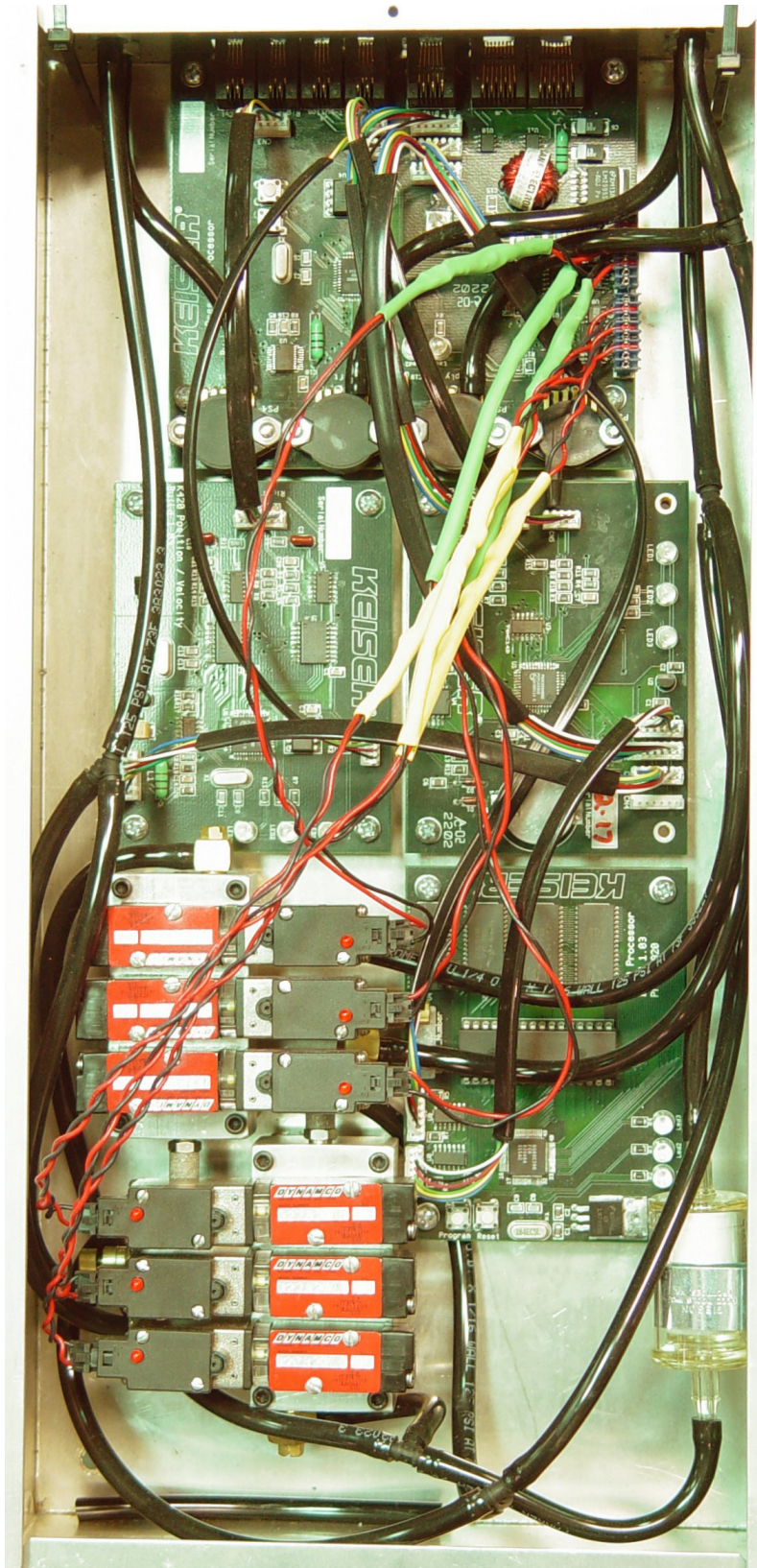


Figure 31 Control Box, Three Valve





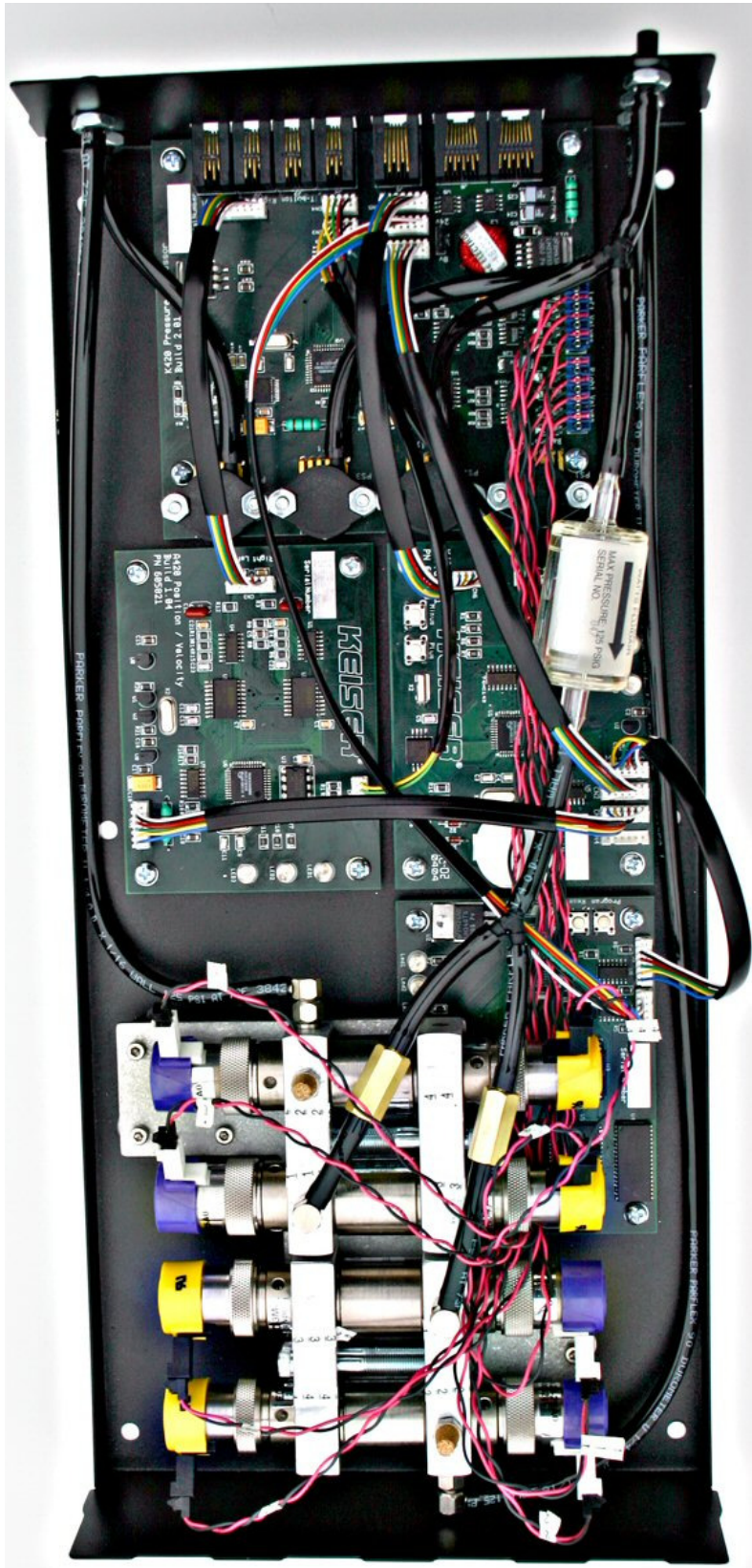


Figure 33 Third Generation Control Box



## Firmware Update Procedure

As of Release 9.3.0, firmware update in the exercise machine has been automated and combined with the main program on the PC. This procedure is still documented here in the event that the automatic process fails and needs to be recovered. The firmware in all four embedded processors on the exercise machine may be updated from the PC. The first step in the update process is to connect the power cables such that the machine to be updated is the only machine connected to the power adapter box. The A420 control program on the PC must be stopped. When replacement firmware is sent to you, it may come on a floppy disk, CD, via email, or be downloaded from the Internet. There are several pieces of software that make up the programs that run on the computers in the control box. All of these programs have files with an extension of “.HEX” and are stored in a subdirectory named “C:\A420\FLASH”.

