CTW Automation Probe Software for the RD Series

Rev D

Contents

Introduction

This manual is for the CTW Probe Analysis Software to be used with the RD series of machines designed, built, and manufactured by CTW Automation. It is intended for the purposes of our customers and their RD machines. It is not intended for mass distribution or publication by anyone other than CTW Automation. It is setup to first go through all the Tabs and screens before proceeding to building and executing a Test.

As with all of our products and services, CTW Automation wants you to be able to use the equipment and obtain results you can use to develop and characterize your shocks, springs and test specimens. To that end, we want to help you get the most out of the equipment and for you to be happy to use it.

Technical Help

Your machine was delivered with a full one-year Support contract. This allows the owner e-mail / phone and remote access help via CTW TeamViewer license. Any time after training, if you have questions or concerns, contact CTW for help.

To get the best help, it is important you try to use the following avenues:

E-mail to: Service@ctwautomation.com

Send your name, location and a number to reach you

Please include your serial number, for example RD3-043

Or

Phone: 336-542-5252

We are located on the East Coast in the Eastern Standard Time zone.

- If you have questions about data or a graph, PLEASE attach the data file to the e-mail. We can open it on our computer and understand more than just sending a picture.

- If you have questions about a particular Test you created, it could be helpful to attach that to the e-mail so we can see what you are using for commands.

- TeamViewer should be loaded on your computer during calibration or install. If you need a copy it can be found on our website: www.ctwautomation.com and go to the Software tab.

Overview of the RD Series of Rotary Actuators – the crank dyno

The RD series is a scotch-yoke type design for creating linear motion. This system delivers a pure sine wave input to the damper or test specimen. Several factors in each model type determine the possible testing envelope including stroke, velocity and force.

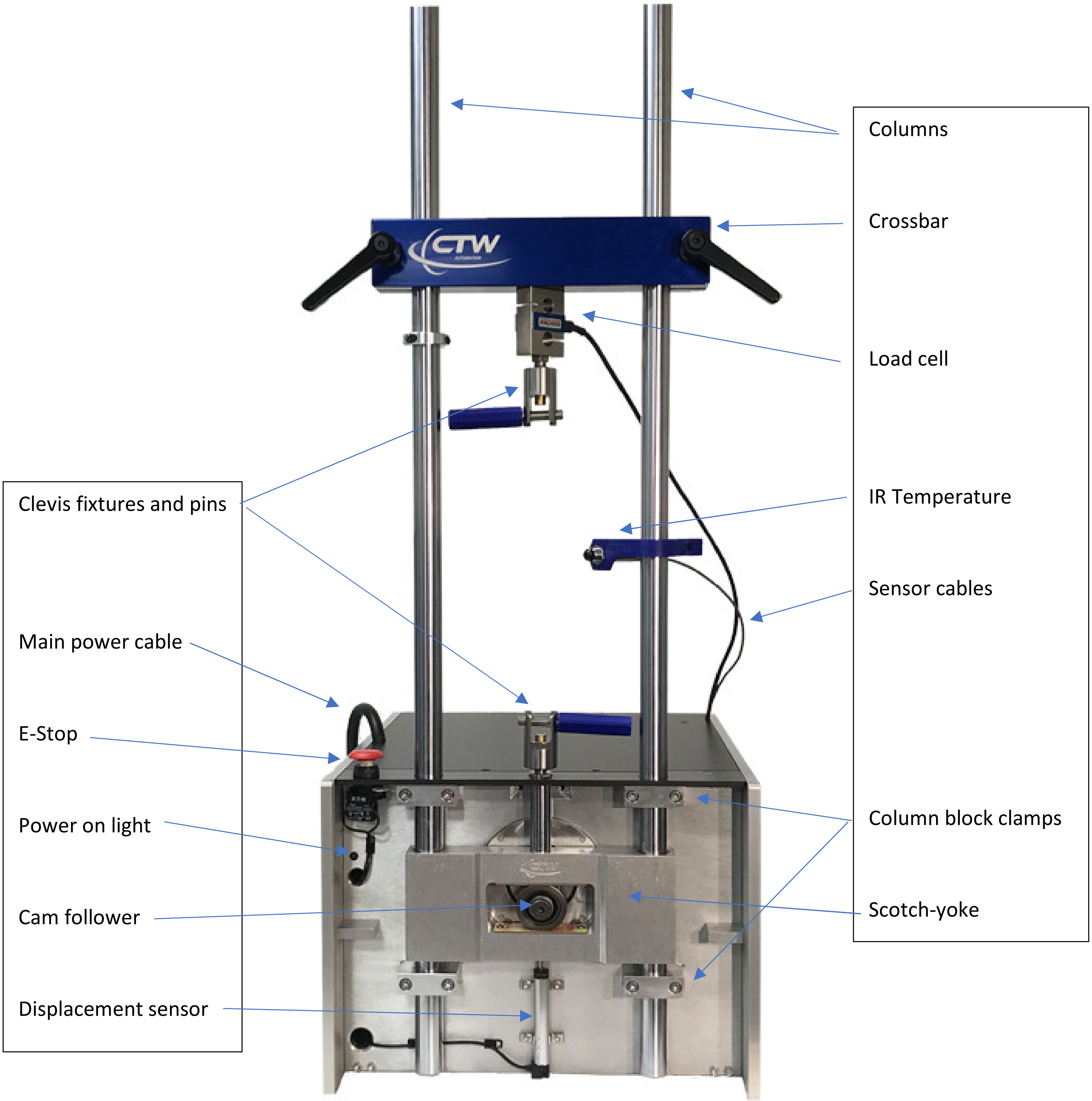
1 – Stroke is changed manually by the User by inserting the cam follower bolt into various holes in the crank head. The table top machines have stroke up to 2.0” or 50mm while the free-standing machines can reach 4.0” or 100mm.

2 – Velocity of each machine covers a very wide range. Testing can go from the very slow speeds to very high all within one Test to get the best “picture” of the damper.

3 – Power and force vary based on each model with the general design to keep increasing as you go through the CTW range. From as low as 2 HP and up to 10 HP.

4 – Table top to free standing models to allow for the correct sizing for any application.

Table top RD2-3 and 5 vs. the Floor mount RD7.5 and RD10 Models



RD Dyno Overview

What does the shock dyno do?

Before we start running test we should think a little bit about what the shock dyno does and how the data is collected.

The scotch yoke type dyno uses a motor controller to command an AC motor to run at some defined RPM. This will move the actuator and the shock shaft connected to it, to a user defined peak velocity. The dyno has sensors that collect data during the test and the data card and software takes the voltage put out by these sensors and turns it into traces on the graph. The dyno uses a system called a “scotch yoke” to turn the rotary motion of the motor and crank into the linear motion we need to push the shock. If you look at the front of the dyno the large bearing in the center of the yoke is bolted at an offset on the crank head where the amount of offset defines the stroke the dyno will run. So if the crank bolt is located 1 inch from the center of the crank head, the total stroke would be 2 inches.

