Help 8 Leverage Ratio

Contents

Overview

DMS offers a Leverage Ratio Measurement Kit for the ShockClock Pro (2 ShockClocks). The kit includes a special Transducer Wave-Guide Tube to adapt the Transducer Head into a Shock Mounted Leverage Ratio Transducer. It also includes a software-unlock-code enabling the software to calculate Leverage Ratio Curves.

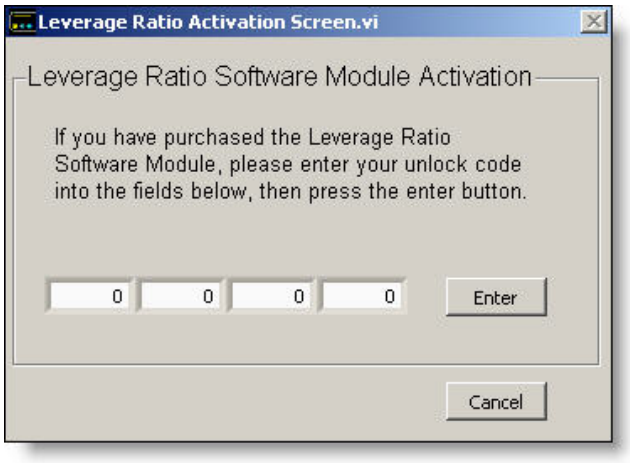
The Leverage Ratio Software has three main functions.

1. Create Leverage Ratio (LR) Files and Motion Ratio (MR) Files
2. Compare Leverage Ratio and Wheel Force Files
3. Convert ShockClock Recordings

Software Activation

The Leverage Ratio Module requires a software-unlock-code.

If you have purchased the LR Module, click the Leverage Ratio Menu, Leverage Ratio Analysis to bring up the “LR Activation” screen. Enter the unlock code that was supplied with your kit.



8.1 The Leverage Ratio Concept

"Back in the day" shocks were mounted at the rear axle and life for the suspension tuner was simple. Just setup the suspension based on bike and rider weight and type of use. Along came long travel and linkages and life became a little more complicated.

What if the suspension could be soft on the little bumps and stiff on the big bumps? This is the main idea behind linkages. Linkages can make the Leverage change through the stroke.

Leverage Ratio is defined as:

$$LR = \frac{\text{Change in Wheel Travel}}{\text{Change in Shock Travel}} = \frac{\text{Shock Force}}{\text{Wheel Force}}$$

By measuring Wheel Travel and Shock Travel simultaneously, we can calculate the **Leverage Ratio** with the Software.

Don't expect to be an expert by doing one Leverage Ratio Curve. When I did my first one back in 1980 I looked at it and thought, "huh?" Now, after doing hundreds of curves they make a lot more sense.

Rear Wheel Force Curves

From Leverage Ratio we can determine **Rear Wheel Force** if we know the Spring Rate and the Preload (**Rear Wheel Force** = the force created by the Shock Spring at the rear wheel). Using "Compare LR Files", up to 4 different wheel force curves can be simultaneously viewed. Spring rate and preload can be changed to show the result different settings will have on wheel force.

See Help 8.5.2

Convert Wheel to Shock (or Shock to Wheel)

Leverage ratio files can be used to convert ShockClock recordings. For instance, a ShockClock recording taken from the rear of a bike can be converted into ***"as if recorded from the Shock"***. For tuners who want to know shock velocities, but are unable to mount a transducer directly to the shock.

See Help 8.6

Have Fun,
Paul Thede
President, Race Tech

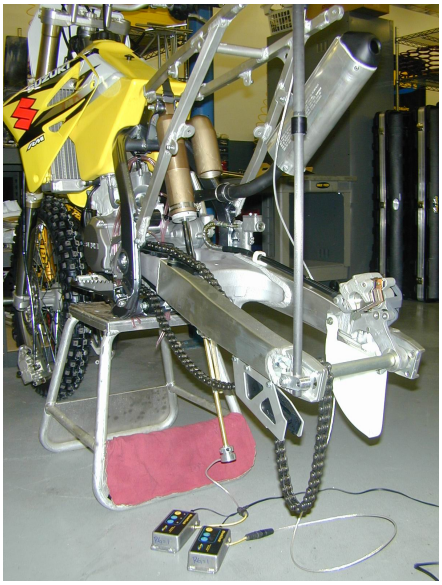
P.S. If you want to understand this better we have Suspension Seminars 951.279.6655.

