LoadForce-250™ and LF-Scope™

LoadForce-250 with version 3.5 firmware

LF-Scope version 2.2

LoadForce, *LoadForce-250* and *LF-Scope* are trademarks of Southwest Products

Table of Contents

Features

- Selectable arbor press or “standard” reloading press. *
- Seating force or recoil force measurements.
- Displays the force needed to start the bullet sliding in the case neck in pounds.
- Displays felt recoil in pounds along with the time duration of the recoil pulse.
- Performs a Moving Average Range analysis of seating forces to determine process control limits. Once five rounds have been seated, the LCD screen will show the High and Low limits of the range. Two asterisks note any rounds that fall outside the range limits.
- Statistics are “remembered” when the unit is powered off.
- Powered by a 9 volt DC wall transformer (included) or a 9 volt alkaline battery.
- When running from a battery, low battery voltage is detected. No further measurements are allowed and the unit warns the user the battery must be replaced.
- Each *LoadForce* sensor has an associated Calibration Key containing specific data for that particular sensor.
- Accessory and replacement sensors are available separately.
- *LF-Scope* software and a *USB Instrument Adapter* are included for plotting, saving and reviewing seating force and recoil force curves.
- A stand for holding the sensor while performing recoil force measurements is included.

* An optional support ring to help use the sensor with an arbor press is available from Recreational Software Inc. The support is not required but it makes operation much easier.

Product Support

For product support questions please contact your dealer.

If you purchased *LoadForce-250* through Recreational Software, Inc., please contact them at www.shootingsoftware.com/support.htm

Credits

Much credit is due to Denton Bramwell at the Promontory Management Group Inc. in Layton, Utah for the Natural Process Limits calculations we are using. To find out more about process control and Six Sigma, contact PMG at http://www.pmg.cc/.

Definitions

Static Friction – The force that must be overcome to initiate the motion of one body relative to another because they have been resting in contact. Also known as starting friction. In our case, the force that holds a bullet in a case neck when the bullet is not moving.

Dynamic Friction – The force that must be overcome to maintain steady motion of one body relative to another because of their contact. In our case, this is the force resisting the movement of a bullet in the case neck while the bullet is moving. This force is lower than static friction.

Bullet Movement Force – This is the force that is required to start the bullet moving in the case neck. It is the same as Static Friction.

Take Up Force - This is the force applied to a bullet before the force needed to make the bullet move in the case neck is reached. It is less than the bullet movement force. If you seat a bullet, then run the cartridge back into the seating die, you will be able to read a force that is applied to the bullet. However the bullet is not pushed deeper into the case neck. The Take Up Force is a part of the Bullet Movement Force.

Alignment Chamber Spring Force – This force is applied by the sliding chamber spring in competition seating dies.

LoadForce-250

Identifying The Parts

LoadForce-250 components

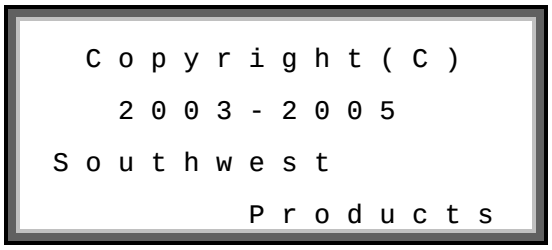
- *LoadForce-250* module.
- Force sensor assembly that can attach to the top of a reloading press just like a shell holder.
- Calibration Key for the force sensor assembly. Each force sensor has its own set of calibration data stored on a key numbered the same as the sensor assembly.
- Sensor cable. One end of the cable is attached to the unit with a detachable terminal block, the other end has a connector for the force sensor.
- Recoil Force Sensor Stand (does not include a force sensor assembly)
- 9 volt DC wall transformer.
- A CD containing the *LF-Scope* program, the drivers for the *USB Instrument Adapter* and documentation.

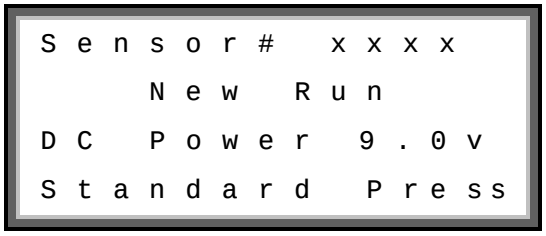
Accessories

- Extra force sensor assemblies
- Arbor press adapter

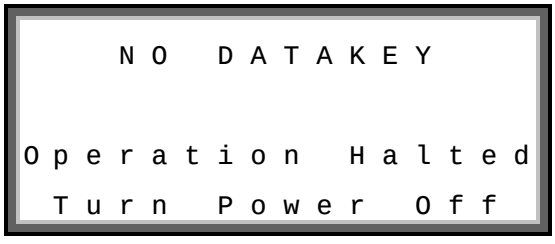
Turning On The Unit

Connect the wall transformer to the *LoadForce-250* module. Plug in the sensor cable and attach the force sensor assembly to the cable. Insert the calibration key in the socket on the right side of the unit. Slide the Power switch forward. The unit will turn on and display the following screens while it initializes and performs power on checks.





If you haven't plugged the Calibration Key into the socket on the right side of the module, you'll see the following screen instead of the one immediately above. The unit will give 6 quick beeps to warn that this error has occurred.



If all the power on checks pass, you will be taken to the Ready prompt.


R e a d y

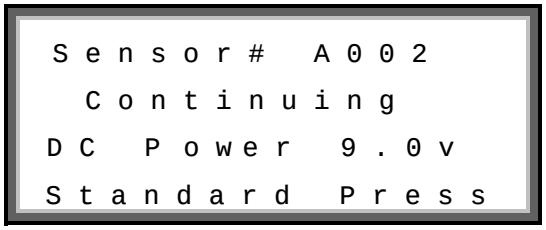
Getting Ready To Run

Before you can take any seating or recoil force measurements, the *LoadForce-250* sensor must be conditioned. You only have to do this once a day. See the chapter on Sensor Conditioning.

When the sensor has been conditioned you need to determine if you need to calibrate your seating die. See Die Calibration. Refer to the Operation chapter for how to make actual seating force measurements.