When the user creates a test, he is giving the software a series of commands on how and when to run the dyno. The stroke is defined by the position of the crank bolt so really the main thing the user is defining is the actual peak speed the shock will be run to. The software collects data from zero velocity up to the peak requested velocity and plots all that data on the graph. Your CTW dyno is collecting data at 1000 samples per second, so that means 1000 times a second the software is checking the displacement, velocity, force and temperature, and it plots force vs the displacement or force vs velocity to give us the graphs we are going to look at.

When the dyno is started, the motor turns the crank at the correct rpm to produce the requested peak velocity at the shock shaft. The peak velocity is at the midpoint of the stroke when the crank is at its highest offset to the sides. Zero velocity occurs at top dead center (TDC) and bottom dead center (BDC), when the shock shaft changes direction, going from the rebound stroke to the compression stroke at BDC, or the compression stroke to the rebound stroke at TDC. There is one point where there is not linear motion and that is where the dyno collects data at zero velocity. It is important to remember that the zero velocity point plotted on the graph is collected dynamically as the shock changes direction.

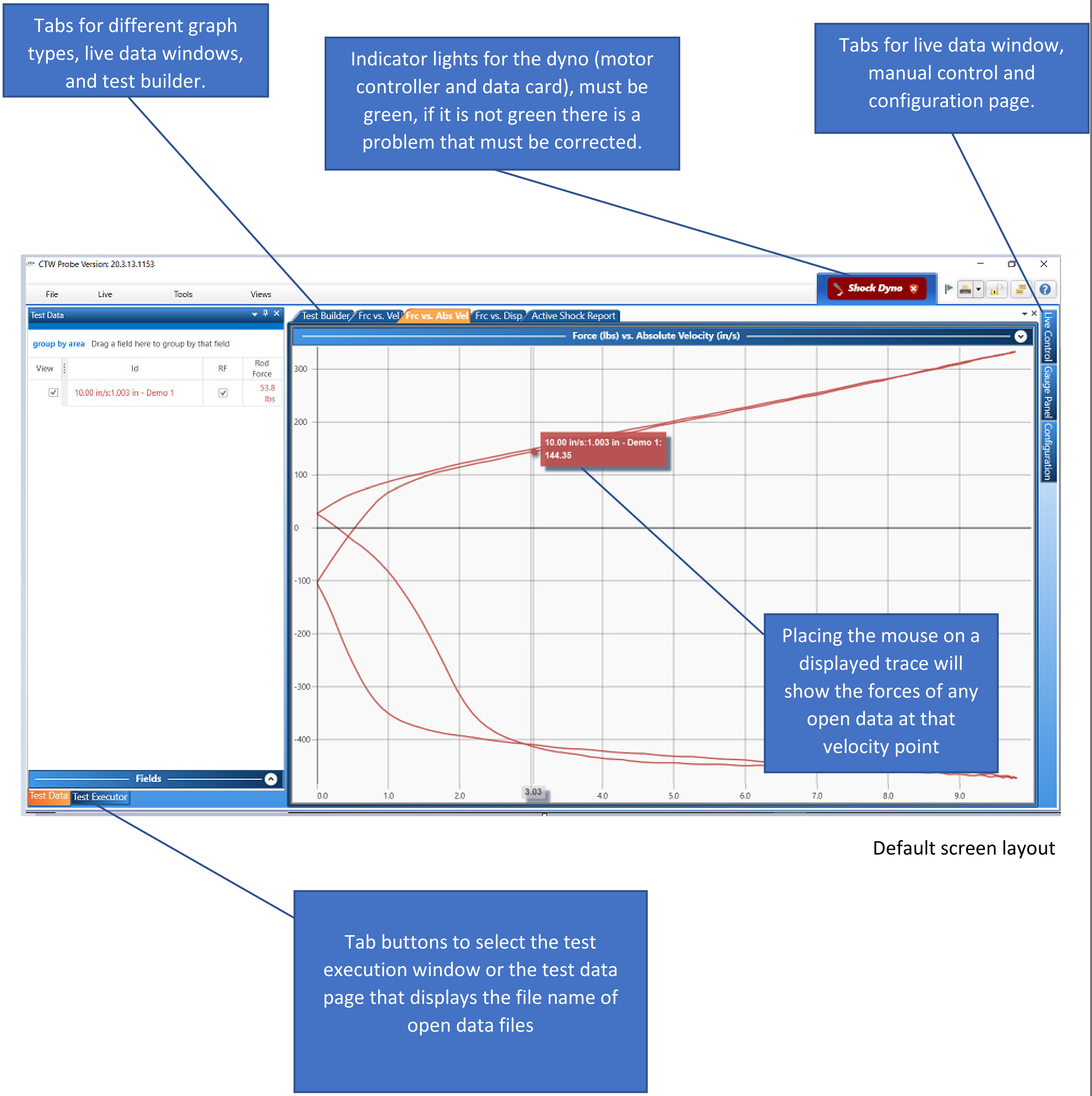
Data between the zero point and peak velocity point is collected as the dyno runs a sine wave over the stroke. A quality scotch yoke dyno is very good for comparing changes to the shock, or to different shocks because the dyno does the exact same thing every test. So we know that any change in the traces are related to the change on the shock.

Once you have collected a test of a shock, that file can be opened at any time to compare with a later run on that same shock or to different shocks.

As soon as we have collected data on a shock we can compare that data to a later run on the same shock to make sure nothing has changed. We can also start to correlate the changes in the shock graph to the vehicle handling and what changes to the shock and data effects what part of the track.

Layout of the software.

CTW software has different windows or pages depending on what function you are executing. Almost everything the user needs to run a test and display data is on this one window.

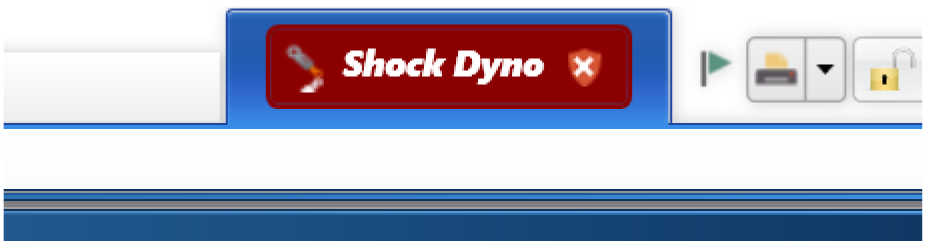


Default screen layout

Running a test

The “Test Executor” window is the panel you perform a standard dyno test from. You must properly load the shock into the dyno and select the test you want to perform, then execute the test.

Before running a test make sure the Shock Dyno light in the upper right-hand corner is green. If this light is red, the dyno will not run the test. Locate the problem with the data or controller systems before proceeding.