8.2 Mounting the Transducers and Making the LR Measurement

Parts Required:

1. Two ShockClocks and a Remote Record Switch to control both ShockClocks at the same time.
2. Hardware to convert one of the standard Transducers into a Shock Mountable Leverage Ratio Transducer. (Included with LR Kit **MSLR 01**.)

Procedure (make the recording):



1. Place the bike on a stand with both wheels off the ground. Remove and disassemble the shock. Record the ***Spring Set Length*** and the ***Free Travel*** (i.e. the shock travel to the Bottom-Out Bumper) during disassembly. Reassemble the shock but leave the Spring and the Bottom-Out Bumper off.
2. Remove the Rear Wheel. Reinstall the axle and snug down the nut so it stays in place. Put the axle in the center of the Adjustment Slot (*to provide a consistent measurement point*).
3. Convert one of the Transducers into a Shock Mountable LR Transducer by removing the Transducer Head and attaching it to the LR Tube. Line up the slots in the Adapter and the Transducer Head.
4. Install the Shock and attach the LR Transducer to the lower shock mount with the Strap. The Transducer Head will be at the bottom. There are two types of Lower Shock Mounts, Clevis and Eyelet:
    a. Clevis Lower Shock Mount – This one is easier because you can tighten the lower shock mounting bolt.
    b. Eyelet Lower Shock Mount – This one is a little trickier because the linkage rotates with respect to the shock axis. This means the lower shock mounting bolt should only be finger tight, allowing it to rotate with respect to the linkage. This will allow the Transducer to remain aligned with the shock.

5. Align the LR Transducer with the shock. Extend the small Control Rod and hose clamp it to the Shock Body. Align the LR Transducer Tube, the Control Rod, and the shock shaft. You may have to bend or twist the aluminum mounting strap or flip the clamp to get a good angle. If it is slightly misaligned it may be OK. **Make sure there is always clearance and there is no contact with the linkage as you move the swingarm through its entire travel. Adjust as necessary.**

   Sometimes the best mounting is with the LR Transducer in front of the shock and sometimes in the back and sometimes on the side.

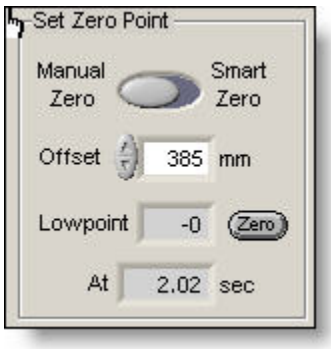
6. Mount the standard Transducer on the rear as you normally would for collecting data on the track.
7. Connect the ShockClocks to the Transducers and connect the Remote Record Switch.
8. Turn the ShockClocks on and begin recording. Lift up on the rear axle to move the swingarm through its full range of travel (all the way up), and then let it back down.

Note: Use the Remote Record Switch so both ShockClocks begin recording at the same time – this is critical!

9. Stop recording and download both ShockClocks. When naming the files include the word “WHEEL” in the wheel file and “SHOCK” in the shock file.

8.3 Creating a Leverage Ratio File

Step 1: Open the Shock and Wheel Files and Set the Zero Point.
After you have made Wheel and Shock recordings open them and set the switch to “Manual” for “Set Zero Point”, and then click the “Zero” Button for both files.