Continuing Measurements After Power Off

All statistical calculations are stored in non-volatile memory while you are in the process of seating bullets and making seating force measurements. The non-volatile memory does not require any type of backup power source. If you are running from battery and the battery dies, just replace the battery and turn the unit on again. You can turn the unit off at any time and then start it up again later to finish what you were doing.



Note the second line in the unit startup information screen. The word “Continuing” indicates that the unit was shut off without clearing statistical and measurement information. If it has been less than 24 hours since you stopped making measurements, you can just go ahead and finish what you were doing. (If it has been more than 24 hours you should perform the Sensor Conditioning procedure before making more measurements.)

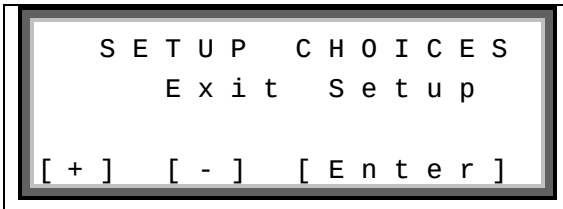
If you don’t want to continue the measurements you were making, just go into the Setup menu and choose the selection to Clear Statistics And Measurements.

If you have cleared statistics and measurements before turning off the unit, the second line of the startup information display will display “New Run” on start up.

Setup Menu Organization

Pressing the [Setup] button at the Ready prompt puts your *LoadForce-250* into setup mode. The second line in the Setup Menus will show the action to be performed when you press the [Enter] button. You scroll through the available menu choices using the [+] and [-] buttons.

Main Setup Menu



Press [+] and [-] to scroll through the menu.

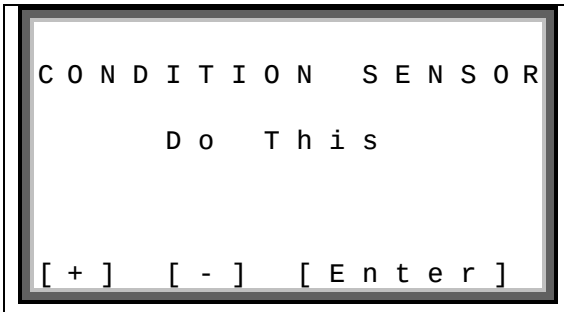
The menu choices available here are:

1. Exit Setup
2. Condition Sensor
3. Tare
4. Clear Statistics
5. Change Press
6. Show Unit Info

Press [Enter] to select your menu choice.

The various setup menu choices are shown in more detail on the following pages.

Condition Sensor Menu



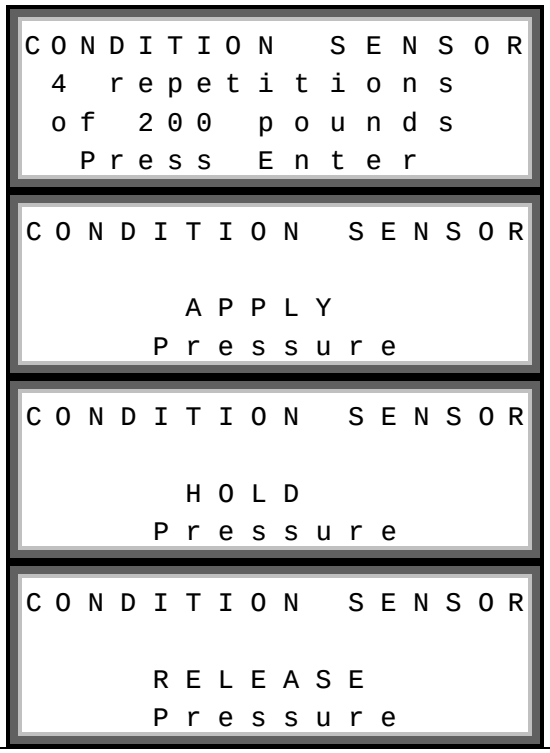
Press [Enter]

OR

Press [+] or [-] to display the menu choice “Exit to menu”.

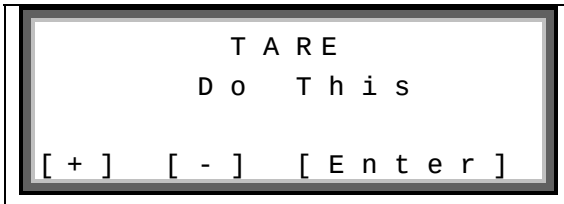
See the Sensor Conditioning chapter for more information.

This is a reminder that there will be 4 repetitions of the Apply/Hold/Release cycle.



After the 4th time you apply pressure you will be taken directly to the main Setup menu screen with the choice “Exit Setup” already shown.

Tare Menu



Press [Enter]

OR

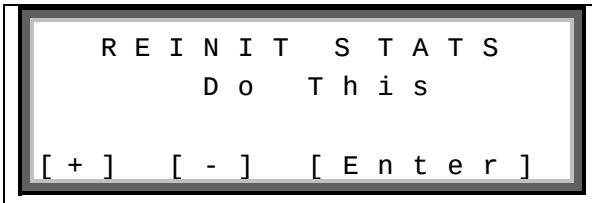
Press [+] or [-] to display the menu choice “Exit to menu”.

See the Tare / Die Calibration chapter for more information.

Place a resized case, without a bullet on the sensor anvil. Raise and lower the press ram.

The measurement will be made and you will be taken directly to the main Setup menu screen with the choice “Exit Setup” already shown.

Clear Stats Menu



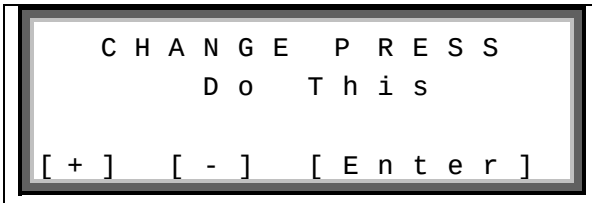
Press [Enter]

OR

Press [+] or [-] to display the menu choice “Exit to menu”.

You will be taken directly to the main Setup menu screen with the choice “Exit Setup” already shown when the operation is completed.

Change Press Type Menu



Press [+] or [-] to display the menu choice “Exit to menu”.

OR

Press [Enter] and the “Do This” choice will be replaced by “Arbor Press”.

Use the [+] and [-] buttons to select the type of press in use.