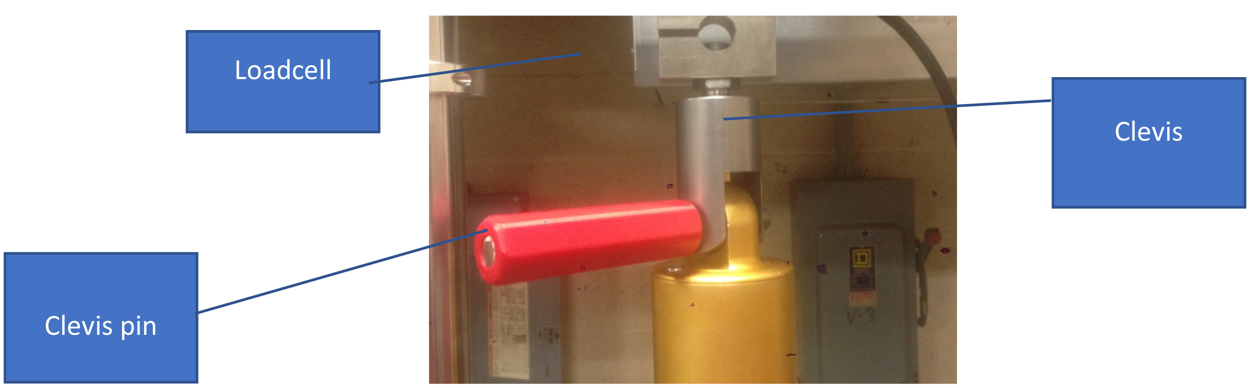


Loading a Shock in the dynamometer.

Before installing a shock in the dyno make sure the dyno is at BDC (bottom dead center). If you are not sure if the dyno is all the way down click the “Move To BDC” button on the test execution page. The dyno will start and run until the yoke has reached the bottom when you click this button. **Always make sure the dyno is at BDC before loading a shock!**

The shock also must be fully extended before it is installed in the dyno. If you are testing twin tube non-pressurized shocks pull the shock shaft out of the body until fully extended. **Always make sure the shock is fully extended before loading in the dyno!**

1. Hang the shock from the upper clevis by sliding the clevis pin through the clevis and shock eye, do not tighten the clevis.



2. From the “test execution” page lick the “zero force” button. This zeros the weight of the shock or any offset in the loadcell out of the data.

3. Loosen the cross-bar handles and lower the crossbar until you can install the lower clevis pin into the shock. If you are testing a mono tube gas pressurized shock the shock will hold the crossbar up while you insert the lower pin, if it is an unpressurized shock you will need to tighten one crossbar handle.

4. Lower the crossbar to compress the shock slightly, this prevents the shock from becoming over extended. Tighten the crossbar handles.

5. Tighten the clevis by turning clevis handles clockwise until snug. Check to make sure you have enough shock travel to prevent bottoming out the shock. If you are on a 2” stroke you should have at least 2.25” of shock shaft exposed.

   You are now ready to run your test.

Executing a test

Once you have the shock properly loaded into the dyno you are ready to run a test and collect data.

1. From the “Test execution” window on the left side of the page, click the “Open” button to select a test. If you have no test created see the “create test” section of the manual; you can create as many tests as you like. Keep in mind a test is just a series of commands, the collected data from those commands is what we will be looking at. Tests are stored your computers document folder at ‘Documents/CTW Automation/Tests’. Tests can be copied and pasted into other computers.

2. To start the dyno and perform the selected test click the “Execute Test” button at the bottom. This will start the dyno and automatically step through each step of the test. Each step will be highlighted as the dyno runs that step.

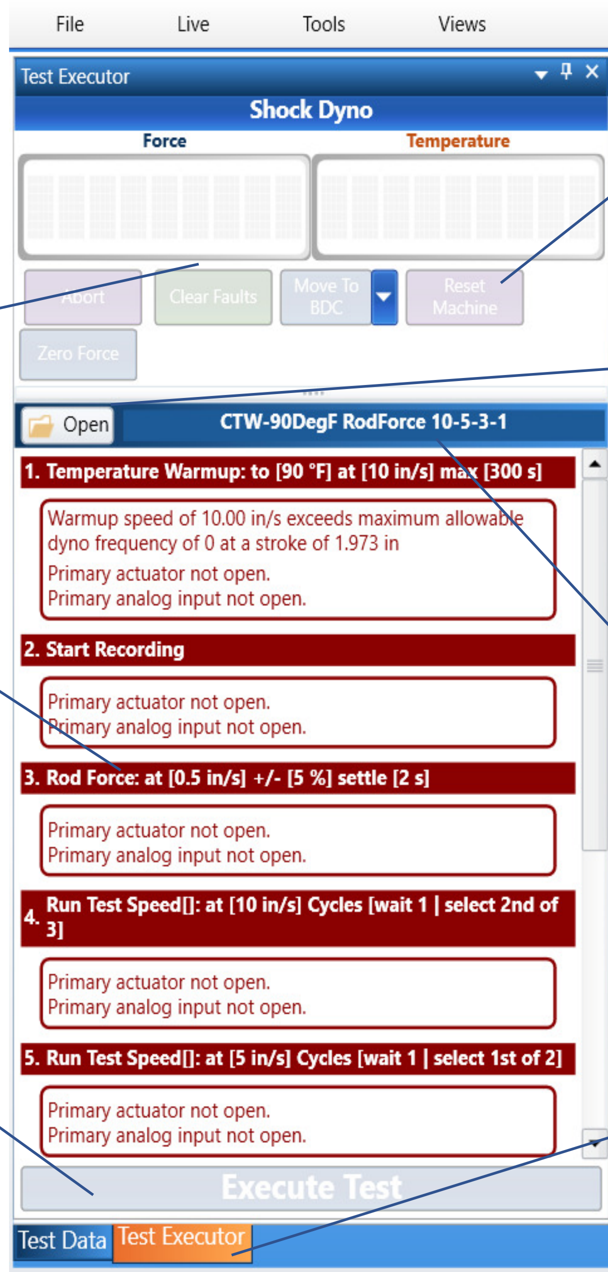
3. At the end of the test when the dyno has completed all steps, the “save” window will open. Name the test when the “save test” window appears after the test is complete. As a default, your data will be saved in a data folder in ‘Documents/CTW Automation/Data’. You can save data anywhere you wish. Data is saved just like any document in Windows so you can save data to any location.