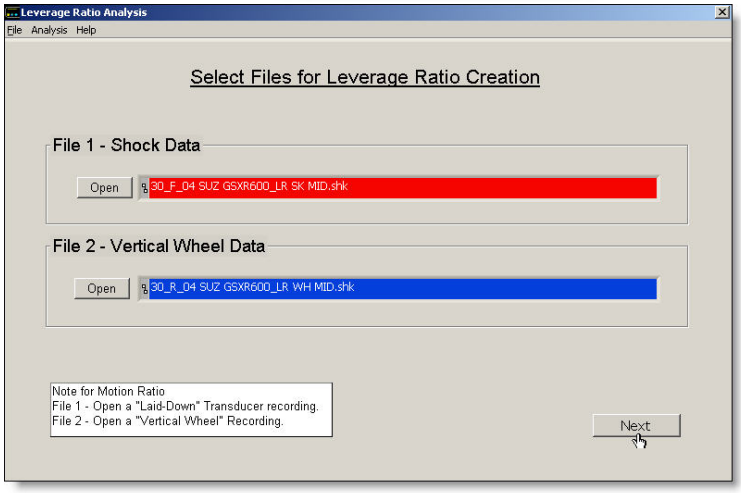


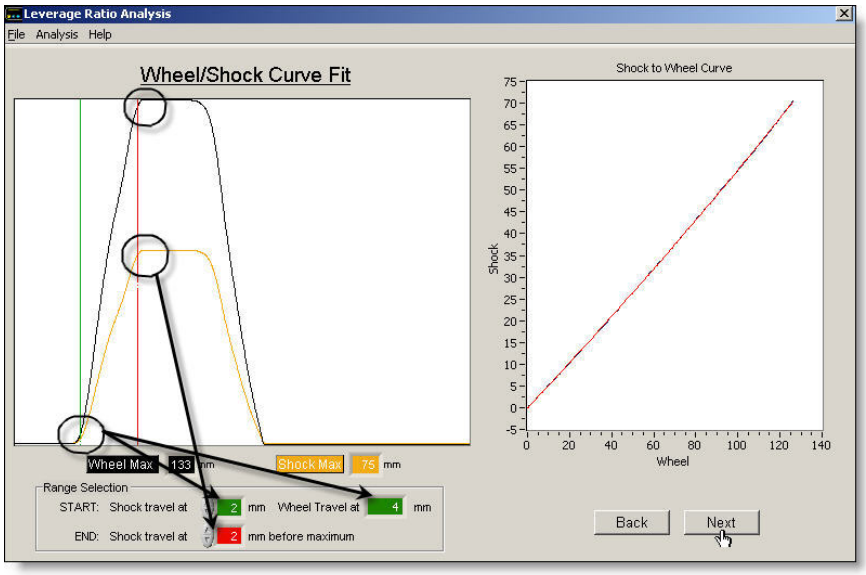
Step 2: Open the Leverage Ratio Software
Select Leverage Ratio Menu, Leverage Ratio Analysis.

Step 3: File Setup
This screen allows you to select the files to use to create the Leverage Ratio.

Open the Shock file in File 1.
Open the Wheel file in File 2.

Click “Next”