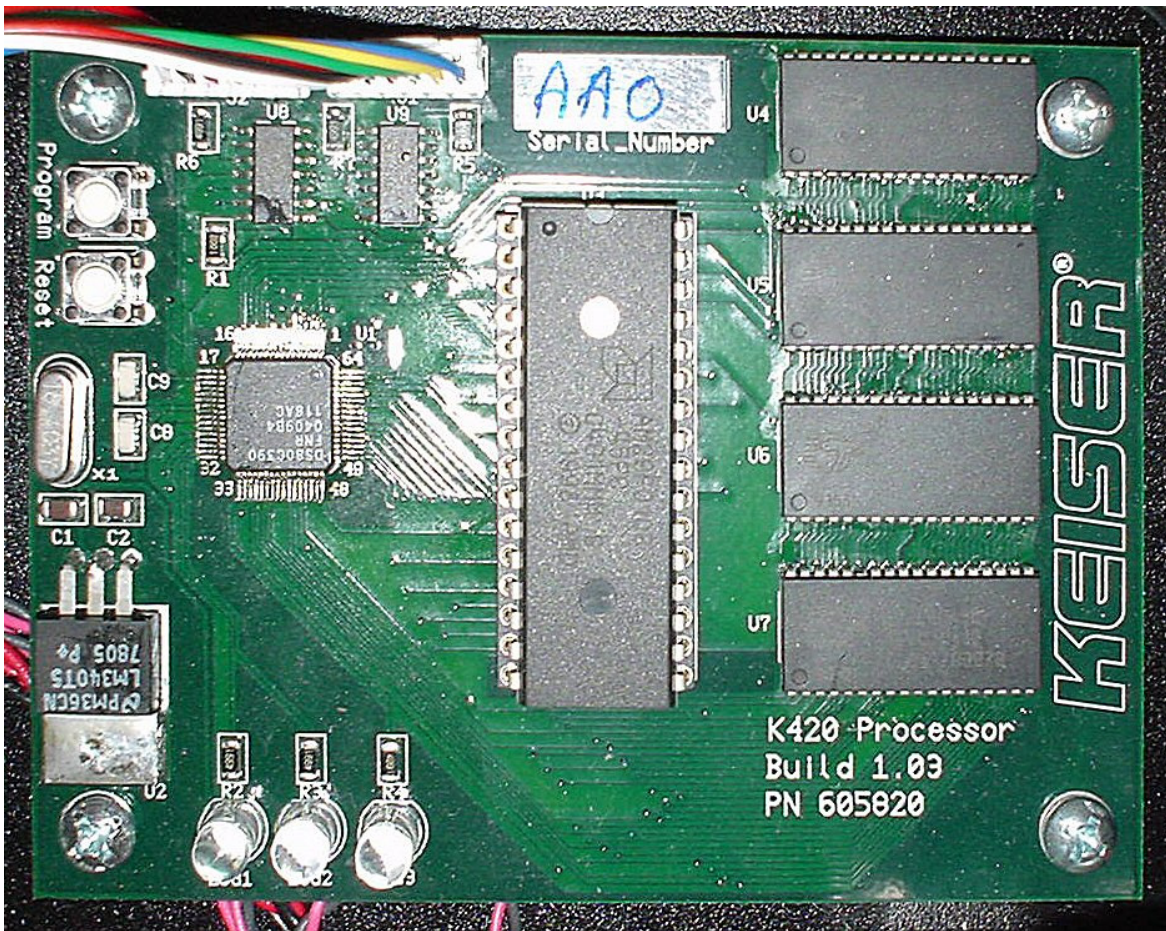
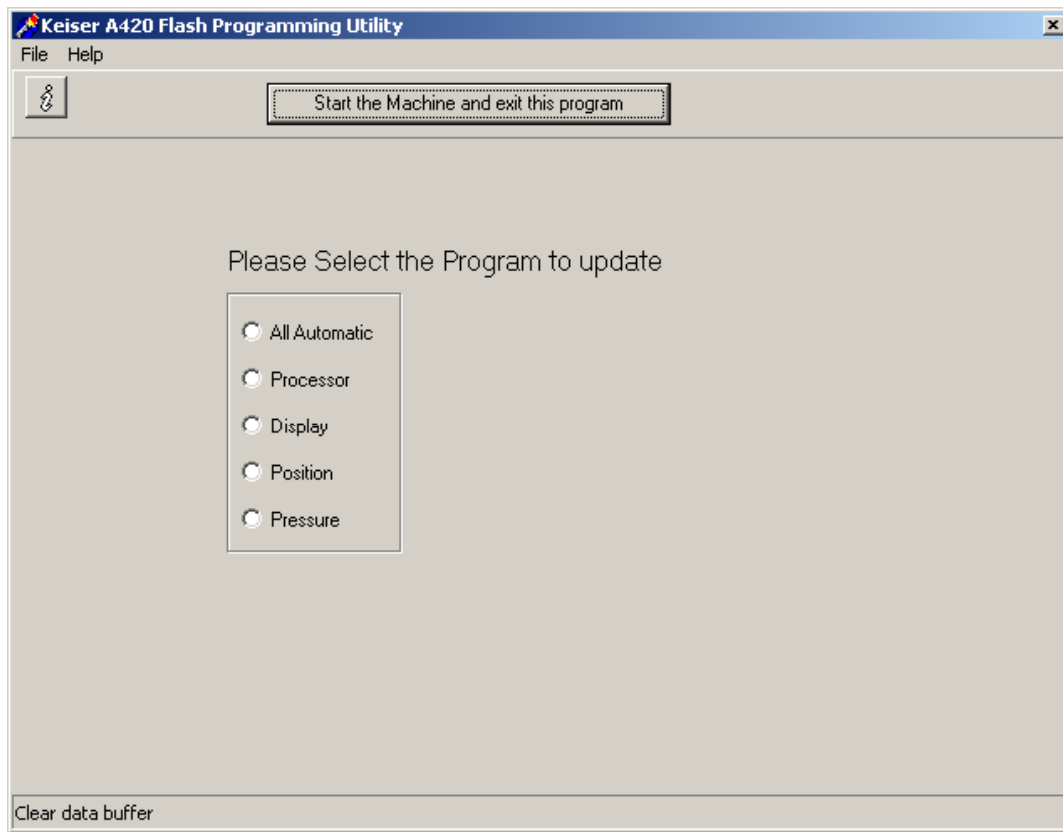


Figure 34 Main Processor Circuit Board

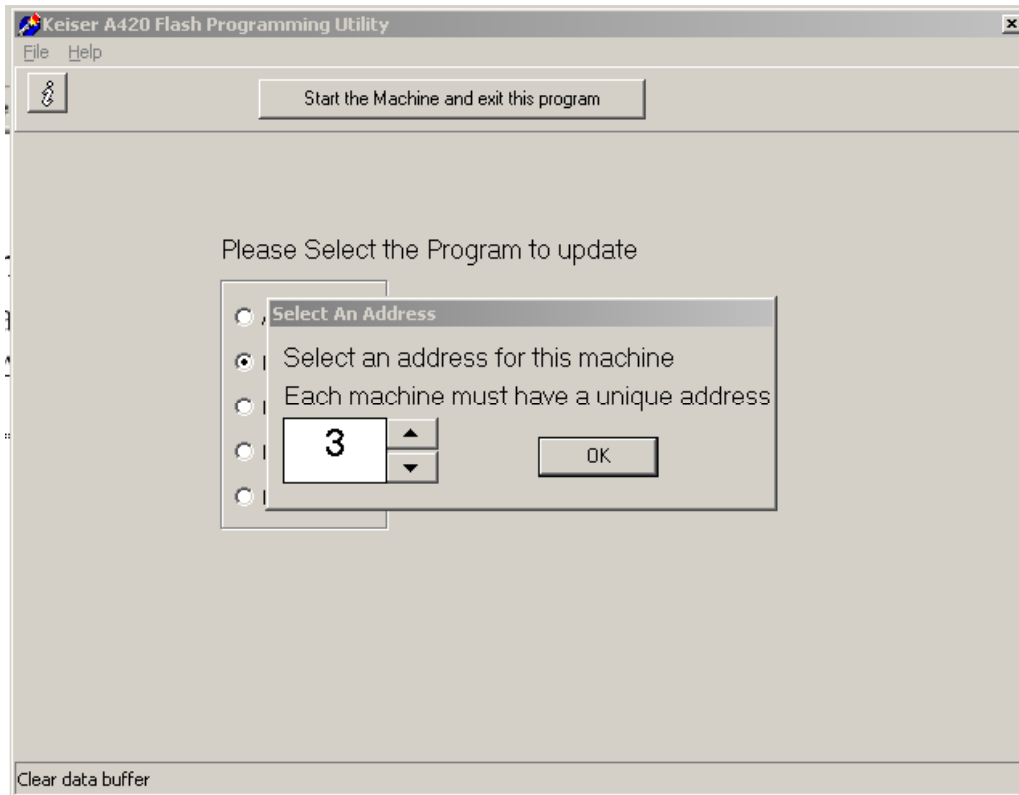
Before proceeding, the machine that needs to be updated must be the only machine connected to the power box. Only one machine at a time may be updated. Next, locate the two push buttons on the processor circuit board in the control box (see Figure 34). One is labeled *Program* and the other *Reset*. To place the machine in the programming mode, press and hold down the *Program* button then press and release the *Reset* button. Release the *Program* button. Start the A420 flash programming utility program on the PC. This program is located in the “C:\A420\FLASH” directory and is named A420Flash.exe. Start

by double clicking on its name. The program will start and display a version message. After clearing the version message, the program prompts you for the COMM port to use. Select the COMM port that the add-in serial card uses. In the case of new machines shipped from the factory, this will be COMM3. In the case of machines that have been field upgraded, it may be some other number. In any case, the COMM port will be three or higher. Note: It is possible to run the machines and programs from COMM1 or COMM2 built into the PC motherboard, however the program will download data at 1/5<sup>th</sup> the speed that can be achieved with the add-in serial card. The flash program must be run from the same COMM port that the main program will be run from later. The flash firmware automatically makes configuration changes to the machine's software to deal with the differing speeds of the ports.