When you have selected the press type, press the [Enter] button. You will be taken directly to the main Setup menu screen with the choice “Exit Setup” already shown when the operation is completed.

Unit Information Menu

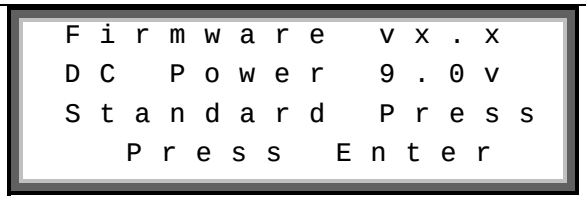
If you have selected the Show Unit Info menu choice, you will be taken directly to this screen.

Line 1: The firmware version currently installed

Line 2: The battery or DC power supply voltage

Line 3: The type of press (arbor or standard) currently selected.

Press the Enter button to exit back to the setup menu.



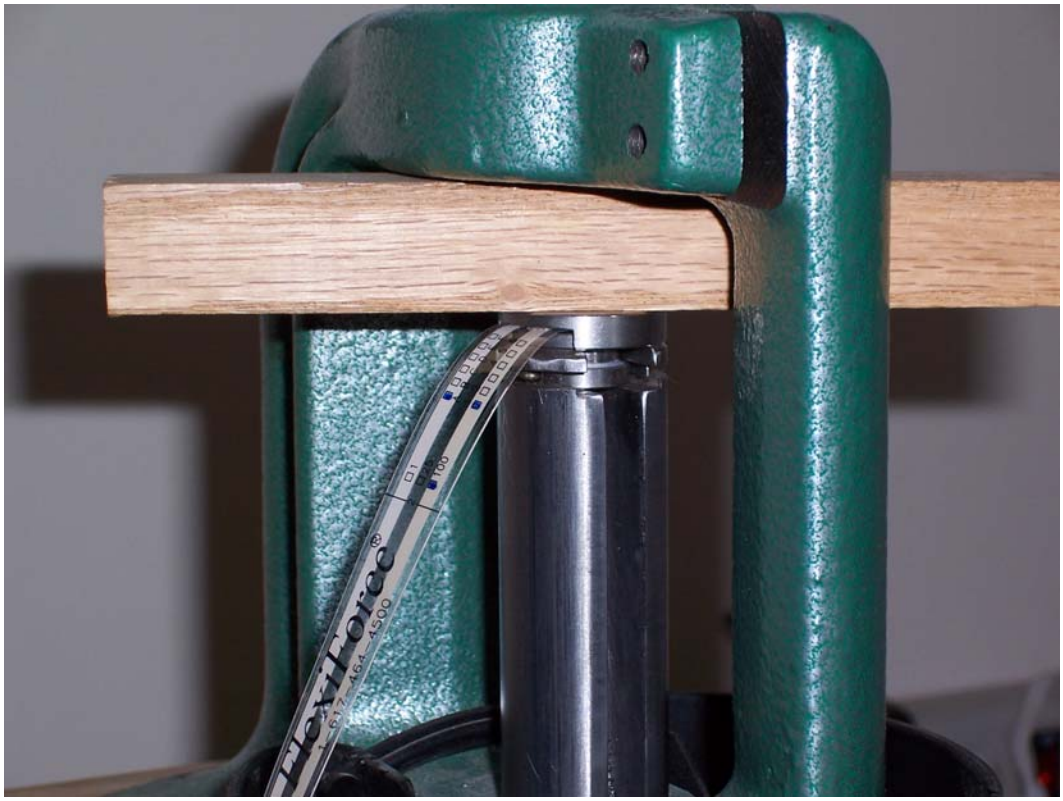
Sensor Conditioning

The sensor used to convert pressure to an electrical value must be conditioned at the beginning of each daily session. To condition the sensor enter the Setup menu and choose the sub-menu for Sensor Conditioning.

Place a block of some sort on top of the sensor anvil (wood, Delrin, etc…). Follow the instructions given on the screen. You will be raising the press ram until the block contacts the press frame and applying pressure against the press frame.

When told to APPLY pressure, don't just lean on the press lever. Build up the force somewhat slowly. The unit will tell you when you have reached the correct pressure by telling you to HOLD. After about five seconds the screen will tell you to RELEASE the pressure. Completely release the pressure so that there is no force being applied to the sensor.

You will be repeating the APPLY/HOLD/RELEASE process four times.



Setup for conditioning the sensor

Tare / Die Calibration

Die Calibration is the process of "nulling" the Alignment Chamber Spring Force in competition seating dies, (See Definitions) so that we only detect the total force that is required to make a bullet start to move in the case neck.

Resized case ready for Die Calibration

This is of particular concern for those using very little case neck tension, as the seating force may be less than the force applied by the chamber spring. By nulling the spring force it is possible to detect a seating force as small as three pounds.

Enter the Setup menu and choose the Tare sub-menu. Follow the on-screen instructions.

Operation

To properly measure seating forces, the following procedure should be used.

Note: Your seating die should not be attempting to apply a crimp to the case mouth during the seating operation.

Pre-Seating and Calibration

- Make sure that all cartridges to be reloaded have been properly resized and primed.
- Fill the cases with the desired amount of powder.
- Using the regular shell holder for that cartridge, pre-seat all the bullets in their cases.

> NOTE: For proper comparison all bullets should be seated to the same depth in this pre-seating stage.

Final Seating and Measuring Seating Force

Install the *LoadForce-250* sensor anvil on the press ram with the unit turned OFF and adjust your seating die to the final seating depth.

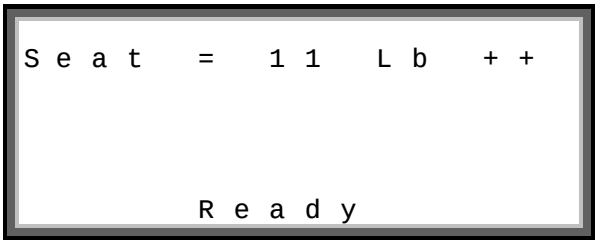
> NOTE: If the unit is turned on, multiple measurements may be recorded while adjusting the seating depth. You can clear these measurements using the Setup menu.