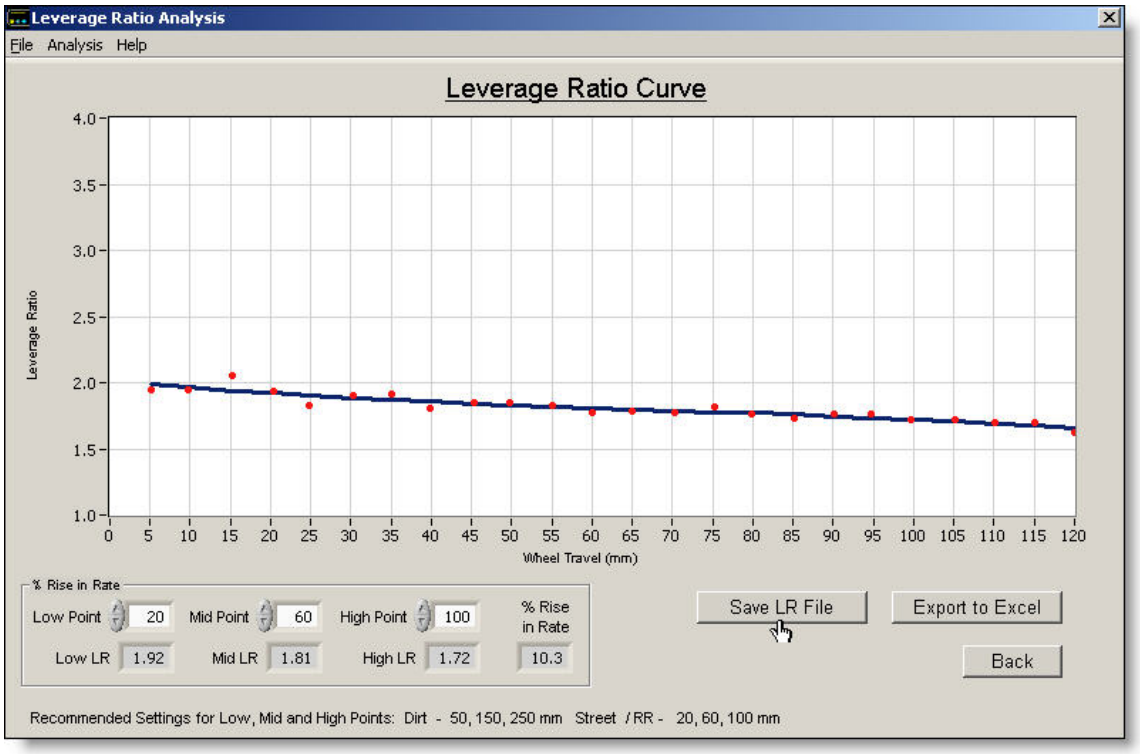
Step 4: Wheel/Shock Curve Fit
The Range Selection will automatically find the point where the shock has compressed by 2 mm. This point is chosen so that free play in the linkage is eliminated from the measurement.

Experiment with different Start points.

Click “Next”

Note: If you use “Select Data Range” to crop the beginning of the Wheel and Shock files, make sure you crop the exact same amount from both files or you will get bizarre results.

Step 5: View the Leverage Ratio Curve



The Leverage Ratio curve is created from the Shock and Wheel data. The red dots are the "raw" Leverage Ratio points. The blue line is the calculated Leverage Ratio Curve.

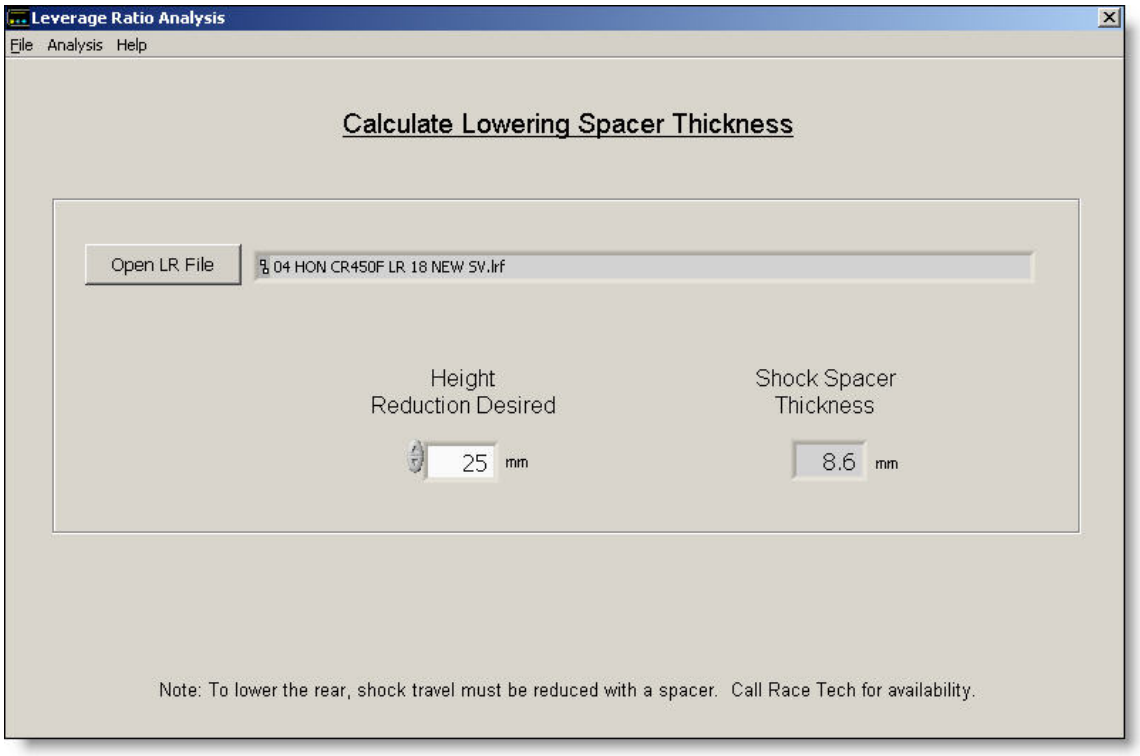
Note that the LR curve slopes down to the right even though the "Rise in Rate" is positive. Because Leverage Ratio is defined as the Wheel Travel divided by the Shock Travel this "negative slope" is actually a "Rising Rate".