**Figure 35 Flash Program Select Dialog Box**

After selecting the COMM port, the program will prompt you for the program to update. Individual programs for each of the separate processors in the machine may be selected, or by selecting 'All Automatic', all the programs may be updated at the same time. Unless directed to do otherwise by the factory, use the All Automatic option (Figure 35).



**Figure 36 Machine Address Prompt**

If either 'All Automatic' or 'Processor' has been selected, you will be prompted for the machine address (Figure 36). Each machine connected to a PC must have a unique address. If you want to change the order the machines are displayed in the machine status screen, you can re-flash the processor program in all the machines. The machines with the lowest address will appear at the top of the form. The flash program will display a small dialog box with the word "Success" if all goes well. If the flash process fails, some other message will show. If the flash process fails, try again from the beginning. For those upgrading from the first release of the software, there will be a message about replacing the flash loader early in the process. If you do not update the flash loader, it will not be possible to proceed. After a major change in software versions, it is advisable to change the machine model from the correct value to a different value and then back to the correct value again. This process forces the software to re-calculate various constants needed for proper operation. See the next section for the procedure to change the model number. If either 'All Automatic' or Pressure has been selected, you will need to select the proper hardware with the Pressure program select dialog box as shown in Figure 37. Click on the image that matches your valve block type. If you selected Three valve, you will be prompted for the Build number of the valve control circuit board in your machine also. It is very important that the pressure software match the correct version to the hardware in the machine. Any of these combinations operate properly with the Fifth release or later software package, provided the correct software is matched to the hardware available.



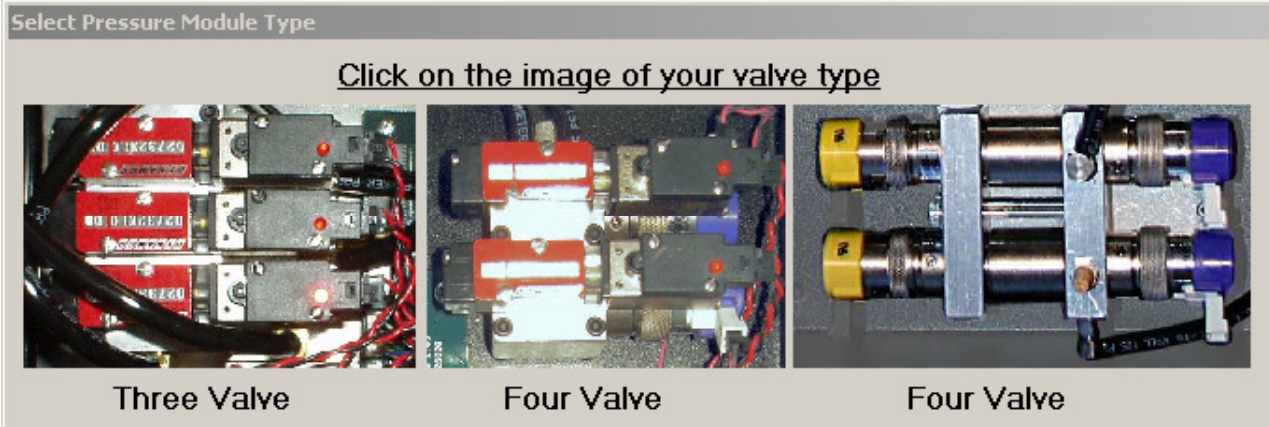


Figure 37 Pressure Program Select

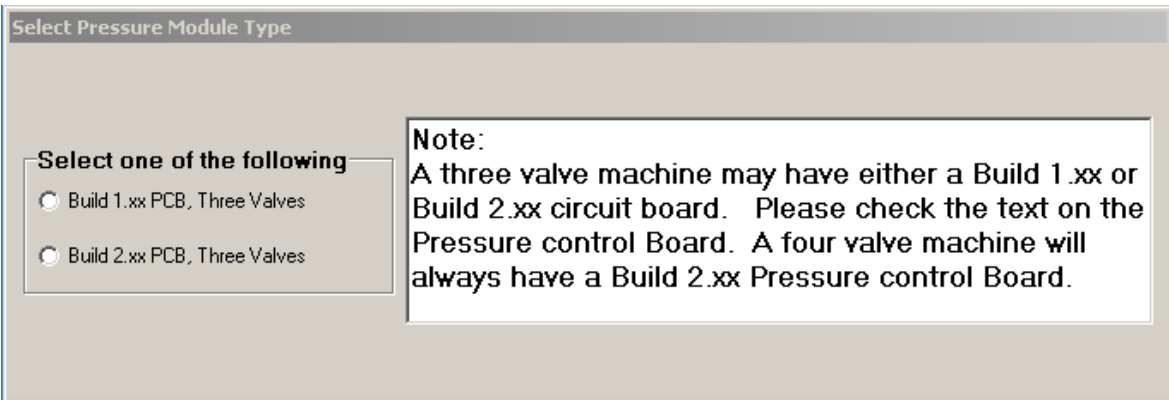


Figure 38 Pressure Circuit Board Select

## Setting the Model



**Figure 39 Plus Minus Push Buttons**

When the software in the display or processor modules has been updated or a circuit board has been replaced, it will be necessary to set the machine model number. This is done in a manner similar to that used on Keiser's standard production machines with digital display. The display circuit board has a pair of push buttons labeled Plus and Minus (Figure 39). To change the model of machine that this processor is set up for, press both the Plus and Minus buttons on the display control PCB (Figure 39) at the same time and release them. The upper left window of the user display will change mode and display the current model number. Release both buttons and then use them to scroll the upper left window through the list of available model numbers. The correct model number will be the first four digits of this machine's serial number. The model change mode will time out and revert to the operating mode within a few seconds. Beginning in late 2005, Keiser serial numbers no longer start with the machine model number. The model number will be printed separately on the machine serial number label. If there is any doubt about the correct model number to use, please contact the Keiser service department. If you wait too long while trying to change the model, you may have to start over. Starting with the sixth release software package, this procedure has changed slightly. It is now possible to select between displaying Pounds of force, Kilograms of force, or the force in Newtons on the user display. When you have completed changing the model number, after a few seconds of no change, the upper left corner display will change to indicate one of three values as follows:

*USLb* = display the force in US Pounds

*EUR0* = display the force in Kilograms (European)

*5 mE* = display the force in SI units (Newtons)

The three modes may be selected by using the same plus and minus buttons as were used to set the model number. The odd abbreviations are due to the limited number of letters that can be created with a seven-segment display.

## **Troubleshooting and Error Indications**

Each of the four circuit boards in the control box has three LED's (Light Emitting Diodes). When the system is operating normally, the LED labeled LED1 on all four circuit boards will flash once per second. Conditions that affect the rest of the lamps are described for each of the circuit boards below.

- a. Processor board LED's - If all three LED's are lit on the processor, it is an indication of a failure of the main program. This will most likely occur after an attempt to update the program has failed. To recover, try to reprogram the processor software again. LED3 will be illuminated when this machine has been selected for communications with the PC. With the second and third versions of the program, this LED will flash periodically as the PC scans the machines for data. If the PC program is not running, LED3 may be either on or off.
- b. Display Board LED's - If one or more of the display board LED's are flashing rapidly (several times per second), a software error has occurred. Note which LED's are flashing before calling for service. The machine display being disconnected or not communicating is one such error. This will cause LED's 1 and 3 to flash rapidly. When the machine is having new software flashed into its chips, the function of these LED's changes to indicate which processor is being flashed.
- c. Pressure Board LED's - LED2 lit steady indicates data is being received from the position board. If communication with the position board fails, LED2 will flash rapidly. LED3 will flash shortly after power is first applied to signify that the valves are being cycled during the power up sequence.
- d. Position Board LED's - if LED2 and LED3 on the position circuit board are flashing then a software error has occurred. Specifically, they indicate that the software running on this board is not able to process data as quickly as it is being provided. These LED's may flash for a short time when the power is first applied, however should not remain on after the machine is running. If these error indicators flash, notify Keiser Service.

Each of the valves has an LED on its body to indicate when that valve is energized. The direction valve may remain energized depending on whether the last change to the system pressure was an increase or decrease, however the fast and slow valves should de-energize within a short time after a change in resistance on the machine. As of the seventh release, the valves being used do not have indicator lamps. The most common problem we have experienced with any of these valves in the past has been dirt or foreign matter getting on the seat of the pilot section of the valve. When this happens, the valve will pass air even when no power is applied. The effect on the system will depend on which valve this happens to. Should this occur, the valve must be replaced. This design includes a separate filter for the pilot air supply to reduce the likelihood of this type of failure occurring.