Test Execution Window

If command buttons are greyed out (inactive) that means there is a problem and test will not run, make sure power is turned on and all cable are connected

Click “reset “ button to reset inverter after an e-stop or error message

Load button will load the test you select



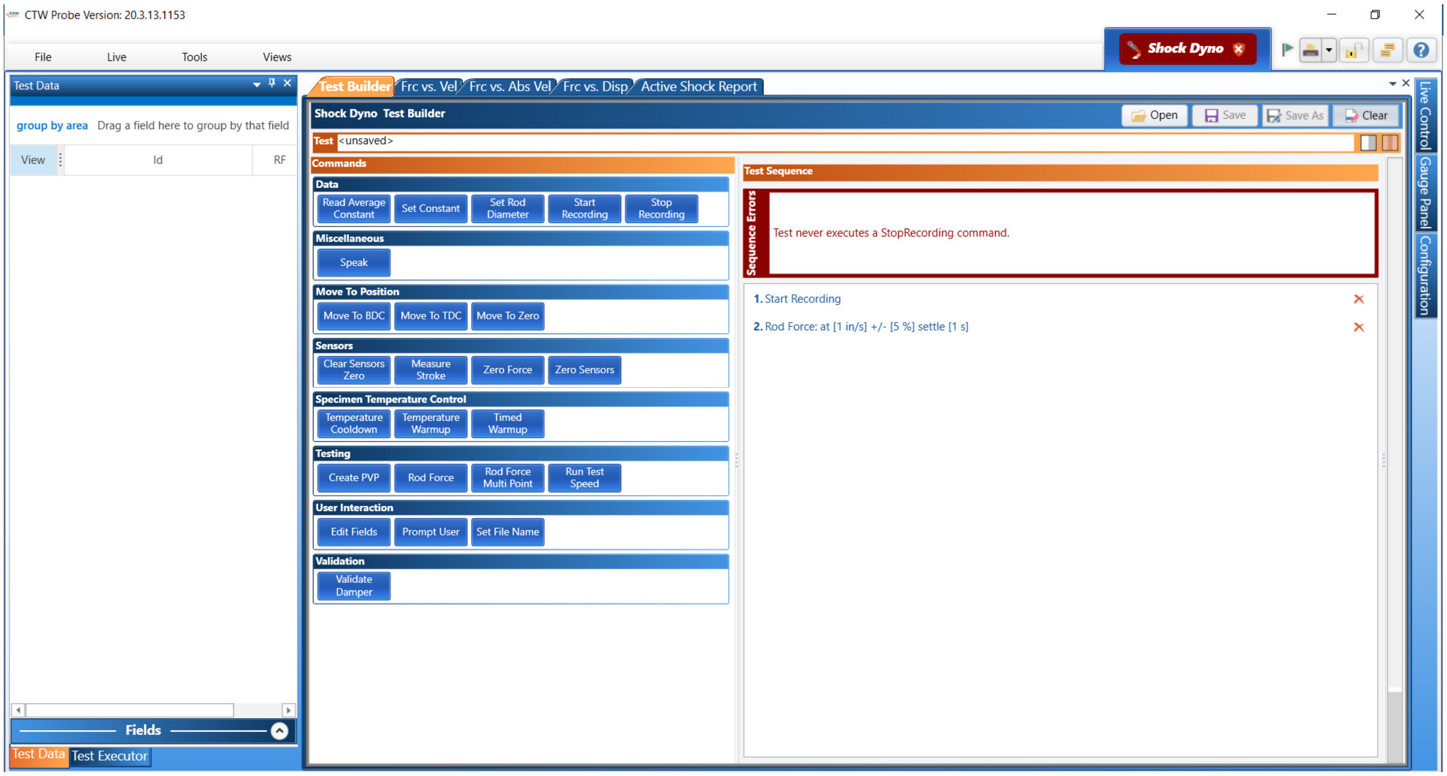
Test sequencer lists each step of the test. Notice in our example some steps are red, this indicates the dyno cannot perform that step

Name of the test you have selected

Execute button will start the test

Click these tabs to open the test executor or test data column

Creating a test.

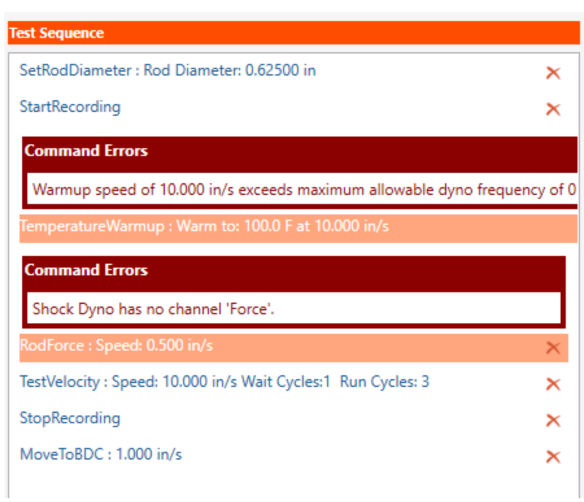


Clicking on the Test builder tab at the top of the page will open the window to create or modify a test. You can click on buttons to add steps to your test. When you click on a command in the "commands" column it adds that command to the "test sequence" column.

If you want to modify an existing test click the "Open" button and select the test from your test folder.

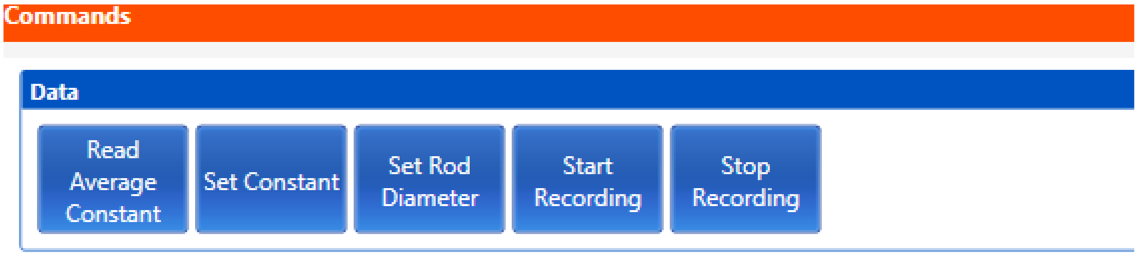
If you create or modify a test it will automatically load in the test execution window when you save the test.

Some commands need definition; for instance the "Test Velocity" (Run Test Speed) button allows you to select the peak velocity you wish to test to, how many cycles you want to run and what cycle you want to use for the data display.



Create test options

Data commands



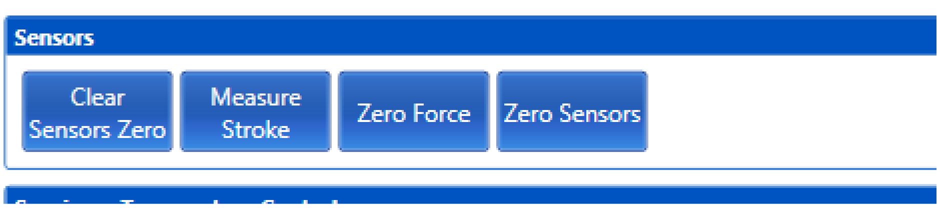
Set rod diameter - Select this button if you want to define your rod diameter and have the software save that number with the test. If a proper rod diameter is entered the software will record the gas pressure in the shock. This is based on the rod force recorded during a test (you must do a rod force test to get gas pressure).

Start and stop recording - tells the software when to start recording data and when to stop. If you forget to include the start/stop commands in your test, the dyno will run the test but not save any data. If you run a test and no data appears on your screen make sure you started and stopped the collection.

