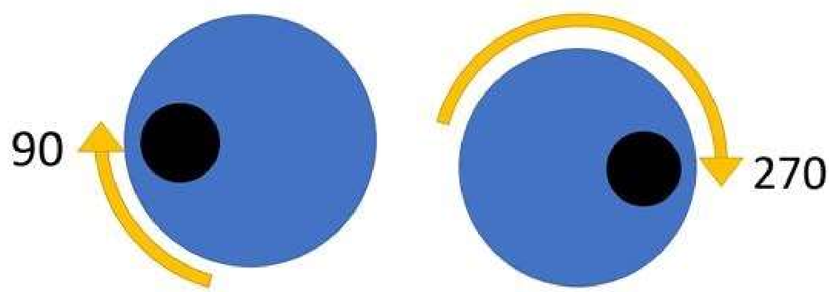
CTW Automation
P.O. Box 1601 / Lexington, NC 27293
423 N Lee Street / Salisbury, NC 28144

To Zero (the load cell) or not to Zero – that is the question when installing the damper

Question: How do I install the damper to get the most repeatable results in my Rod Force/Gas force reading? When do I zero the load cell and what is any offset that I see? What does the Rod Force / Gas Test do?

Rod Force (CTW Probe) and Gas Force (Roehrig) is a software event that happens before the actual test runs at a speed. Because dampers usually have gas or springs or other internal forces that we want to account for, we developed a way to measure these and remove them from the data. We do this because this is a static load within the damper, when you set your ride heights or sag you also remove the effects of this force. Even if there is no gas, performing a Rod Force test is still the best way to always get repeatability and consistent results for comparing damper to damper. During the Rod Force cycle, the dyno will rotate to mid-stroke (90 degrees on the crank rotation) stop and measure the force on the load cell. It will then rotate to the other side at mid-stroke (270 degrees), stop and measure the load cell reading. It adds these two forces together, divides by 2 to get an average and this is the Rod Force. This number is subtracted from all the data for the test. This allows you to compare dampers with different gas forces.



Rod Force reading taken at two places at mid-stroke

Things can still go wrong for a few reasons which can be the amount of bleed in the system and any internal spring type devices. For example, with low bleed dampers, you want to move slower and settle for longer since the internal forces in the damper need to time to equalize. For dampers / forks with internal spring devices, a multi-point gas test is much desired since the rod force will change drastically from BDC to TDC and rather than a static number at mid-stroke, you will want to develop a curve that can remove a changing amount of force based on the position of the crank.

CTW Feature highlight:

The CTW Automation Probe software allows you to alter your Rod Force test method for each and every Test so that you can have a faster one for high bleed dampers and a slower test for low bleed. You can also set how fast it moves from the first position to the second at the same time.

Another CTW feature is that you can add a “prompt” to any test at any time. This could allow you to open all your bleeders so that the Rod Force test was done with very little restriction and then at the prompt, which acts as a pause, you could set them for the test. This is not available in Roehrig.

The Roehrig method is more Global. In the F12 / Edit Preferences area, you can set the Gas Force settle time but it will be the same for every test. There is an Advanced area that you can change the “move to speeds” in each test to help, but it is harder to deal with in Roehrig.

How and When to Zero the Load cell

Testing: In an effort to understand just what comes in to play for the Rod Force (or Gas Force for Roehrig) and how to zero the load cell to achieve the best result, we tried a few experiments on how to do it.

- We used the method that hangs the damper from the upper fixture and zero the load cell.
- We used the method that zero’s with no damper, only the clevis fixture.
- We used the method to load the damper into the upper/lower clevis fixture and zero the load cell with the crossbar free to move.

We also used a 7lb. mass to take our findings to an extreme for verification purposes. Think heavy and lighter dampers and fixtures.

- Damper weighs just under 4 lbs.
- Crossbar and load cell weigh about 15 lbs.

We ran the test using the Rod Force method (Dynamic Gas Test method for Roehrig users) with a 2 second settle time. Results at the end.