A bullet ready to be seated

- Turn ON the *LoadForce-250* unit.
- If required, perform Sensor Conditioning.
- If you are using a Competition Seating Die, perform the Die Calibration function using a correctly sized cartridge case without a bullet.
- For the first 5 cartridges, seat the bullets and make a note of the force required for each cartridge.
- Seat the 6th cartridge. Upper Limit and Lower Limit values will be displayed.

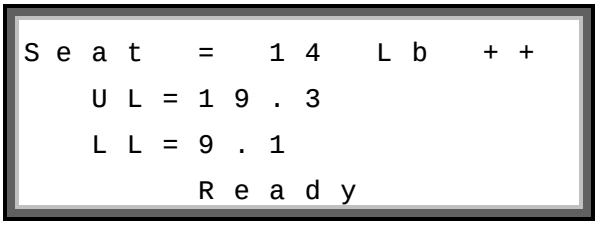
> NOTE: These limit values will give you a very rough idea of where your seating forces will be. Enough, that you can construct your sorting chart. See the chapter titled Sorting By Seating Force Value for more in depth information.

A " + +" displayed after the seating force means the value has been included in the statistical calculations. A "- -" indicates the value has been discarded from the calculations. A "**" indicates that you need to determine what to do with the measured value. These are quick indicators. If required, instructions will be shown on the display.

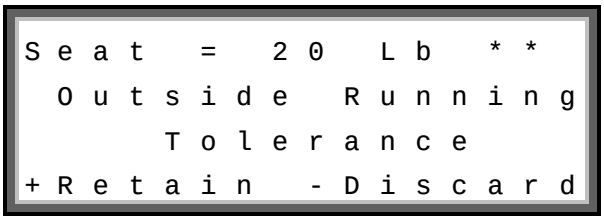


Any cartridges that require much higher, or much lower, seating force than the bulk of the cartridges loaded, will have a different pressure curve. See Control Limits Calculations for a more in depth explanation.

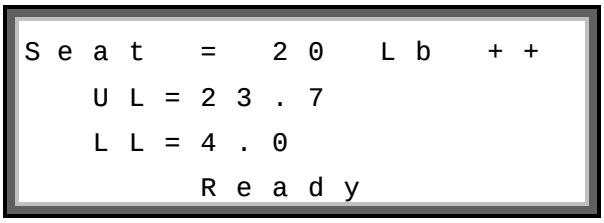
Starting with the 6th cartridge, the Upper Limit and Lower Limit of the average range will be displayed along with the actual seating force. The seating force for the first five cartridges should be written down. Once the sixth cartridge is seated and the control limits are known, the first five can be compared to those control limits manually.



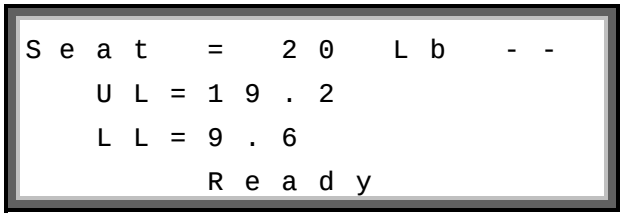
For any cartridges with a seating force that exceeds the calculated control limits you will have the option of keeping the cartridge or discarding it.



If you choose to keep that cartridge, press the Yes button. The seating force value will be used in the control limits calculations and the display will change to look like this:



If you choose to discard the cartridge from the statistical calculations, press the No button and the display will look like this:



Discarding a cartridge means that the seating force value will not be added to the control limits calculations. Whether you actually fire the cartridge or not is up to you. It could be used as a fouler.

To shoot groups, make sure that the cartridges in each group have seating forces as similar as possible.

Control Limits Calculations

Consistency is essential to high-precision shooting. To aid you in maintaining consistency, *LoadForce-250* has built in process control calculations for calculating the Natural Process Limits of the neck tensions you measure.

If all your data falls within the limits, your neck tension is stable and predictable. In other words, you are processing your cases consistently and they all have similar neck tension, hardness, etc….

If the data does not fall within the limits, you almost certainly have some source of variation in your process that should be found and eliminated. In other words your cases do not have similar neck tension, hardness, etc… and you need to figure out why. For instance, it could be due to old brass that has grown hard.

In a stable and predictable process, practically all the data will fall between the upper and lower Natural Process Limits. As you gain experience, you will be able to decide whether you need to work on bringing your Natural Process Limits closer together.

Batches as small as six will give useful results, but you should regard the centerline and limits as "fuzzy" rather than "crisp". By the time you have 24 cartridges in a batch, the centerline and limits will be very well defined.

If you find an unusual case, you will probably want to eliminate it from the lot. If you do that, the data for that cartridge should also be deleted from the data set. The *LoadForce-250* module will assist you by letting you determine whether a cartridge that exceeds the control limits should be kept or not.

Sorting By Seating Force Value

In order to make the best use of *LoadForce-250* you need to organize the cartridges you measure by the seating force value. Once you've done that you can easily choose to shoot cartridges of identical, or similar seating force. This removes one more set of variables from the best accuracy formula.

In the past you may well have spent a lot of time preparing your brass, trimming necks, annealing brass, etc… When you think about it, you were spending all that time on the case necks to try and regularize the seating force across all your cartridges. What you never really could get a good handle on was whether or not all that work did any good until you shot them. Now you can measure the resulting seating force and correlate that to your groups on the target. You will also see if some of the brass needs more work, or to be discarded.

Cartridges sorted by seating force

Pictured above is a simple way to sort cartridges by their seating force. When you get the first Upper Limit and Lower Limit values with the 6th cartridge, add about 20 to the upper limit and subtract 20 from the lower limit. Lay out masking tape and mark it with values between those numbers. Leave yourself plenty of room between the numbers so that you can reach the columns easily. (Believe me. You don't want to knock them over.) You might want to invest in a set of small plastic bins. Just mark each bin with a force value and put the seated cartridges into the bins.

In the picture, notice that the sorted cartridges create a bell shaped curve. Most of those cartridges have seating forces in a narrow range of only four pounds. That's pretty good. However, there are some cartridges that are in the wings of the bell curve, not grouped in the center.

If more of the same cartridge were to be loaded and sorted, we would expect the center four columns to get much larger. We wouldn't be surprised to find that the adjacent columns filled in some more either. Unfortunately, the number of cartridges out along the wings might also increase.

It appears, by extrapolating from the data represented by this curve, that these case necks need more work.