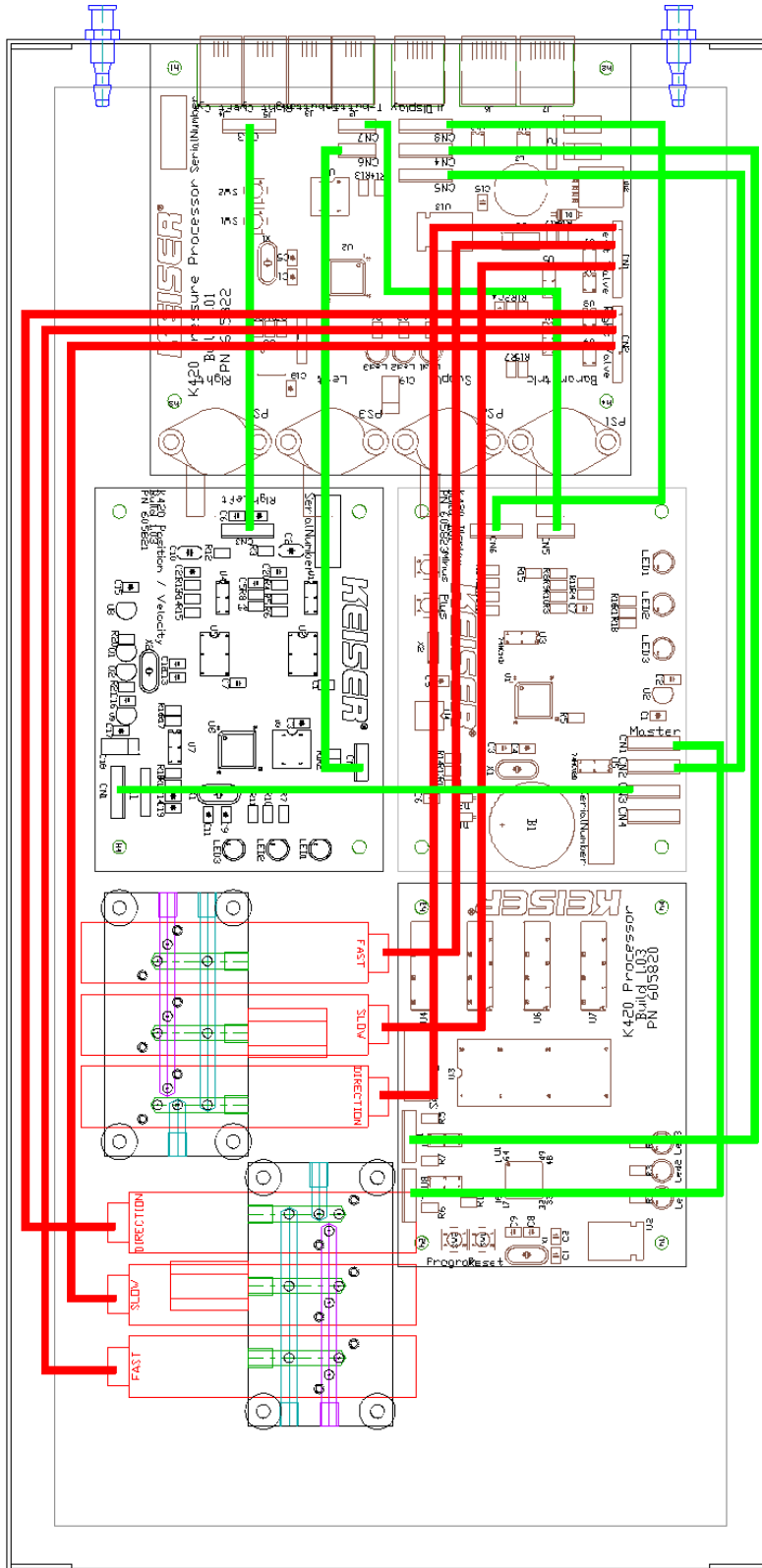


Figure 40 Wiring Diagram 3 Valve

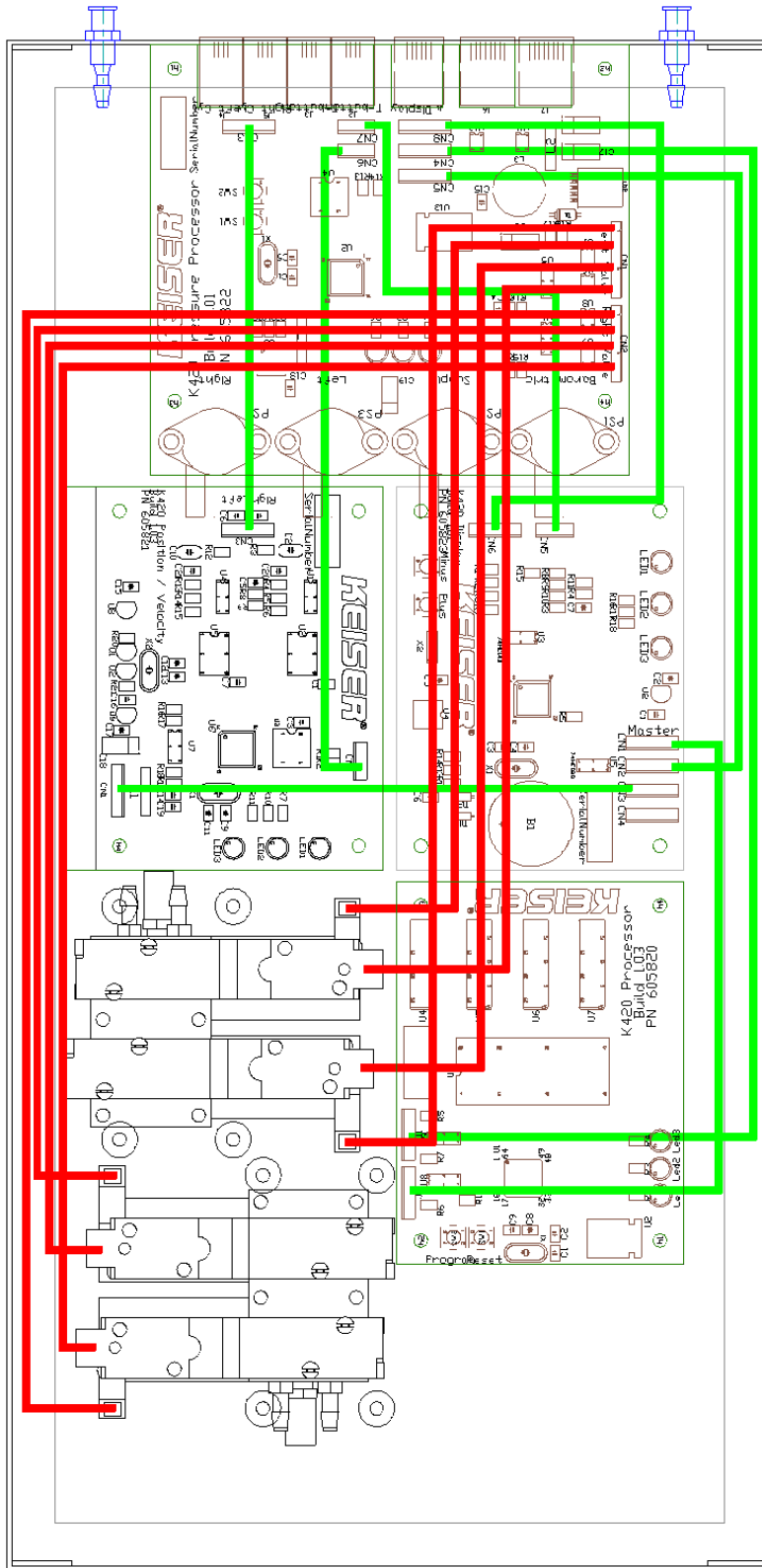