Conclusions: For a crank type machine, CTW will describe the best method to install a damper into the test area so that you can get the most repeatable results when it comes to Rod Force / Gas Test and where the damper is displayed on the graph. And that is the key, a shock dyno is nothing more than a measuring tool. In order to be accurate and repeatable, you need to do the same thing every time.

Note: this method does require that the load cell is mounted to the upper fixture or crossbar as it has been called for so many years.

1) The damper should be installed into the upper fixture, loose or tight it does not matter, and then the load cell should be Zeroed. In this manner, we are removing the mass of the damper and fixture from the load cell signal and creating a baseline to compare any-and-all dampers. If the weight of the damper is not removed, a large portion of it will be applied to the Rod Force number resulting in a smaller number.
2) Loosen the crossbar and lower the damper into the lower fixture and attach. Both ends should now be secured so that all free play in the system is removed.

Note: at this point the load cell will be reading the mass of the crossbar and the part of the load cell above the strain gauge inside (both of which are removed after tightening the crossbar). In the case of a damper that does not have gas pressure or a spring, the crossbar will slowly fall until something stops it like the mechanical bottoming out of the damper.

Now you need to determine how much to "preload" the damper from full extension. In the past, the Roehrig simple way to begin was always 2.0", but this is arbitrary and only a way to start the learning process. For some people, they do not have enough shaft travel for 2.0" to work. The idea is to use the same amount for every damper or at least every similar condition.

Note: In the case of circle track cars, when measured on the car at ride height, the front dampers are usually more compressed than the rears. You could have a larger preload for the front dampers and a smaller one for the rear. Make a gauge block and use it for consistency and repeatability.

If you have a non-gas damper, then you will need to extend the damper and set a distance to preload from there. Even though it does not have gas, you still want to test it at the same point and same way, every time.

3) Apply preload and clamp the crossbar. When you do this, all the load cell is now reading is any force created by the shaft displacing fluid and compressing the gas charge and/or any internal springs. There is a very small part of the damper mass that has been removed and that would be anything on the other side of what is the resultant force. This includes the shaft and lower eyelet as this weight was removed in the beginning.

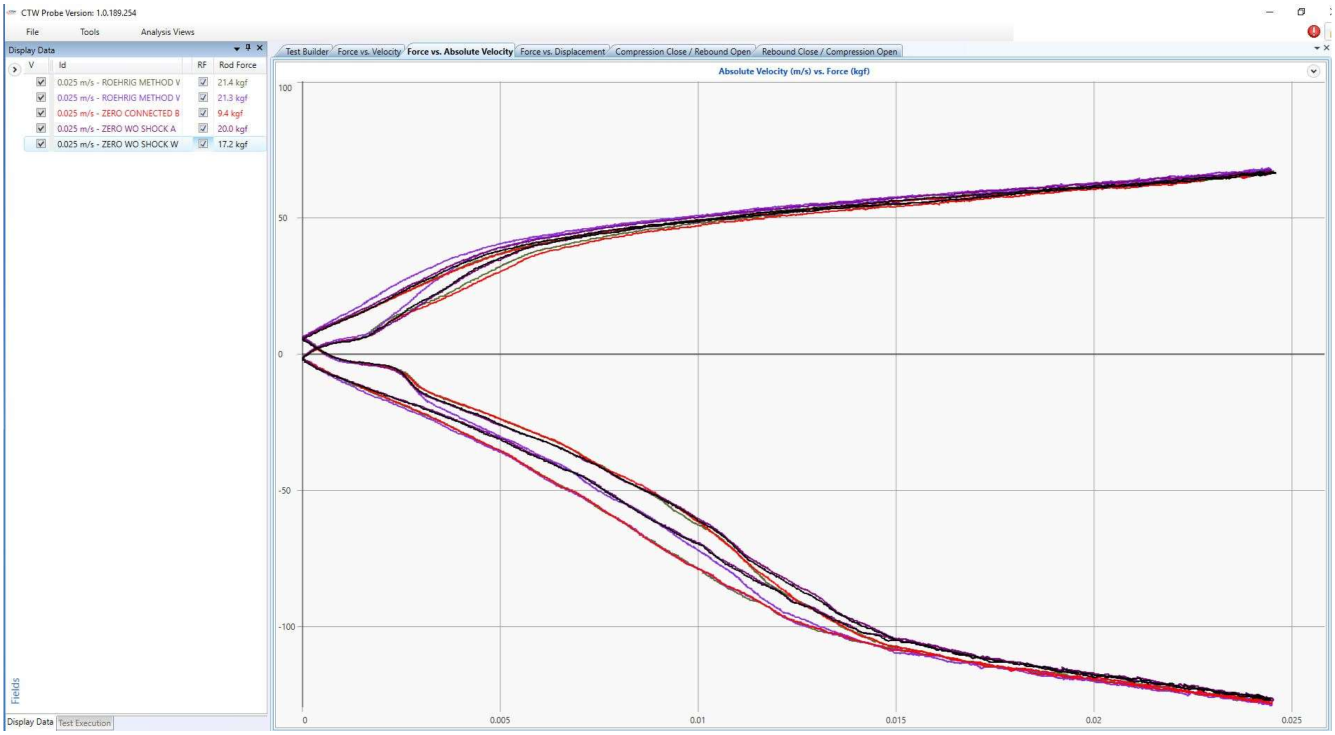
In the end, because you measure the Rod Force and remove it, the dynamic data will line up and that is what you wanted from the start. If you do see offset differences, moving vertically up and down the Y-Axis, you are most likely looking at friction and spring like effects that are a result of moving. These will need to be addressed in other manners.