Obviously, we'll still use the cartridges that are not centered in the bell curve. We'll just make sure that each group only uses cartridges with identical seating force values.

Finding The Best Seating Force

Another way to use *LoadForce-250* data is to help determine the best amount of neck tension for a load. Load your cartridges with intentionally different neck tensions by changing your neck resizing bushing or neck thickness. Sort the cartridges by their seating force, but don't worry about creating a nice bell shaped curve. When you shoot the groups, correlate each target with the seating force / neck tension value. Examination of the targets will tell you the best neck tension to use for that load.

Crimp Force Measurement

In addition to measuring the bullet seating force, you can also use *LoadForce-250*™ to regularize, or detect problems with, the force that is used to crimp bullets in the case neck.

NOTE: This crimp force measurement should not be attempted at the same time bullets are being seated. We strongly recommend performing any case neck crimping as a separate operation.

If two cartridges have different neck thickness, when you run the cartridge into the crimp die the same distance the amount of force exerted on the bullet will be different. These two cartridges will have different internal ballistics. By performing the crimp operation while monitoring force with *LoadForce-250* you will be able to see the difference. You can then segregate those loads that have different crimp forces.

If you are sure all your brass has regular neck thickness, you can use *LoadForce-250* interactively to insure that the same crimp force is applied to each cartridge. Alternatively, this can tell you if you have neck thickness variations from cartridge to cartridge.

The easiest way to monitor crimping force is to put the *LoadForce-250* module into it's Indicating mode. Press the [- / Indicate] button when the Ready prompt is showing and the display will change to "Indicating". In this mode *LoadForce-250* acts much like a scale. It displays any forces that are applied to the anvil immediately. There are no statistics calculated in this mode. Press the [-] button to exit the Indicating mode.

Recoil Force Measurement

The *LoadForce-250* module may be used to quantify the felt recoil of a rifle. To measure recoil force you will need to use the Recoil Force Sensor Stand to hold the force sensor in the proper position behind your rifle.

About Recoil Force

Recoil force is very subjective. A rifle that one person thinks has unbearable recoil may actually feel mild to someone else. Anecdotal evidence suggests that larger, heavier people feel recoil worse than those of lighter build. This is because those larger people have more inertia and they can't be moved by the rifle's recoil as easily. As a result their flesh and muscles are compressed further by the recoil impulse.

Recoil pads and even the material a rifle stock is made of can make a large difference in perceived recoil. In the case of recoil pads they work by "spreading out" the time that recoil force is transmitted thus lowering the peak value in the process. The total recoil force, as energy, cannot be changed for a given load in a given rifle. Only the way it is perceived.

When measuring recoil force using *LoadForce-250* you are not measuring free recoil energy or free recoil velocity, you are measuring the actual force, in pounds, that is applied to your shoulder by recoil.

If there is substantial friction between your rifle and the rifle rest, this will reduce the force that you feel during recoil.

Measuring Recoil Force

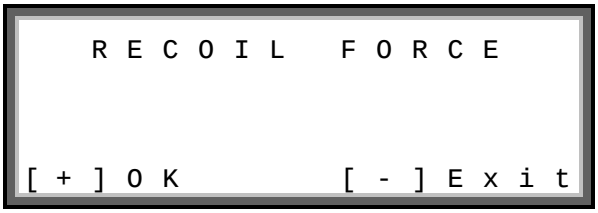
Note: Do not attempt to place the measurement stand against something solid such as a wall or a tree. You are likely to break your rifle stock. If you cannot stand the recoil of the firearm you are testing, a large sandbag (100 pounds) placed in the same position that your shoulder would occupy is a potential substitute.

Rifle set up for making recoil measurements. (*LoadForce-250* module not shown for clarity.)

To make Recoil Force measurements you first need to set up your rifle on a rest. Make sure that the rifle is aimed at a safe bullet impact area. Now set up the Recoil Force Sensor Stand behind the butt of the rifle. Remember that the rest should have as little friction against the rifle as possible.

Connect the sensor to the sensor cable, plug the cable into the *LoadForce-250* module and turn on the module.

When the rifle is ready to fire, with your shoulder against the pad on the recoil stand, press the [+/Recoil] button on the module.



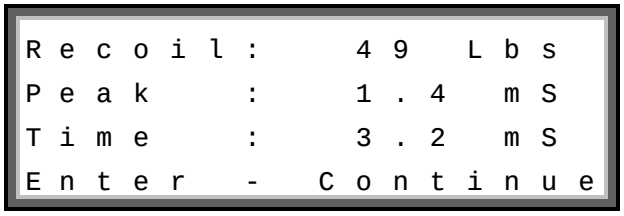
Press the [+] button and the screen will change to this:

You must apply some force to the recoil measurement stand with your shoulder. The best method is to hold the rifle against your shoulder just as you normally would to maintain control during firing. The "trick" is that you want to make sure that the recoil force stand does not turn at an angle while you are applying pressure. For proper operation the recoil force must be applied as close to on axis as possible.

The screen will display the force that you are applying on the third line of the LCD screen. When the unit has determined that the force has been steady for 4 seconds, the unit will beep three times very quickly and the screen will change to this:

While maintaining your steady pressure against the recoil force stand, take the shot. The screen will display the peak force in pounds and the total time that any force was applied in milliseconds.

> NOTE: If you jerk the trigger when firing, the trigger pull will start the unit capturing data. Your peak recoil force will show up correctly but the time will be inflated by the amount of lock time for your firearm.



Press [Enter] to continue and you will be taken back to a screen where you can choose to perform another recoil test, or exit back to taking seating force measurements.

Viewing The Recoil Curve

To view the actual recoil force curve in detail you need to have the *LF-Scope* software running with the USB Instrument Adapter connected. The recoil curve data will be transmitted automatically to the PC when it is captured.

DC Power

LoadForce-250 can be powered by either a 9 volt battery or the supplied DC wall transformer.

DC Power Supply

- 2.1 millimeter coaxial jack, center positive
- 7.5 to 16 volts DC (9 volts nominal)
- 50mA minimum

Battery Life

Normally you will want to run the unit from the supplied DC wall transformer. Optionally, you can run from a 9 volt battery for about 18 hours*.