Figure 41 Wiring Diagram 4 Valve

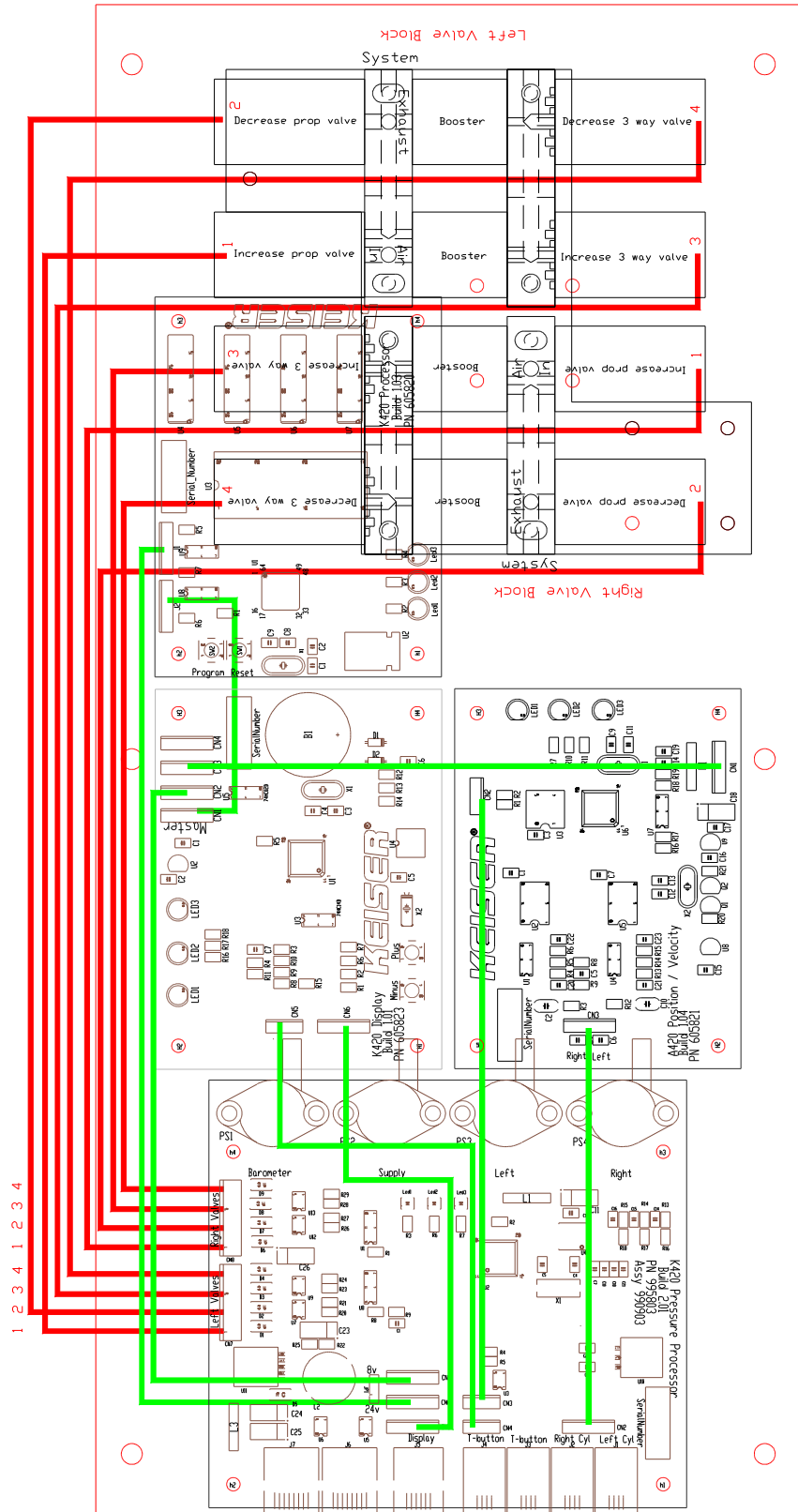
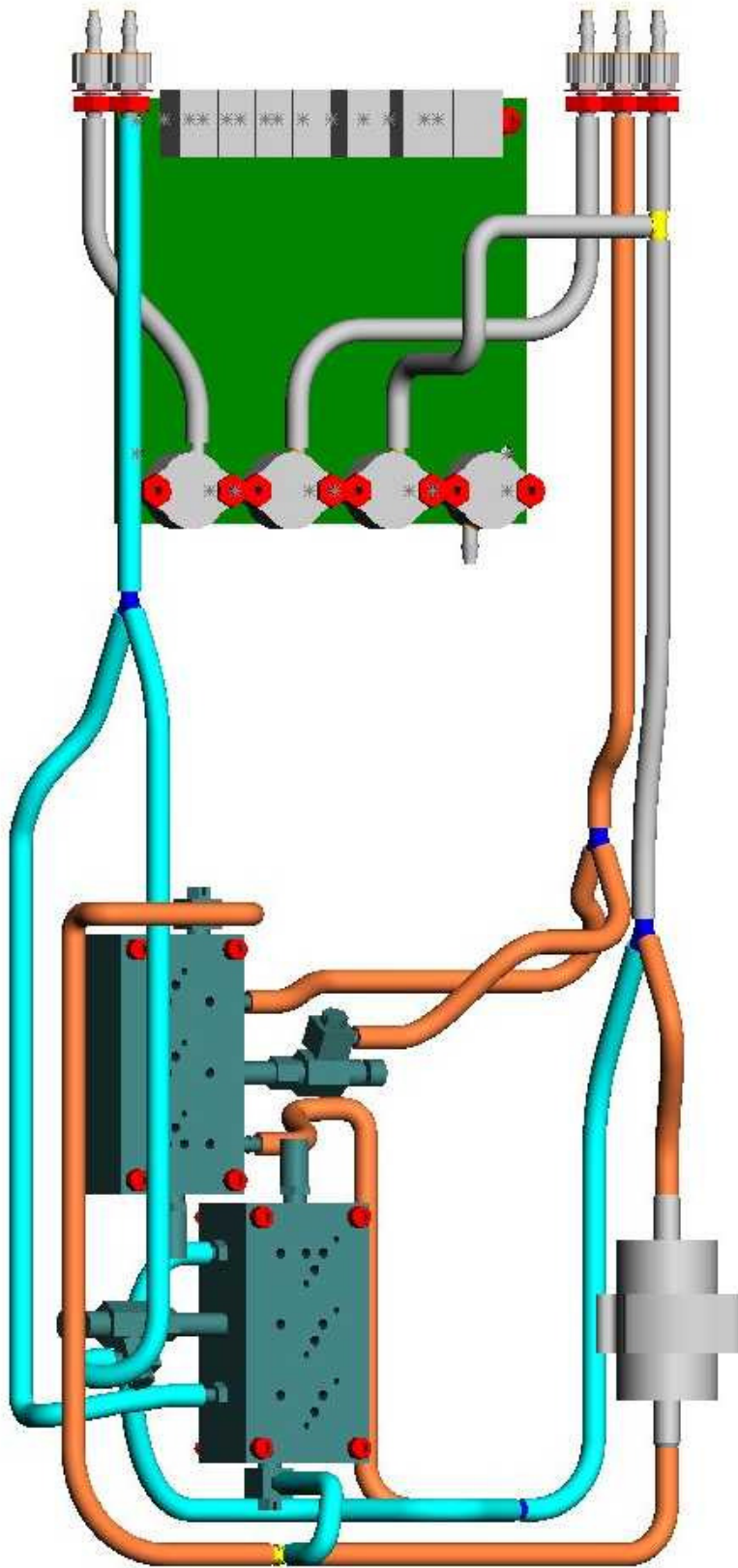