- It is also important to understand that you should ALWAYS do a warm-up or cycle time before the Rod Force test. This is so important in so many ways and I have seen it cause problems for a long time. If there is friction from the mounting procedure or the fixtures themselves or the damper, by running a simple 5 seconds warm-up, you help to remove these and stabilize the damper and/or fork. We really recommend a Temperature warm-up but we will take either as long as it is done.
- And if you use twin tube dampers, you know that they need to be oriented in a particular way to work properly. And if they happen to be placed horizontally before running on the dyno, they will need to be "primed" before they settle. If these do not go through a warm-up phase before the rod force test, you will never get a repeatable result.
- Warm-up / Rod Force / test speeds. Always.

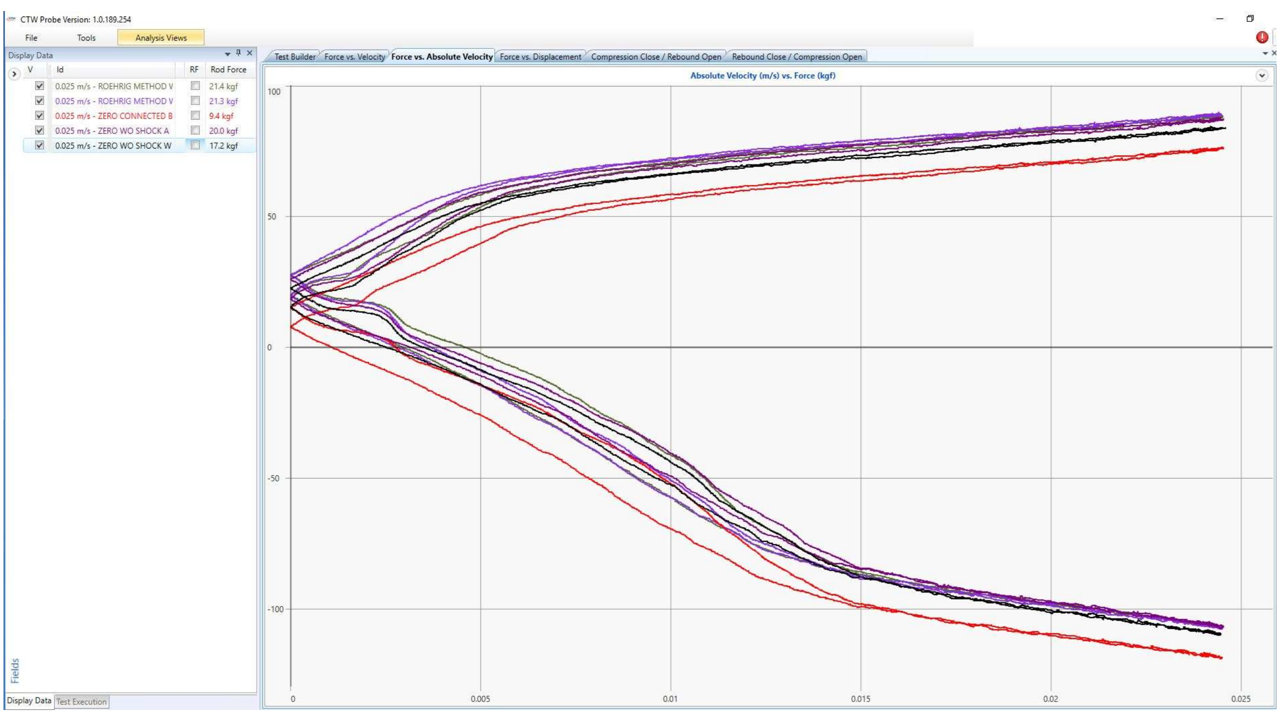
CTW Automation
P.O. Box 1601 / Lexington, NC 27293
423 N Lee Street / Salisbury, NC 28144

Testing results

Data with various Zero methods but Rod Force removed: Y-Axis +/- 0.3 Kgf.



Data with Rod Force put back into the data: Y-Axis – whacky



Rod Force reading from software at 2 secs settle time	Software Rod Force Result:
Zero with damper hanging from crossbar	47.0 lbs.
Zero with damper hanging and 7lb weight on damper	47.2 lbs.
Zero without damper	44.2 lbs.
Zero without damper but 7 lbs. on damper	37.8 lbs.
Zero connected top/bottom but crossbar lose	20.8 lbs.

This does show two things. It shows that it matters how you zero the load cell. It also shows that if you do a Rod Force measurement, the data will be aligned so that you can compare the dynamic results. But if you do not zero the same way, you cannot use the Rod Force data for analysis.

Things to consider.