If you've been taking seating force measurements but you want to take a break, just turn off the power to the unit. All statistical calculations are saved to non-volatile memory as they are made. When you are ready to start again, turn on the unit and continue from where you left off.

*These measurements were made with a fresh, Energizer Max 9 volt battery. Your actual battery life will vary.

LCD Screen Adjustment

To adjust the contrast of the LCD insert a small screwdriver (either Phillips or straight blade) in the hole in the rear of the unit until it engages the adjustment screw. Turn the screwdriver until the screen contrast is where you want it. This adjustment may need to be changed depending on ambient light conditions and your viewing angle.

Note that as a battery discharges, the screen contrast may need to be adjusted for optimum viewing.

Ambient temperature can also affect the LCD contrast and may necessitate a contrast adjustment.

LF-Scope

In the process of determining both recoil forces and seating forces, *LoadForce-250* collects quite a bit of data. Once the forces that are going to be displayed on the module's LCD screen are determined, the rest of the data is, normally, thrown away.

The *LF-Scope* program shows the information about the recoil force or seating force curves plotted in graphical format. The information about the curves can be saved to disk for further manipulation if desired.

With the *LF-Scope* program running, the *LoadForce-250* module automatically sends all the data it collects to the PC when the calculations are finished.

When the module collects seating force data, one reading is taken every 2 milliseconds for one second. When recoil force data is collected, one reading is taken every 200 microseconds for 51 milliseconds.

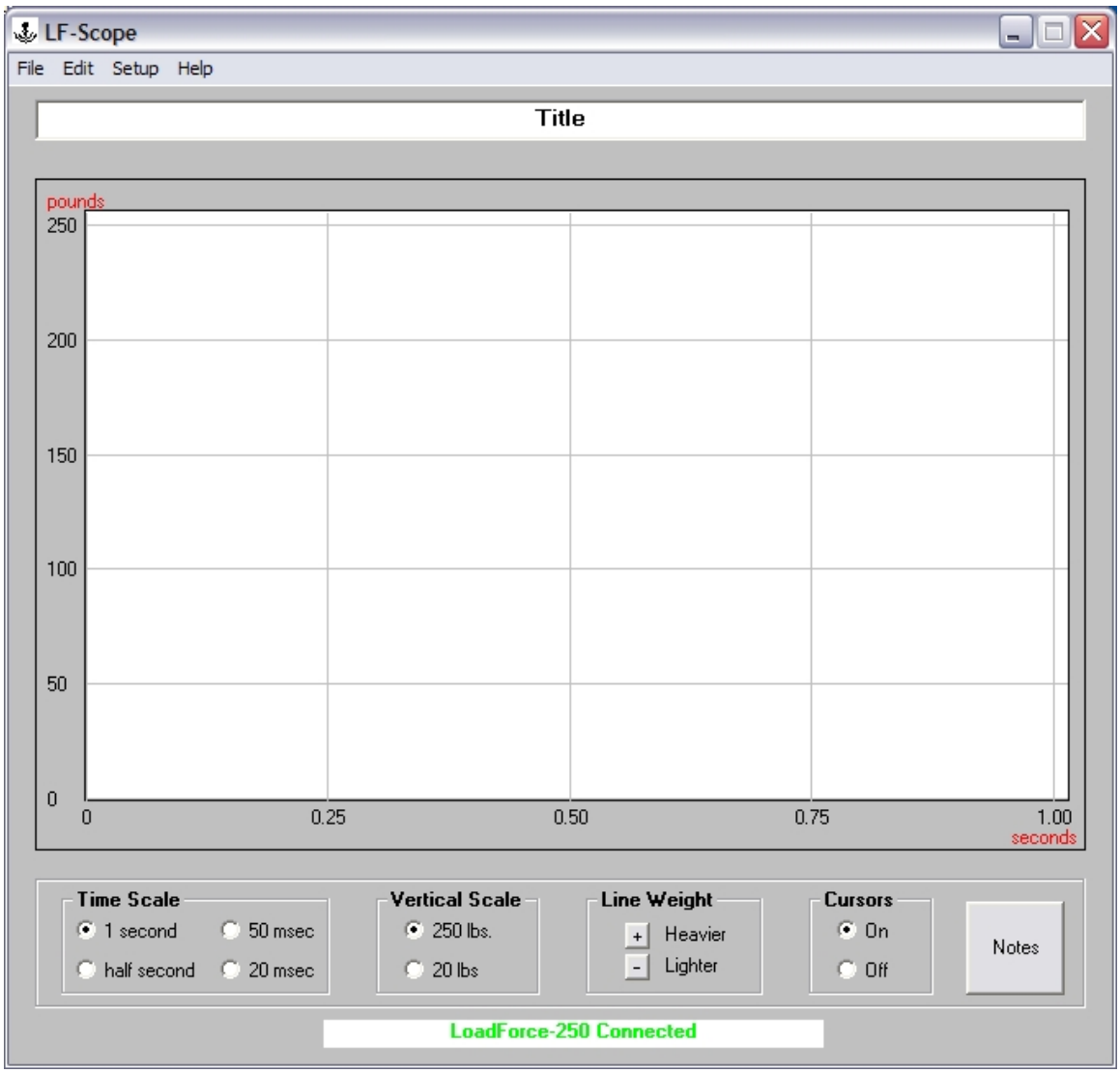
Connecting the *LF-Scope* program

You connect the *LoadForce-250* unit and the *LF-Scope* program with a USB Instrument Adapter (USBIA). The USBIA plugs into the 8 pin RJ45 connector on the left side of *LoadForce-250* and also into a USB port on your PC.

Look for installation instructions in a PDF file name USBIA Install.pdf either on the product CD or in the directory where you installed the LoadForce programs and documentation. Follow those instructions to connect the USBIA to your computer and install any necessary driver programs.