Move to commands

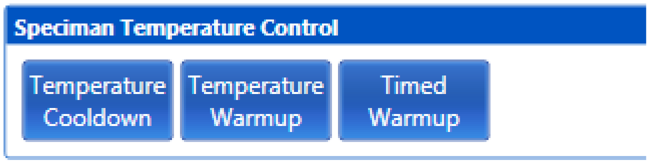
These buttons are used to tell the dyno where to park at the end of the test. For most users, select the Move to BDC button at the end of your test so the dyno will always return to the bottom of the stroke.

Sensor commands



Sensor commands tells the software to do something with sensor data before or during the test. For most tests, none of these commands would be used during a normal test.

Temperature commands



These buttons allow the user to warm the shock up before the test. You can warm up for a time or to a defined temperature. You can also run the shock slowly to allow it to cool down before removing. Once the button is selected and moved into the sequencer list double click on the button to open the parameters for that command.

Test commands

Test commands are steps that will record data.

Rod Force will stop and record the gas (or rod) force of the shock.

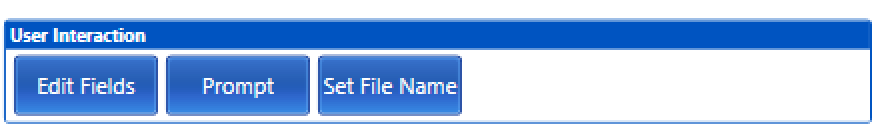
Rod Force Multi Point will stop and record the gas (or rod) force of the shock at several user defined points.

Pause will stop the dyno until told to restart, this is helpful if you are running a series of test and changing the adjuster between runs.

Create PVP will draw a PVP (Peak velocity plot) composite graph of all the speeds in the test sequence list.

Run Test Speed (or speeds) This step will be the speed the data will be collected at, defined as the peak speed the dyno will reach. Select the "Run Test Speed" button. If you want a multi CVP collection (more than on speed) click the "Run Test Speed" button for each requested speed. For each run you will define the cycles to reach peak speed, cycles to collect and the speed to collect at.

User interaction



Edit Fields allows the operator to modify the field he will be saving with the data run.

Prompt will allow you to pause the test. This is helpful when making adjustments to a damper between test velocities.

Set File Name defines the file name before the test is saved.

Displaying and viewing data after a collection.

After running and saving a test the data will display automatically. You can also open saved data by using the FILE/OPEN DATA pull down menu.

The graph below depicts the data on the force vs absolute velocity graph compared to the position of the crank bearing on the yoke. We break one cycle of the crank head into four quadrants. Each defines what is happening to the shock in that quarter.

The shock shaft (and shock piston) is constantly being accelerated or decelerated by the offset bolt in the dyno yoke. When the dyno changes direction, from compression to rebound at the top of the stroke, and rebound to compression at the bottom of the stroke, there is a momentary pause between the up and down direction. At that point the dyno records the zero velocity points. When the crank bearing is at its highest offset, mid stroke, that is where the dyno records the peak velocity. With a sample rate of 1000 sample per second, the software is checking the velocity and the force 1000 times each second and putting a point on the graph at that force and velocity intersection. The line we look at on the graph is really a series of collected points that the software connects together.

Four quadrants

Compression open – From BDC to mid stroke in the compression direction the shock is being accelerated, the graphs shows the force related to that increase in velocity. As velocity increases force increases. The parts inside the shock define how quickly the force changes. Sometime in this quarter the compression valve stack will open

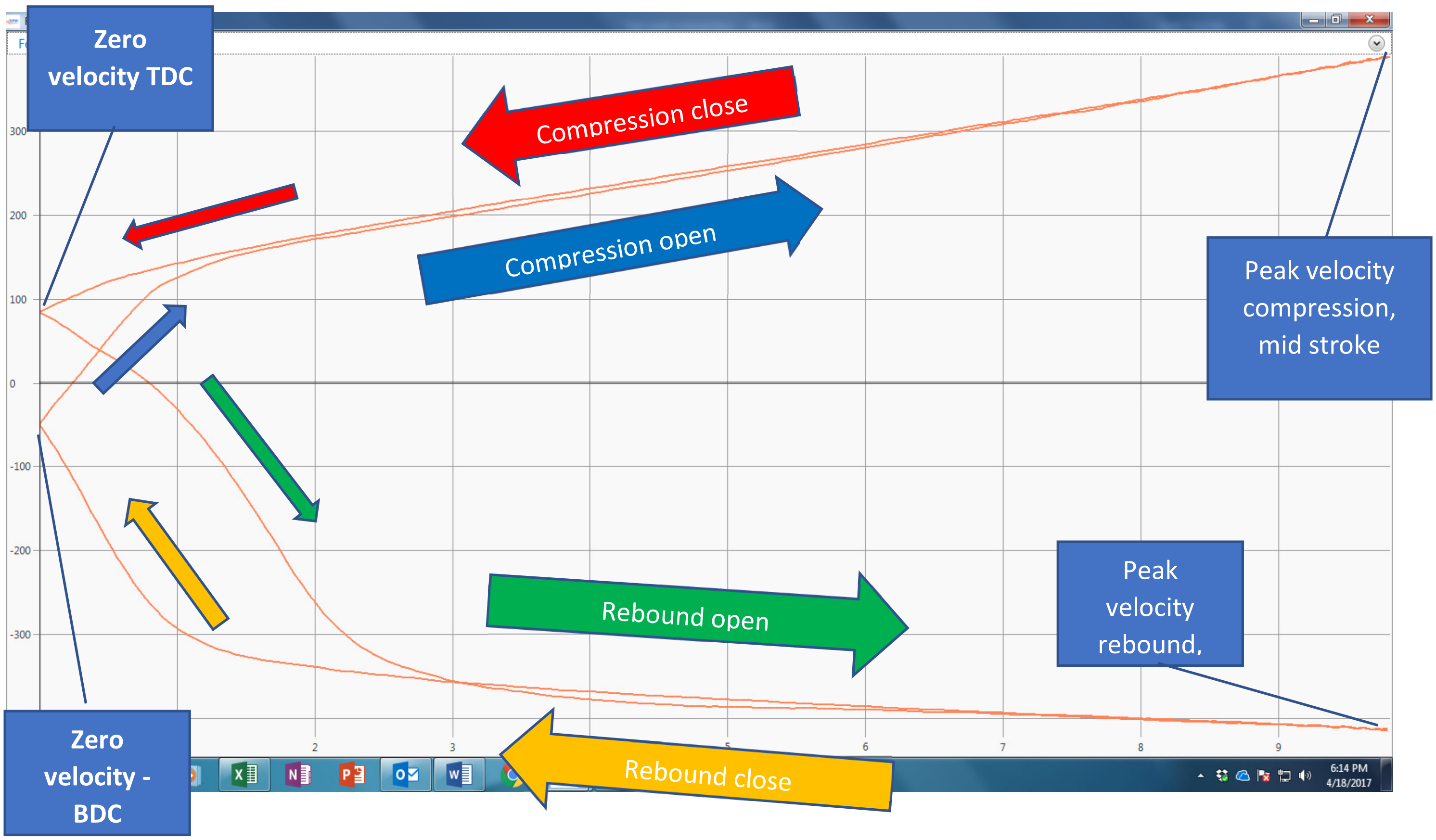
Compression close- - At mid stroke the shock has reached its peak velocity and then must slow down to go back to zero velocity at TDC. As the shock slows down the shim stack in the shock will close