Step 6: Save the Leverage Ratio Curve

Click "Save LR File".

8.4 Lowering a Bike – Calculating Shock Spacer Length

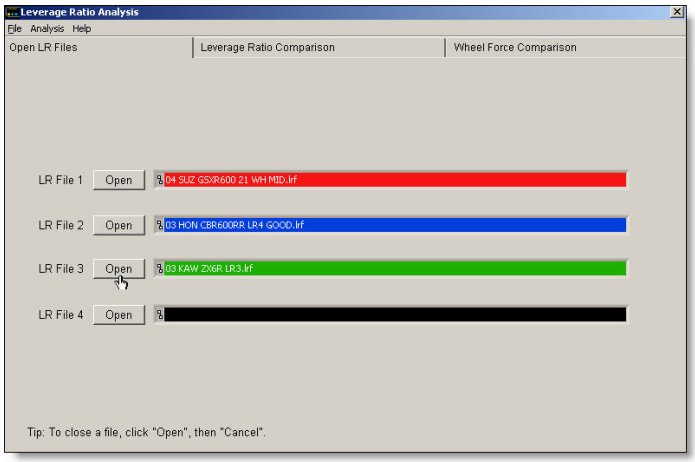
If you want to lower the bike you need to shorten the shock. Generally this is done by putting a spacer in the shock. We can use the LR Curve to calculate the length of this spacer. Click on the Leverage Ratio Analysis Menu and select "Calculate Lowering Spacer". Select the Leverage Ratio File you want to use and input the amount you want to lower the bike at the axle.



8.5 Comparing Curves

8.5.1 Leverage Ratio Comparison

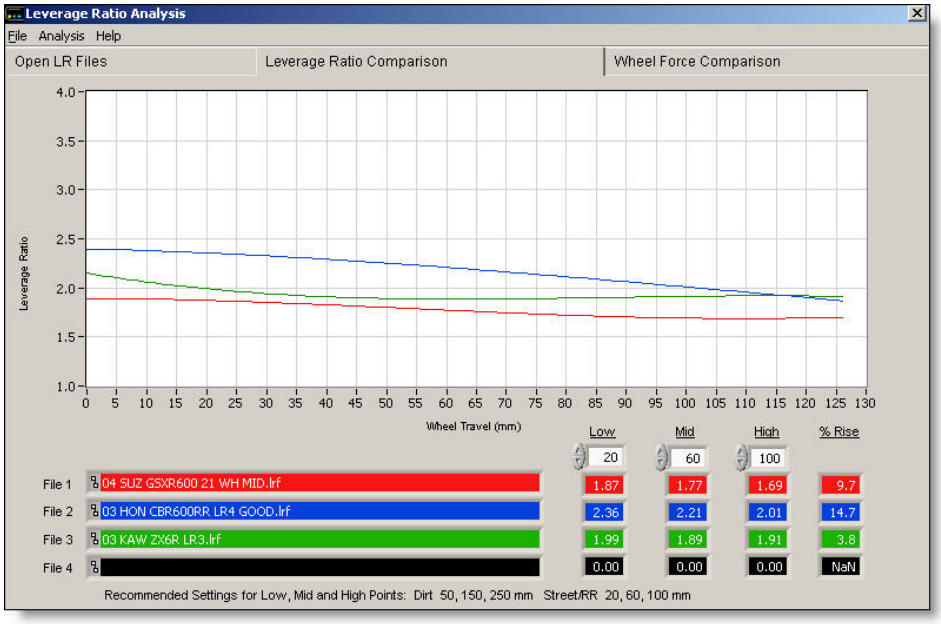
From the main Leverage Ratio Analysis Menu select “Compare Leverage Ratio Files”. Choose any files (up to 4) you want to compare. Click the Leverage Ratio Comparison Tab to view the curves.