Figure 42 Third Generation Four-Valve Wiring Diagram



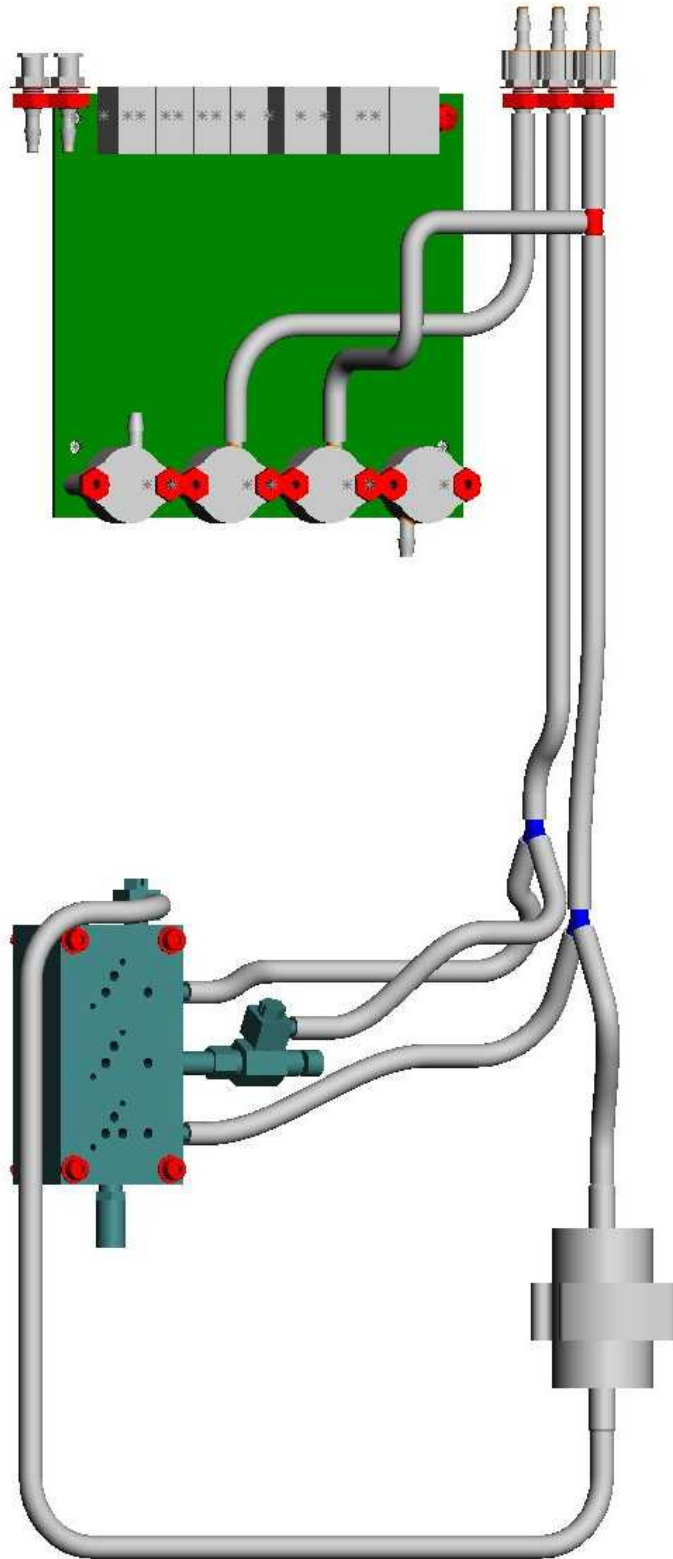


Figure 43 Third Generation Four-Valve with simplified wiring

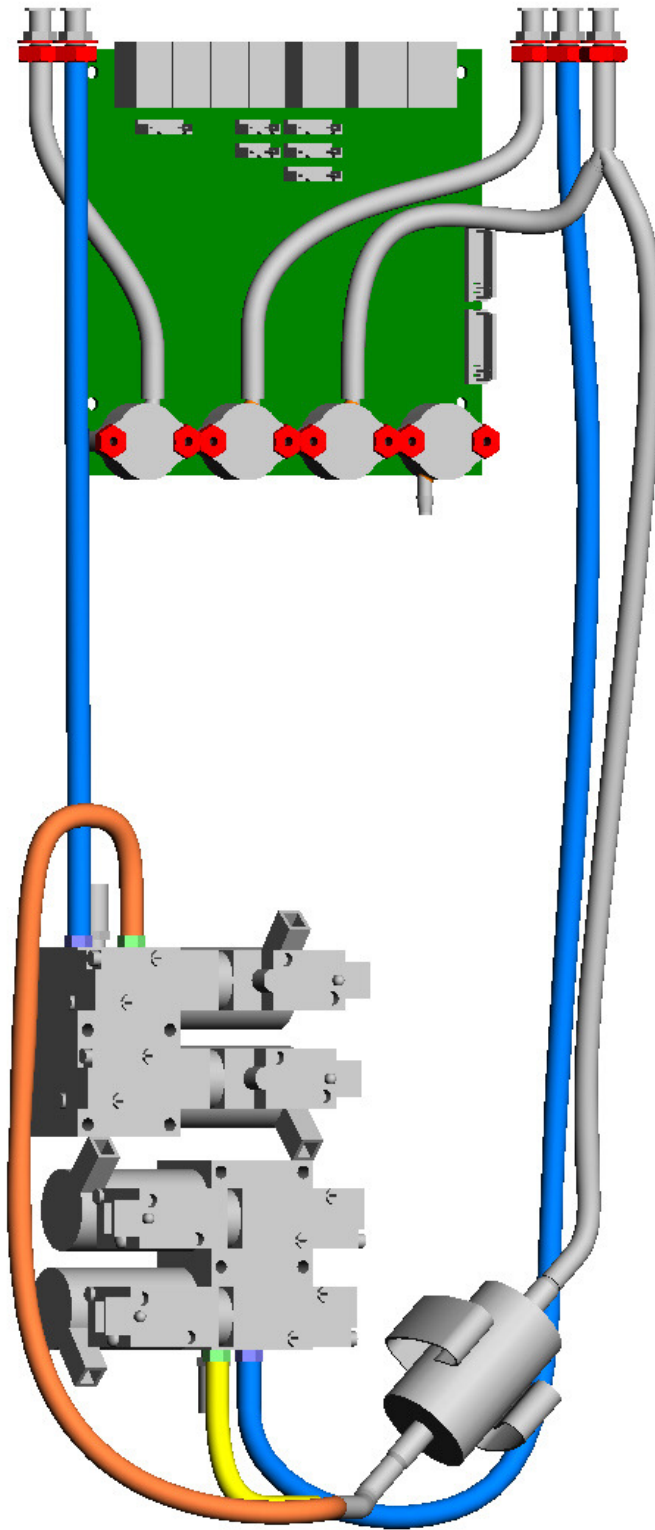


**Figure 44 Dual 3 Valve Air Hose Diagram**

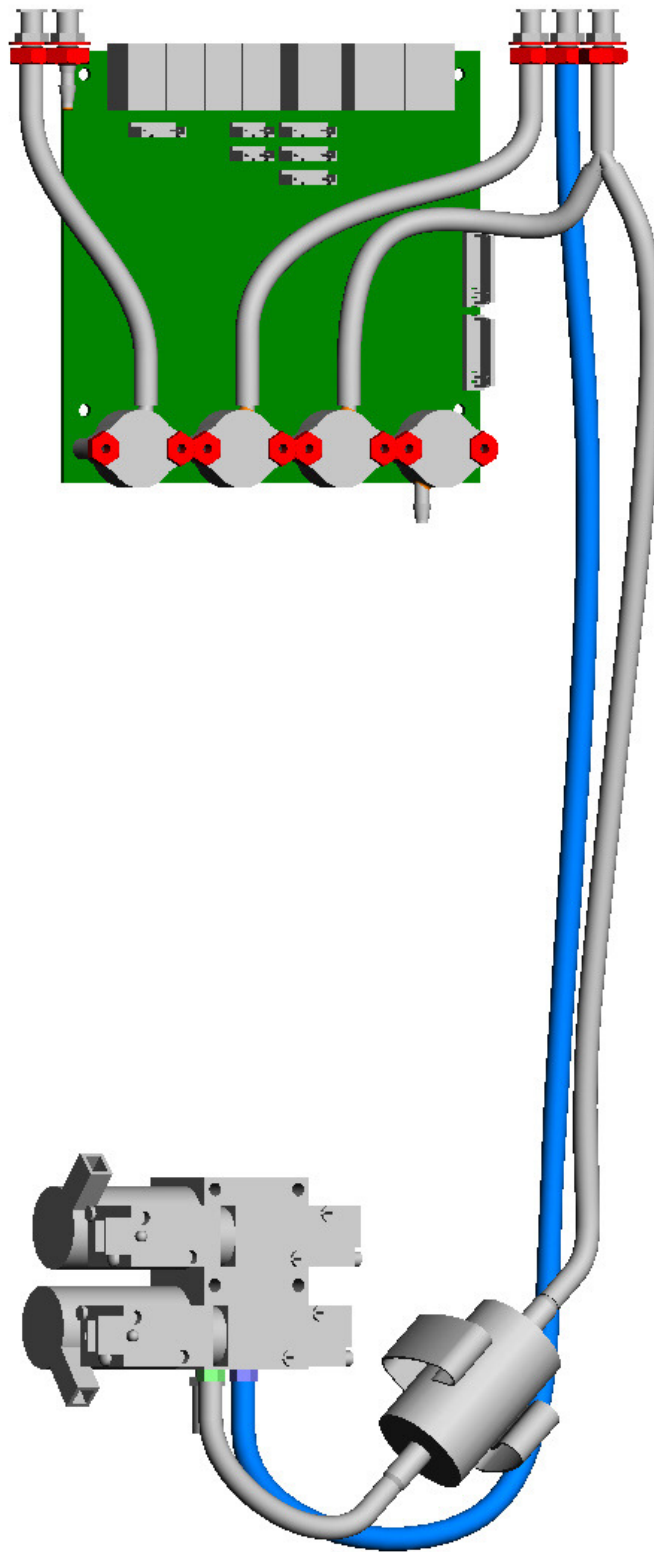




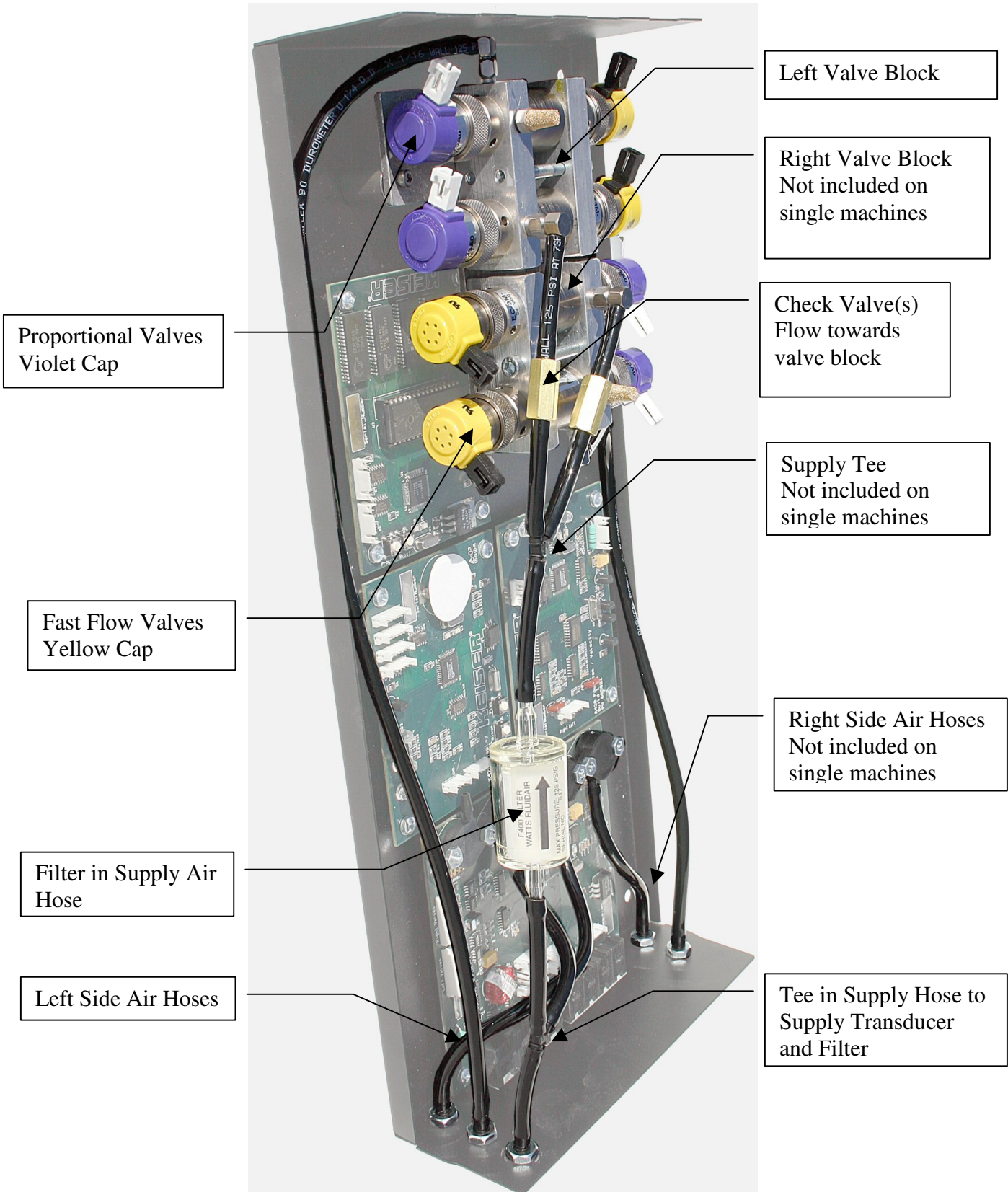
**Figure 45 Single 3 Valve Air Hose Diagram**