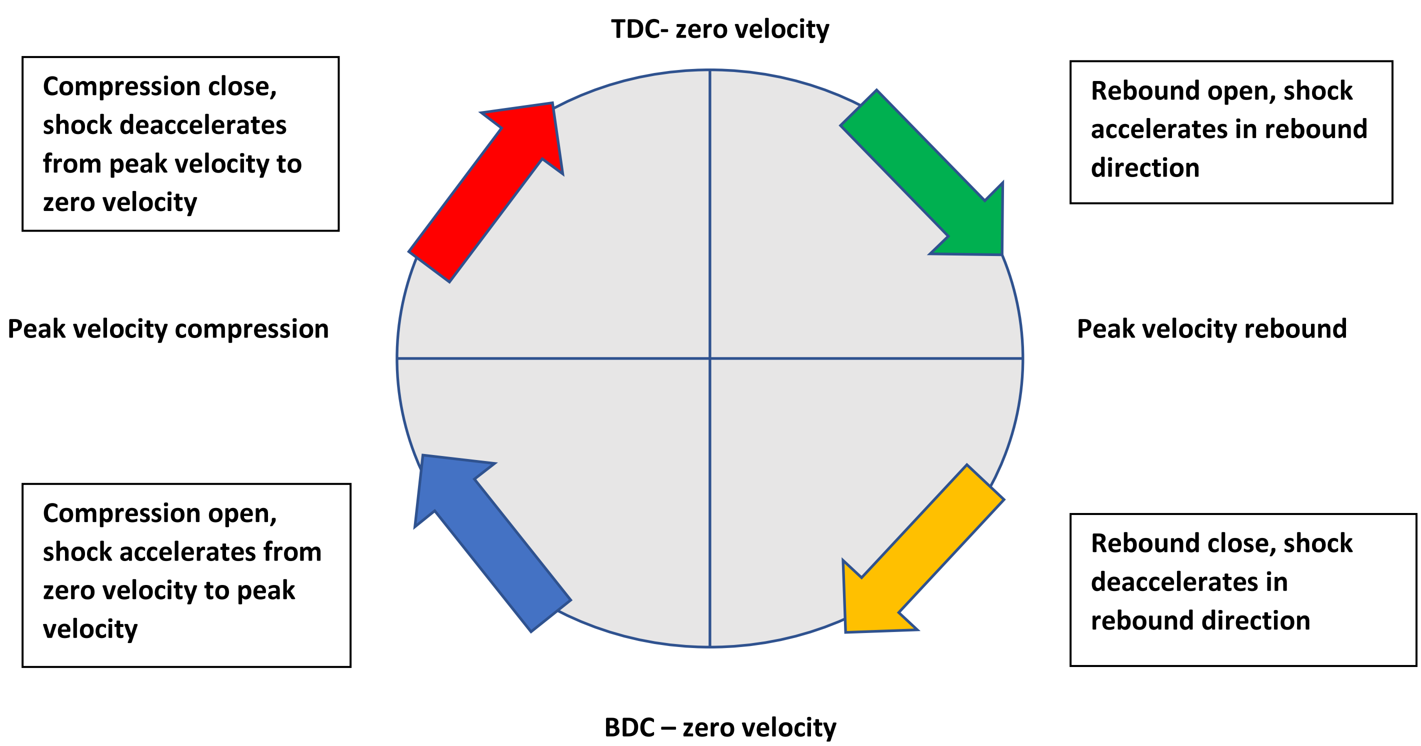
Rebound open – From top dead center the dyno and shock move back down pulling the shock shaft in the rebound direction. The shim stack on the rebound side of the piston opens in this quarter.

Rebound close **–** Finally the shock slows down from peak velocity at mid stroke in rebound back to zero velocity at BDC. One complete cycle has been run and graphed.

A scotch yoke dyno is running a sine wave pattern, so the acceleration and deacceleration is always at a constant rate. Although the crank is turning at a constant RPM, the yoke and shock shaft is being accelerated and deaccelerated at all times. This constant speed change is what allows us to see data not only at the peak points but at any point from zero to that peak velocity. If the speed of the dyno was to change the test data might be affected.