At Race Tech we simplify the comparison by setting the Low Point, Mid Point, and High Point. This allows the software to calculate the “% Rise In Rate”.

	Low Point	Mid Point	High Point
Dirt	50 mm	150 mm	250 mm
Road Race	20 mm	60 mm	100 mm

Rise in Rate along with the leverage at the Midpoint (Dirt - 150 mm, RR – 60 mm) define the curve fairly well.



For example a 04 YZ 250 has a rise in rate of around 33% while a KX 250F has 15%. From experience this means the KX 250F will have more of a trade-off. It will be more difficult to get bottoming resistance while retaining plushness on the smaller bumps. Experience is the key.

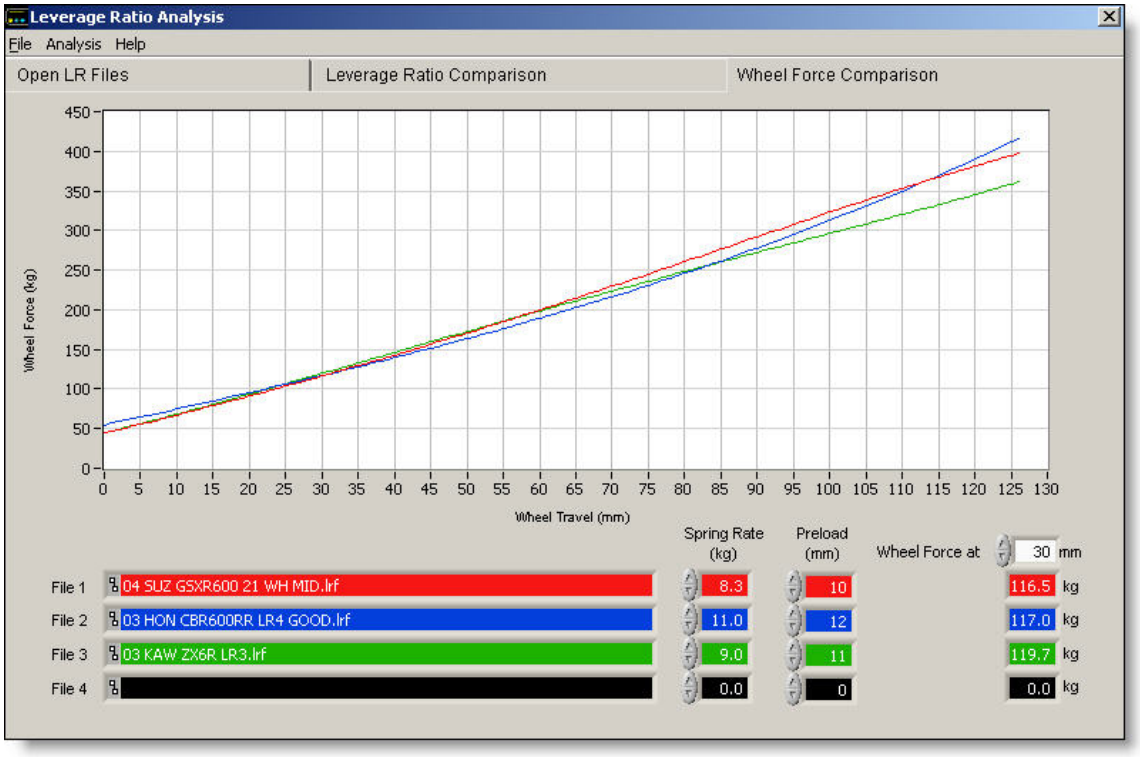
For other types of vehicles, come up with your own Low, Mid, and High Points. As long as you stay consistent with the Points this gives a simple way to compare.