If you do not remove the weight of the damper, this mass will show as a negative amount on the load cell (the weight applied in the tensile direction on load cell). It will result in a lower Rod Force reading by that exact amount.

If you zero the load cell after the damper is installed on the top and the bottom, but before clamping the crossbar, you will also be removing the mass of the crossbar which will result in a lower than actual Rod Force reading.

If you try to load the damper top and bottom and the carefully clamp the crossbar with no preload to try to just have the “sprung mass” of the damper zeroed you will more times than not accidentally push or pull on the crossbar and cause loading that is not real. You can try this just looking at the force reading on the live screen. Clamping the crossbar tends to move it a small amount due to machining and bore parallelism which causes a few pounds to be added or removed. You simply cannot repeat this if you ever get it right.

If you zero after installing and preloading and clamping the crossbar you actually remove the Rod Force created by the damper during preload and again, you will get a false reading.

Note: if you want to understand some of the physics involved, try this experiment on your dyno.

Hang the damper from upper clevis and clamp the crossbar, zero the load cell.

1 - Now if you push down on top of the crossbar, what do you think will happen to the live force reading? Push up as well.

2 -If you add weight to the damper on the clevis pin, what do you think the live force reading will show?

Now, mount the damper top and bottom and tighten the fixtures, but leave the crossbar lose, and zero the load cell. Repeat these simple tests.

This will help to explain some of the mystery. If you have a non-gas damper, simply let it mechanically stop.

I hope this has been helpful. I am sorry if it is long but some of the simplest ideas tend to be the difficult ones to explain.

Follow along with CTW as we learn together.