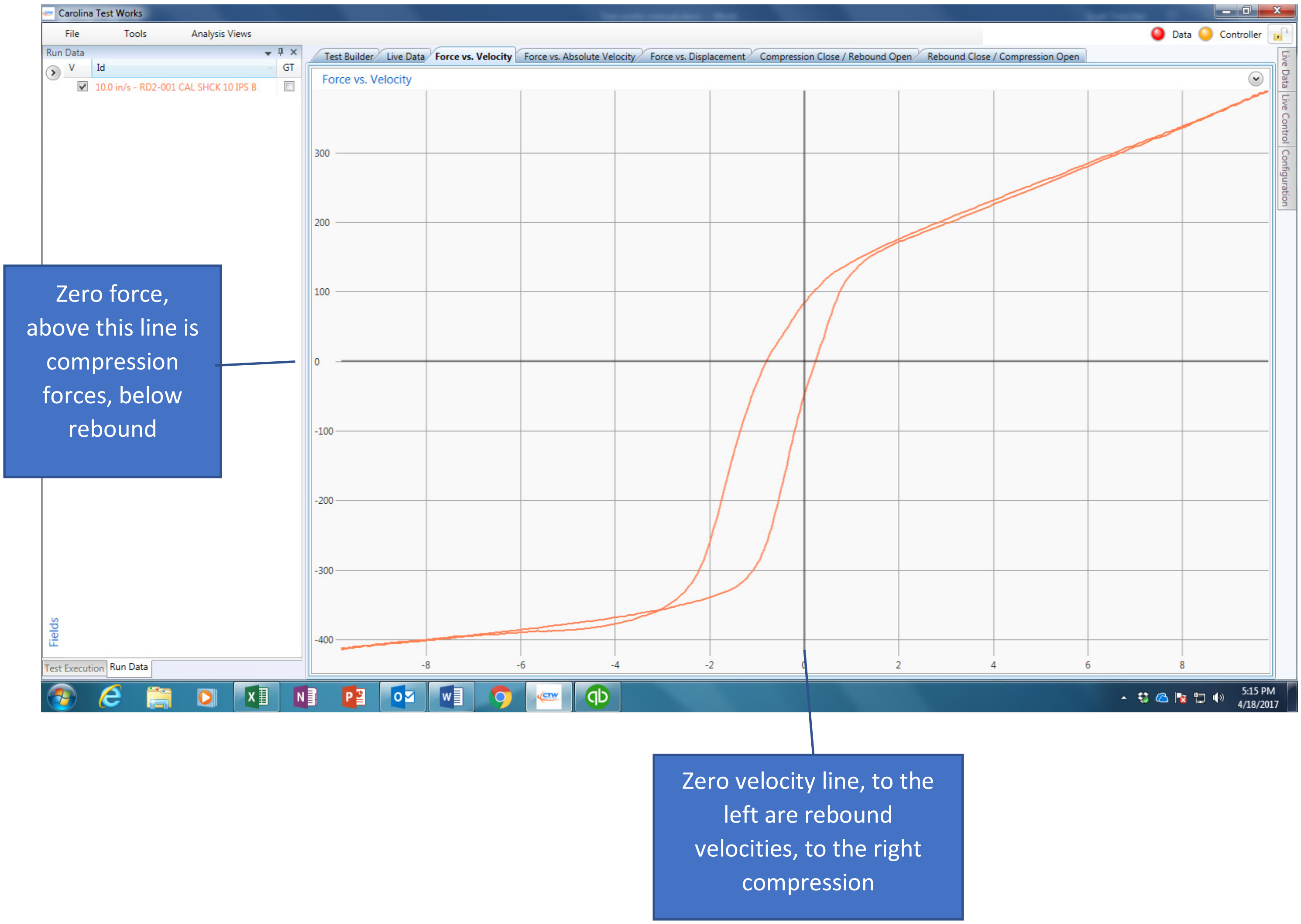
force vs absolute velocity graph



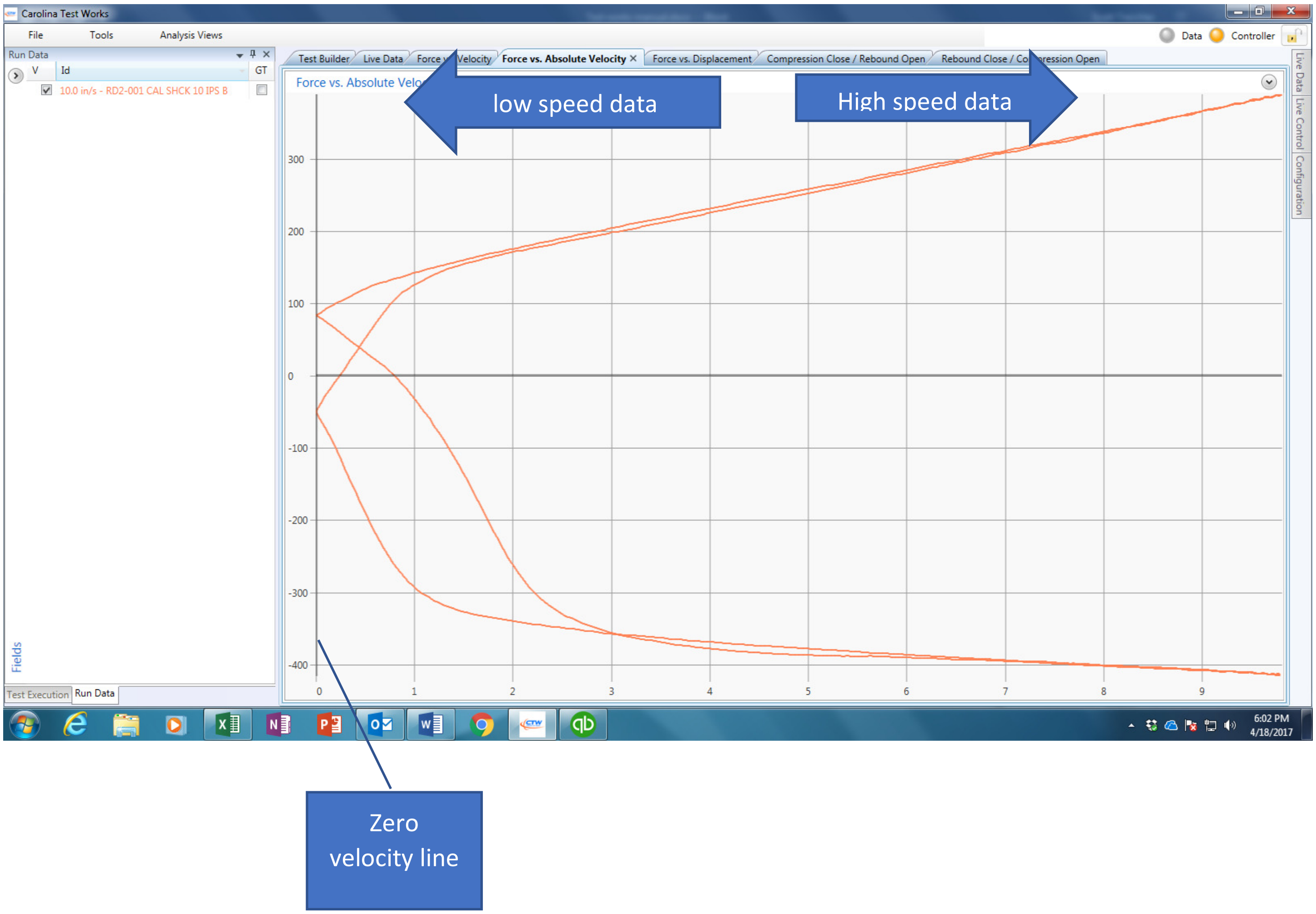


Data can be viewed in several different graphs. Data can also be viewed as a table from a report.

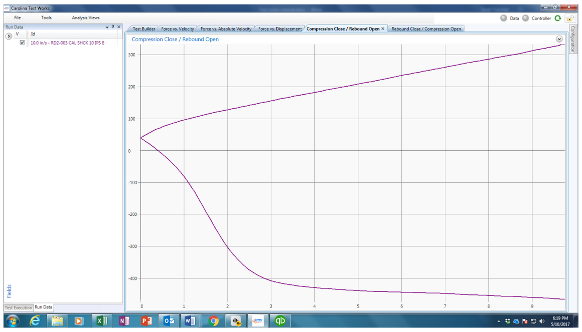
Force vs velocity – This graph displays a complete cycle of data, one complete revolution of the crank and one complete stroke of the yoke and shock, from BDC back to BDC. Forces above the zero force line are forces produced moving in the compression direction, while below the zero line are forces produced as the shock shaft is moved in the rebound direction. Rebound velocity is a negative number.