Starting the module and the software

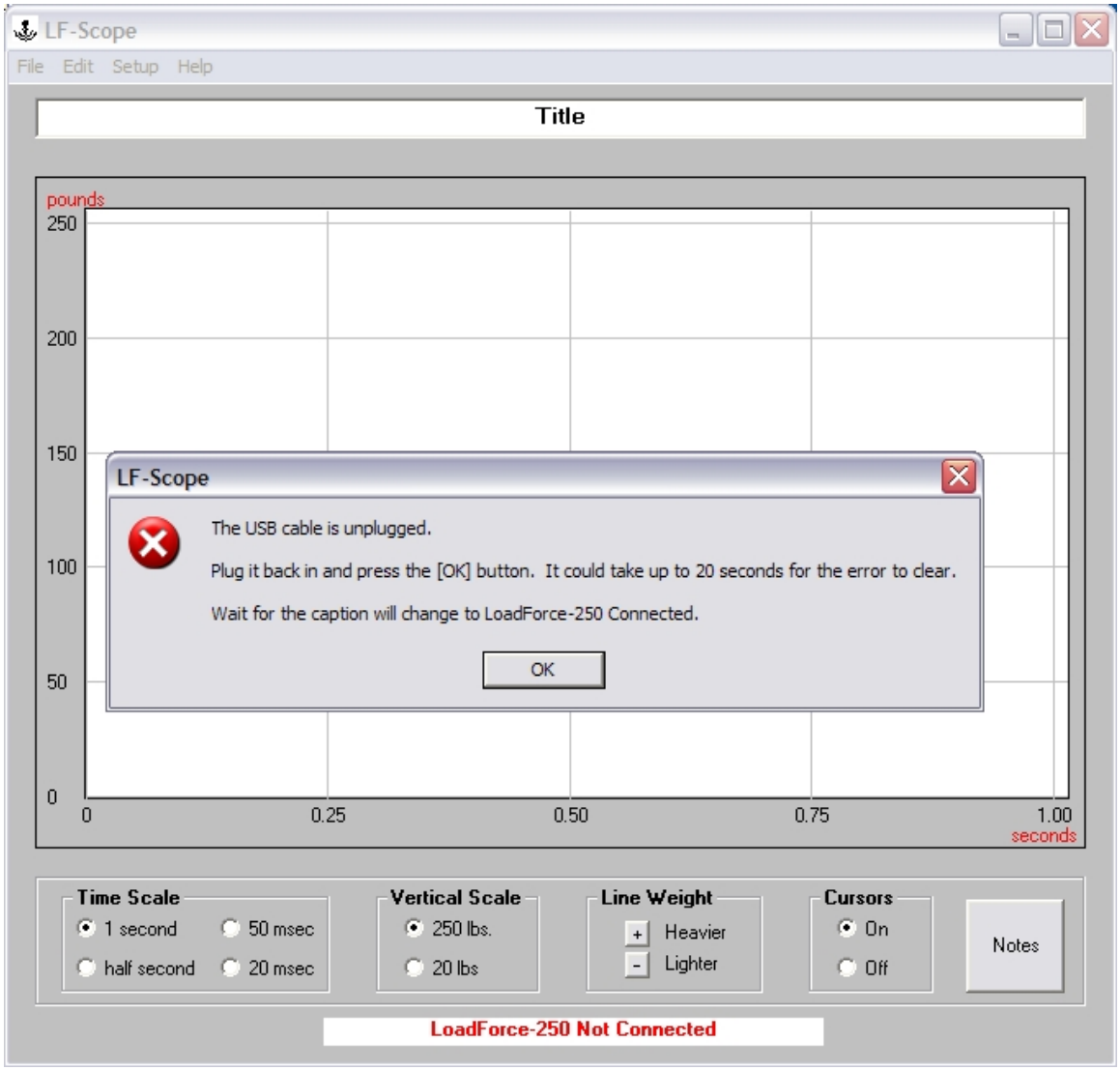
When you start the *LF-Scope* program with the USBIA already connected, the main screen will look like this



If the USBIA is not plugged in to the PC, the caption at the bottom of the program screen will read "LoadForce-250 Not Connected" in red.

If that happens go ahead and plug in the USBIA. After a few seconds the program will detect it and change the caption to indicate it is plugged in.

If the USBIA is unplugged from the PC while the program is running a message box will pop up and the program screen will look like this:



Reconnect the USBIA to the PC and press the [OK] button. When you do that the program will start looking for a USB connection again. Be patient. It could take up to 20 seconds to get reconnected.

Displaying Data

When the USBIA is plugged into the *LoadForce-250* and the *LF-Scope* program is running, any data captured is automatically sent to the *LF-Scope* program for display. A "Sending Data" message will appear at the bottom of the *LoadForce-250* display while the data is being sent. When the transmission is complete the message will clear. If the message does not clear it means that the USBIA is plugged into the *LoadForce-250* but the PC side is not working. (Either the USBIA is unplugged or the program is not running.) To clear this problem, just unplug the RJ45 connector from the side of the *LoadForce-250*.