8.5.2 Rear Wheel Force Comparison

Click on the Wheel Force Comparison Tab to view the force created by the spring at the Rear Wheel. This is really the "bottom-line". It is far more critical than the Leverage Ratio itself when it comes to spring forces. You can input different Spring Rates and Preloads to compare the Rear Wheel Spring Forces. Notice the different spring rates used in the example below.

To see the Wheel Force at any particular point, input the Wheel Travel you want to see in the "Wheel Force at" box.

Note: The software only calculates forces for straight rate springs not progressively wound.



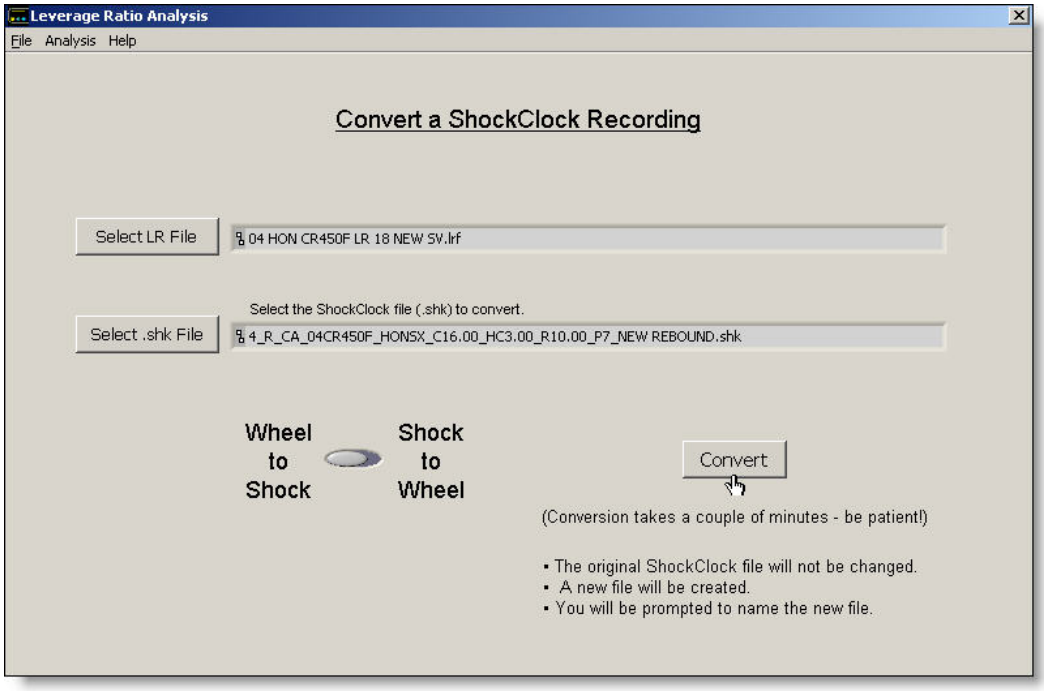
8.6 Convert a ShockClock Recording

Leverage ratio files can be used to convert ShockClock recordings. For instance, a ShockClock recording taken from the rear of a bike can be converted into ***"as if recorded from the Shock"***. This is a solution for tuners who want to know shock velocities, but are unable to find a way to mount the transducer directly to the shock.

Also if you want to lay the transducer down at the rear wheel to keep the rider from feeling it you can convert these recordings into Rear Wheel Recordings! See **Help 9 Apply MR.**

Convert Wheel to Shock (or Shock to Wheel)

After creating a LR file, click on the Leverage Ratio Analysis Menu, and select "Convert a ShockClock File".



Select the Leverage Ratio File (.LRF) you want to use. Then select the ShockClock file you want to convert. Select "Wheel to Shock" if the ShockClock recording was taken at the Wheel and you want "**as if recorded at the Shock**".

Select "Shock to Wheel" if the recording was taken at the Shock and you want "**as if recorded at the Wheel**".

Click "Convert". Please be patient. This can be a huge amount of calculations for the computer. Save the file. You can use the new file normally as if it were measured at the other location.

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