**Figure 46 Dual 4 Valve Air Hose Diagram**



**Figure 47 Single 4 Valve Air Hose Diagram**



**Figure 48 Third Generation Air Hose Diagram**

## Upgrading from a Previous Version, Re-installing

It is assumed the person performing the following is familiar with general Windows software installation and add-in card installation. Read these instructions completely before proceeding. As of this release, some of the installation has been automated, and all that is necessary is to insert the CD into the PC and let it begin to auto play. This version of the A420 software has been tested and is compatible with Microsoft Windows 2000, Windows XP and Windows Vista. Windows 95, Windows 98 Windows NT 3 or 4 and Windows ME will not work.. As of release 7.7 we no longer support installing the software as a viewer on Windows 95 / 98 / ME. Remember to preserve any data files that were created with the previous version. The steps necessary to get the software operating, whether an upgrade or new install follow.

1. Run Setup.exe as downloaded from the Internet. If you were provided with an install CD, it should run this file automatically when inserted. The setup.exe program installs the iButton drivers. This step has been automated and improved over the previous release. Follow the prompts on the screen.
2. Install the VScom high-speed serial card following the instructions in the next section of this manual. When the card has been successfully installed, note which COMM port number it installs to. In most cases it will install as COMM3. You will need to know which port it is installed on in order to complete the installation. If all is well, the port number will be three or more. If it appears to have installed on COMM1 or COMM2, contact the factory, as something is wrong. Move the serial cable that connects the power supply module to the PC to the connector on the new high-speed serial card. If you already have the high-speed card installed from installing the third release or later software, you can skip this step. As of release 7.7 the device drivers for this add on card will be installed in a folder under the A420 program, for example C:\A420\Drivers\VScom Drivers\. Please read the next section for a more detailed set of instructions. If you have a functional install of a previous version, it is not necessary to re-install these drivers.
3. Decide the order by which the machines should appear on the main screen of the program. Perform the instructions in the section on firmware upgrade for each machine. During the firmware upgrade procedure, assign an address of "1" to the machine that will appear on the top line of the form and "2" to the machine you wish to appear on the second line and so on. Continue this procedure on all machines. This is necessary to insure that all machines have a unique address. If two machines are programmed with the same address, results from both will be unpredictable. You will need the COMM port number determined earlier to run the firmware update software. See the section on firmware update procedures. If this succeeds, the add-in serial card is operating properly. You must upgrade the firmware on all machines connected to this PC.
4. Once all machines have had their firmware upgraded, start the new A420 program. The first time the program runs, it will prompt for the COMM port number. Use the same port number that was used to update the firmware. If the COMM port has changed on a machine that has had this program installed in the past, a menu item

appears on the program under the Machine heading that will allow you to change the COMM port number.

**WARNING** -- whenever changing the software in the display processor, always change the model of the machine. Use the model change procedure to change the model to the lowest value possible then increase to the proper value. Newer versions of the software do not store the model information in the same location as older versions do, causing the model setup pointers to be incorrect after a version update.

## **Installing the High Speed Serial Card and Drivers**

The instructions for installing the high-speed serial card each version of Windows. There is a section for each below. All of these installations assume that the A420 software has been installed first.

### **Windows 2000**

1. Turn off the computer and insure that the power cable is unplugged.
2. Install the add-in card into any free PCI slot in the computer.
3. Power up the computer and log in as administrator.
4. The Found New Hardware Wizard appears, and shows “Welcome to the Found New Hardware Wizard”.
5. Click on Next.
6. Windows 2000 searches for the driver files for PCI I/O port. From the listed boxes, choose Search for a suitable driver for my device (recommended) and click on next.
7. Windows will ask you where to search for the drivers. Check the box labeled Specify a location, and uncheck all the other selection boxes. Click on Next.
8. Use the browse button to select in sequence from the C: drive the folders “VScom drivers” then “Win2000” and finally “PCI\_Driver”. Click on OPEN and in the next window, OK. (example C:\A420\Drivers\VScom Drivers\Win2000\)
9. The next screen will show the driver files search results for “VScom PCI100HV2 driver”. Click on next.
10. When the Completing window appears, click on Finish.
11. A new “Found new hardware” window will appear. Click on next.
12. Windows 2000 searches for the driver files for VScom COM port. From the listed Box, Choose Search for a suitable driver for my device (recommended) and click on next.
13. Windows will ask you where to search for the drivers. Check the box labeled Specify a location, and uncheck all the other selection boxes. Click on Next.
14. Use the browse button to select in sequence from the C: drive the folders “VScom drivers” then “Win2000” and finally “PCI\_Driver”. Click on OPEN and in the next window, OK. (example C:\A420\Drivers\VScom Drivers\Win2000\)
15. The next screen will show the driver files search results for “VScom COMM port”. Click on next.
16. When the Completing window appears, click on Finish.

The drivers have been installed. To determine which COMM port the driver has installed to, right click on the “My Computer” icon on the desktop and choose Properties. Select the hardware tab and click on Device Manager. Click on the + next to VScom Multi IO cards to expose the item VScom PCI100HV2 controller. Double click on this item and select the advanced tab. The COMM port will be listed in the window. It must be COMM3 or higher to operate correctly with the Keiser A420. Record the COMM port number. You will need it later in the installation process.

### **Windows XP**

If it is necessary to install or re-install the VScomm drivers on a Windows XP machine, use only the drivers that are installed in the C:\A420\Drivers\VScom Drivers\WinXP folder by the Keiser install program. These are the drivers we have tested with at the factory and are the only drivers we will support.

**Windows Vista**

If it is necessary to install or re-install the VScomm drivers on a Windows Vista machine, use only the drivers that are installed in the C:\A420\Drivers\VScom Drivers\Vista folder by the Keiser install program. These are the drivers we have tested with at the factory and are the only drivers we will support.



## **Notes on ‘At the Handle’ Position and Force Conversions**

This section describes the conversions from force, velocity, and position at the cylinder to force, velocity, and position at the handle for those machines for which this option has been implemented. The saved data file is always saved in SI units and represents values at the cylinder. The conversions are made to the data as it is read in to the program to generate the graphs. Checking the “No Translation” box at the top of the form before opening a data file will disable the conversions. Only those models listed below have conversions enabled as of version 2.15.0.5. Since the conversions for many of these models have not been tested with data from actual machines, the possibility of arithmetic errors that have not been discovered exists. Should you locate what you believe to be a conversion error, please let us know. Note that errors if present will only affect the graphing of position, velocity and force at the handle. The translation software does not modify the power data. Should an arithmetic error be discovered, since the data saved is at the cylinder data, a revised program will be able to show data captured with this or any older version of the software with the error corrected. Note that only those models listed below have the ‘at the handle’ translation feature enabled. All other machines will display values as ‘at the cylinder’.

### Model 1121 Air 250 Leg Extension 120 degree

The conversions for this machine are the same as those for the 1122 below with the range limiter portion of the calculations removed. See below.

### Model 1122 Air 250 Leg Extension 120 degree, with range limiter

The conversions for this machine are based on the design dimensions of the machine and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocity are given in angular units, either degrees or radians (per second for velocity). Force is given in units of torque, either Newton-meters or foot-pounds. Range of motion conversions have been verified on an actual machine. Since the mechanics of this machine are varied by changing the range of motion setting, it is necessary to set the range of motion setting on the user display to match that on the machine. Not matching the setting on the display to the setting on the machine will result in incorrect data displaying for range of motion and user force at the handle. Correcting for this kind of error after the fact is difficult.