Saving Traces

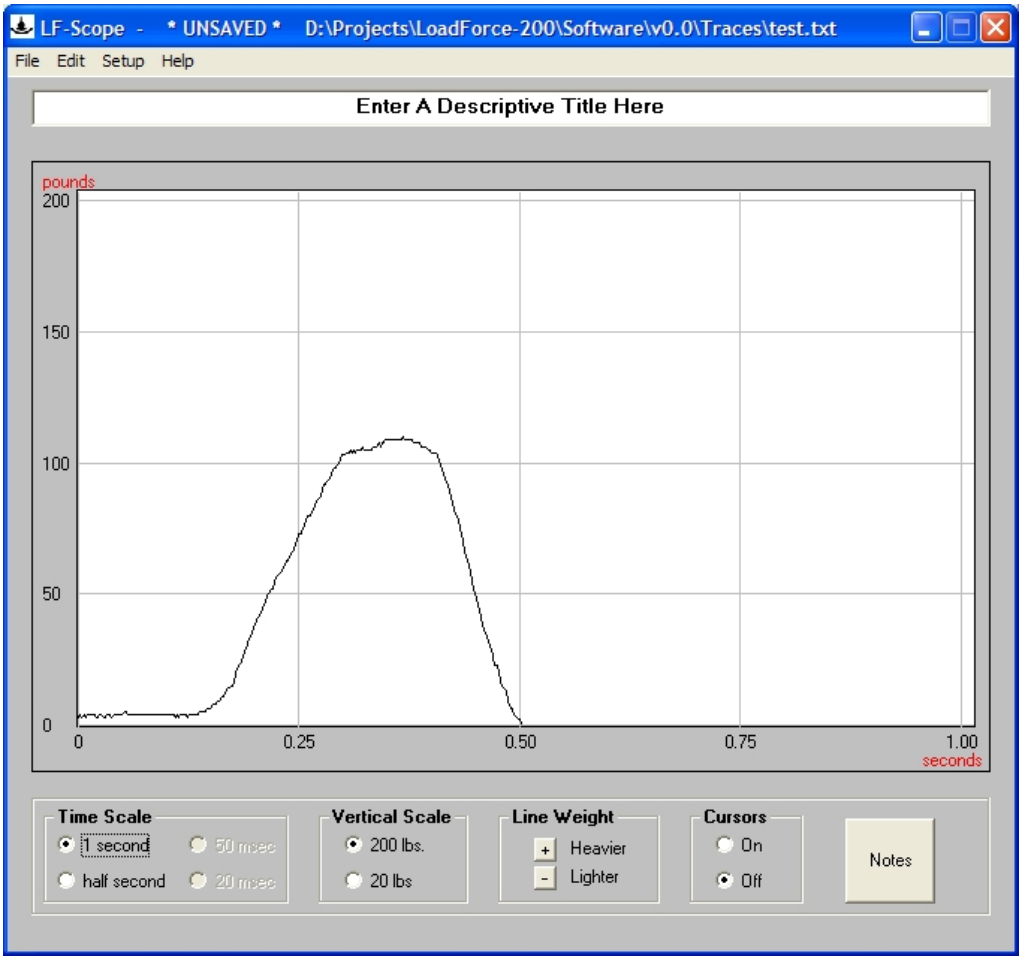
To save the data for future reference, enter any information you want about the rifle, cartridge, etc… in the Title box and Trace Notes. When you are finished, select Save from the File menu and create a unique file name for the data.

Viewing Saved Traces

Select **Open** from the **File** menu and a window will open allowing you to select a saved file for display. By default, the Traces directory was set up by the installation program. If you have checked the Use Traces Directory menu on the Configuration menu, the program will always look in this directory first for trace files. If you have unchecked the Use Traces Directory menu, the program will look in the last directory you used to open a trace file.

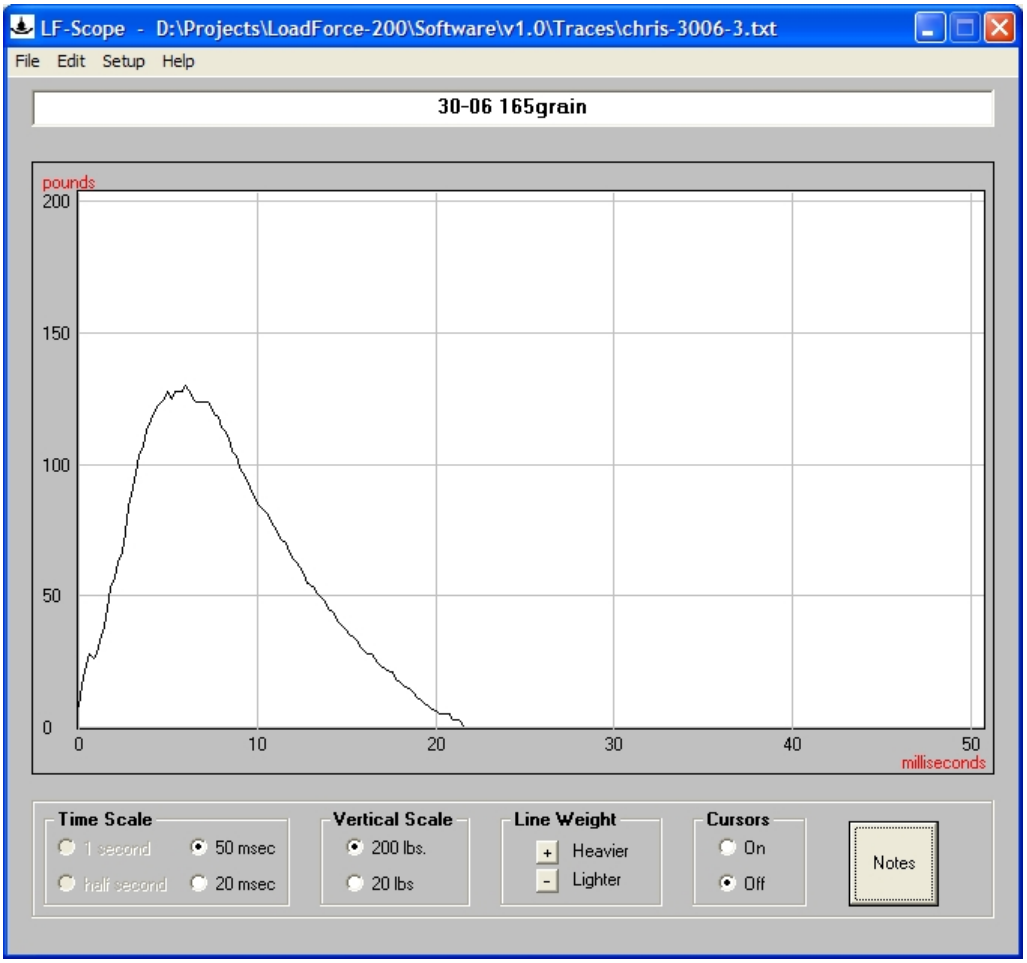
Select the file you want, and the traces will be displayed. The name of the file will be displayed in the windows title bar of the main program screen, right above the menu selections.

Seating Force Curve



Graph of seating force versus time

Recoil Force Curve



Graph of recoil force versus time

Data File Format

Recoil Data File	***SeatingForce Data File***
Recoil Data SW Version x.x Data Points 250 Peak Time in msec 74 Read granularity in msec 0.2 0 14 1 26 2 33 3 35 4 34 5 30 6 26 7 22 8 20 9 18 10 18 ⇓ ⇓ 249 2 [End Data] [Chart Notes] Title 1/2/2005 2:29:15 PM	Seating Data SW Version x.x Data Points 500 Peak Time in msec 110 Read granularity in msec 2 0 14 1 26 2 33 3 35 4 34 5 30 6 26 7 22 8 20 9 18 10 18 ⇓ ⇓ 499 2 [End Data] [Chart Notes] Title 1/2/2005 2:29:15 PM