### Model 1131 Air 300 Dual cylinder Leg Extension 120 degree

The conversions for this machine are based on the design dimensions of the machine and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocity are given in angular units, either degrees or radians (per second for velocity). Force is given in units of torque, either Newton-meters or foot-pounds. The conversion for this model machine has not been checked on an actual machine, only verified by hand calculations.

### Model 1222 Air 250 Leg Curl with range limiter

The calculations for this machine are very similar to those for the 1122 machine. The conversions have been verified on an actual machine.

#### Model 1231 Air 300 Dual cylinder Leg Curl

The conversions for this machine are based on the design dimensions of the machine and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocity are given in angular units, either degrees or radians (per second for velocity). Force is given in units of torque, either Newton-meters or foot-pounds. The conversion for this model machine has not been checked on an actual machine, only verified by hand calculations.

#### Model 1335 and 1336 Air 300 Biaxial Chest Press

The conversions for these machines are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocity are given in linear units, either meters or inches (per second for velocity). Force is presented in linear units, either Newtons for SI units or pounds for Imperial units. Force is calculated with the assumption that the force vector is perpendicular to the seat back throughout the range of motion.

#### Model 1431 Air 300 Shoulder Raise

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocity are given in angular units, either radians or degrees (per second for velocity). Force is given in units of torque, either Newton-meters or foot-pounds. The conversion for this model machine has not been checked on an actual machine, only verified by hand calculations.

#### Model 1531 Air 300 Squat

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocities are given in linear units, either meters or inches (per second for velocity). ROM and Velocity are arc travel of the tip of the exercise arm. Force is presented in linear units, either Newtons for SI units or pounds for Imperial units. The conversion for this model machine has not been checked on an actual machine, only verified by hand calculations.

#### Model 1621 Air 250 Military Press

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocities are given in linear units, either meters or inches (per second for velocity). ROM and Velocity are arc travel of the tip of the exercise arm. Force is presented in linear units, either Newtons for SI units or pounds for Imperial units. Force is assumed to be a vector parallel to the seat back.

#### Model 1721 Air 250 Arm Curl

This machine was instrumented with a range of motion sensor and data collected with A420 electronics to build a position translation table. This method produces translations that make for more visible noise on the force curves than the trig methods

used by other machines. While the noise is visible on the graph, it does not make the data unusable. The accuracy is excellent with this technique. Data is displayed as rotary motion values in either SI or Imperial units.

#### Model 1921 and 1931 Air 250 Tricep, Air 300 Tricep

The conversions for these machines are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the handle. Since these machines share a common design, the calculations are the same. Range of motion and velocities are given in linear units, either meters or inches (per second for velocity). ROM and Velocity are arc travel of the tip of the exercise arm. Force is presented in linear units, either Newtons for SI units or pounds for Imperial units. Force is assumed to be a vector parallel to the seat back. The conversion formulas were taken from the A400 series of research machines.

#### Model 2021 Air 250 Upper Back

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocities are given in linear units, either meters or inches (per second for velocity). ROM and Velocity are arc travel of the tip of the exercise arm. Force is presented in linear units, either Newtons for SI units or pounds for Imperial units. The force vector is assumed to be parallel to the floor.

#### Model 2035 Air 300 Upper Back

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocities are given in linear units, either meters or inches (per second for velocity). ROM and Velocity are the vertical motion of the center of the exercise arm handle. Force is presented in linear units, either Newtons for SI units or pounds for Imperial units. The force vector is assumed to be perpendicular to the frame of the machine.

#### Model 2121 Air 250 Lat Pulldown

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocities are given in linear units, either meters or inches (per second for velocity). ROM and Velocity are the vertical motion of the center of the exercise arm handle. Force is presented in linear units, either Newtons for SI units or pounds for Imperial units. The force vector is assumed to be perpendicular to the floor. The calculations have been verified on an actual machine. The calculation formulas were taken from the A400 series of research machines.

#### Model 2235 Seated Butterfly

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocity are given in angular units, either radians or degrees (per second for velocity). Force is given in units of torque, either Newton-meters or

foot-pounds. Due to the design of this machine which used a single air cylinder for both handles, the range of motion and velocity values at the handle will only be correct if both handles are moved in unison. If the subject uses only one arm, the range of motion, force, velocity and acceleration displayed on the graphs will be incorrect. The power values will always be correct. All values are combined values assuming both limbs are in use. The conversion for this model machine has not been checked on an actual machine, only verified by hand calculations

#### Model 2331 Air 300 Abductor

The conversions for this model machine are done with a lookup table generated from a CAD model of the cam used in the machine. Range of Motion and velocity are given in angular units, either degrees or radians (per second for velocity). Force is given in units of torque, either Newton-meters or foot-pounds.

#### Model 2431 Air 300 Adductor

The notes for the 2331 apply to this model also.

#### Model 2521 Air 250 Leg Press

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the pedal. Range of motion and velocities are given in linear units, either meters or inches (per second for velocity). ROM and Velocity are arc travel of the pedal. Force is presented in linear units, either Newtons for SI units or pounds for Imperial units. Force is assumed to be a vector parallel to the floor.

#### Model 2531 Air 300 Leg Press

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the pedal. Range of motion and velocities are given in linear units, either meters or inches (per second for velocity). ROM and Velocity are arc travel of the pedal. Force is presented in linear units, either Newtons for SI units or pounds for Imperial units. Force is assumed to be a vector parallel to the floor. Small errors in the dimensions used for the calculations for this machine were discovered prior to the fourth release software. The changes will make a small difference in the graphs of force at the pedal and velocity at the pedal. The errors will not affect any of the power values. The formulas were taken from the A400 line of research machines. The A400 series used the same erroneous dimension data and suffered from the same small errors as the first four release versions. As of release 9.3.5 the minimum resistance has been reduced on this model. This allows the machine to be used as a training machine with very low resistance values. Data collected at these very low settings will not be of a good quality for research purposes.

#### Model 2621 Air 250 Standing Hip

The conversions for this machine are based on test run on an actual machine that show a straight linear conversion from cylinder motion to rotary motion that is within less than 2 degrees over the range of motion. Range of Motion and velocity are given

in angular units, either degrees or radians (per second for velocity). Force is given in units of torque, either Newton-meters or foot-pounds.

#### Model 2721 Air 250 Abdominal

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocity are given in angular units, either radians or degrees (per second for velocity). Force is given in units of torque, either Newton-meters or foot-pounds. The conversion for this model machine has not been checked on an actual machine, only verified by hand calculations.

#### Model 2821 Air 250 Lower Back

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocity are given in angular units, either radians or degrees (per second for velocity). Force is given in units of torque, either Newton-meters or foot-pounds. The conversion for this model machine has not been checked on an actual machine, only verified by hand calculations.

#### Model 2822 Air 250 Lower Back with Range limiter

The conversions for this machine are based on the design dimensions of the machine and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocity are given in angular units, either degrees or radians (per second for velocity). Force is given in units of torque, either Newton-meters or foot-pounds. Since the mechanics of this machine are varied by changing the range of motion setting, it is necessary to set the range of motion setting on the user display to match that on the machine. Not matching the setting on the display to the setting on the machine will result in incorrect data displaying for range of motion and user force at the handle. Correcting for this kind of error after the fact is difficult.

#### Model 2936 Air 300 Seated Calf

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the pedal. Range of motion and velocities are given in linear units, either meters or inches (per second for velocity). ROM and Velocity are arc travel of the pedal. Force is presented in linear units, either Newtons for SI units or pounds for Imperial units. Force is assumed to be a vector from the kneepad to the center of the pedal. The formula was taken directly from the older A400 research machines.

#### Model 3000 Performance Zone

The conversions for this machine are based on design dimensions and trig conversions from measured values at the cylinder to calculated values at the handle. Range of motion and velocities are given in linear units, either meters or inches (per second for velocity). Force is presented in linear units, either Newtons for SI units or pounds for Imperial units.

## Model 3020 Functional trainer

Conversions for the FT are based on the math created for the 3000, which has a very similar mechanical design. The translations produce data that will be correct for one rope used at a time. Power data is always correct whether or not both ropes are used simultaneously, however position, velocity and acceleration are a combination when both ropes are used. Range of motion and velocities are given in linear units, either meters or inches (per second for velocity). Force is presented in linear units, either Newtons for SI units or pounds for Imperial units. As of release 9.3.5 the minimum resistance has been reduced on this model. This allows the machine to be used as a training machine with very low resistance values. Data collected at these very low settings will not be of a good quality for research purposes.

### Future Revisions

Please email comments on operation of the A420 software or any other suggestions for future improvements to [A420@keiser.com](mailto:A420@keiser.com).

### Service

Should field service or software troubleshooting be required, we use the Internet to diagnose machine problems by remote control. A working Internet connection to the PC will be required to diagnose problems with the machine.

**Keiser Service Department  
2470 South Cherry Ave  
Fresno, CA 93706  
1-800-888-7009 Toll Free  
1-559-256-8000 Direct Dial  
service@keiser.com Email**