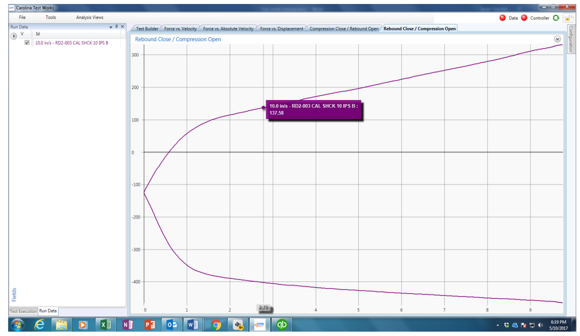


Force vs absolute velocity – The most common graph type used for shock analysis. This graph displays the exact same data as the Force vs velocity graph above. The zero velocity line is moved to the left of the graph, so the rebound lines are “folded over” and all the velocities are in a positive direction. Just like for F vs V graph all forces above the zero force line are compression forces, while forces below are rebound.

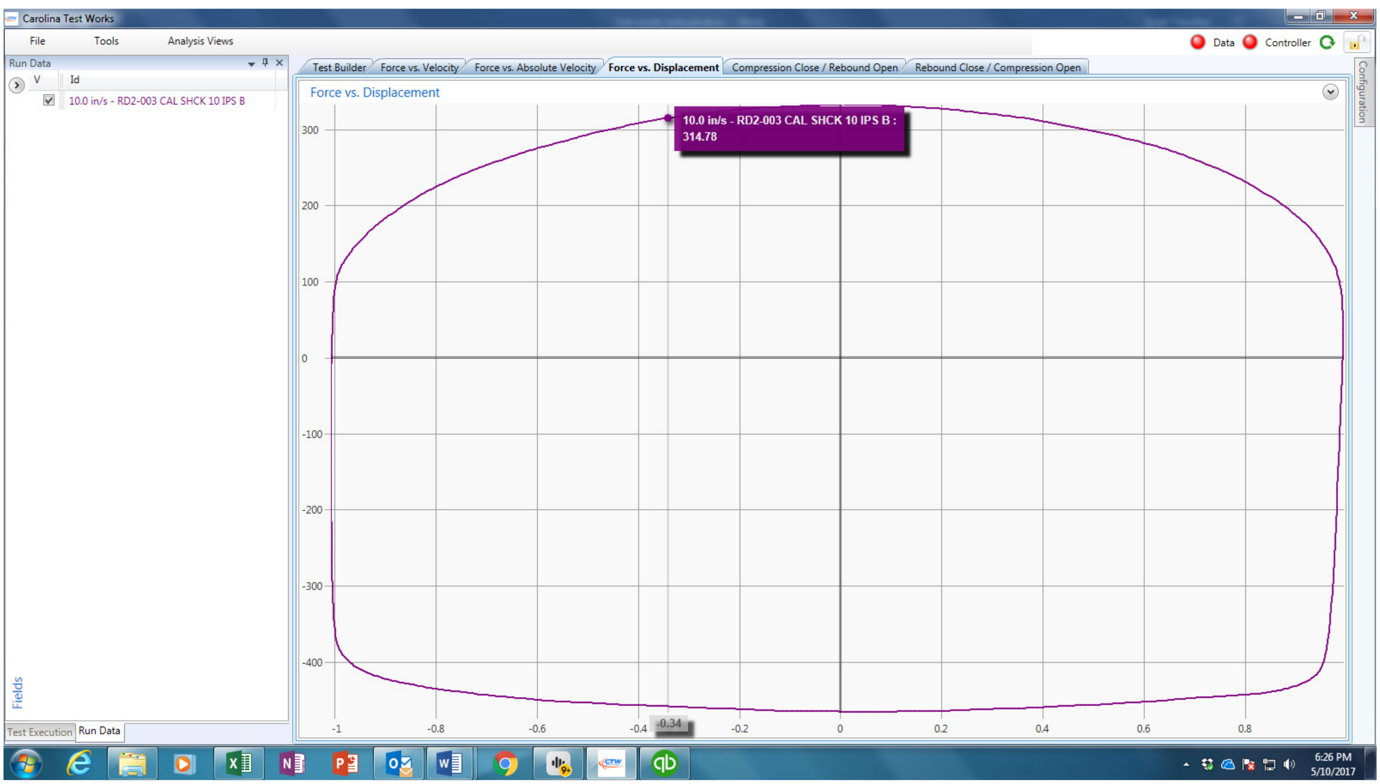


Compression open/rebound close, rebound open/compression close - Both theses graphs are the force vs absolute velocity graph just cut in half. The graph is cut at the peak velocity points. It is the ame data as Force vs absolute velocity, just displayed in two graphs.



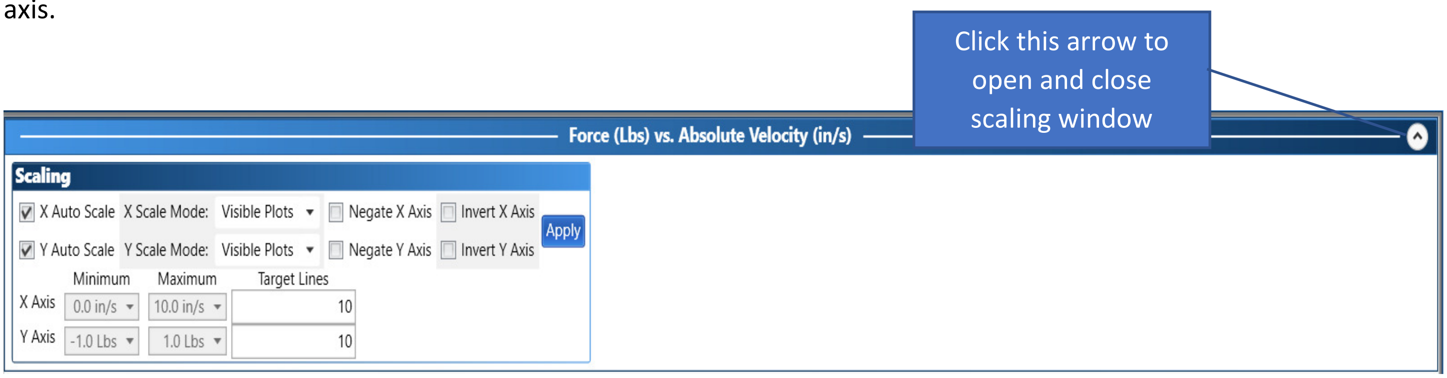


Force vs Displacement - This graph still displays the force on the Y axis but now displacement is on the X axis. So we are looking at the force at any given displacement.



Other features and tools

Scaling - As a default, the program will “auto scale” the graph to fit the data trace just inside of the paper. So the scaling on the page will increase or decrease depending on the velocity or force your shock produces. If you want to lock the graph scaling you can do that by clicking on the arrow in the upper right-hand side of the graph, this will open the scaling page. Remove the check from auto scale, type in your minimum and maximum for each axis, and hit apply when done. Each graph type scales independently. You can also select the number of target lines for both the X and Y axis.



Units - In the file menu click “Unit System” to select US standard or metric units. Use the “unit preferences” to define which metric units your perfer (mm,m,cm) and unit precision.

Layout - The “layout” selection under the file pull down menu allows the user to reset his software layout to a factory default or save and reload a custom layout.

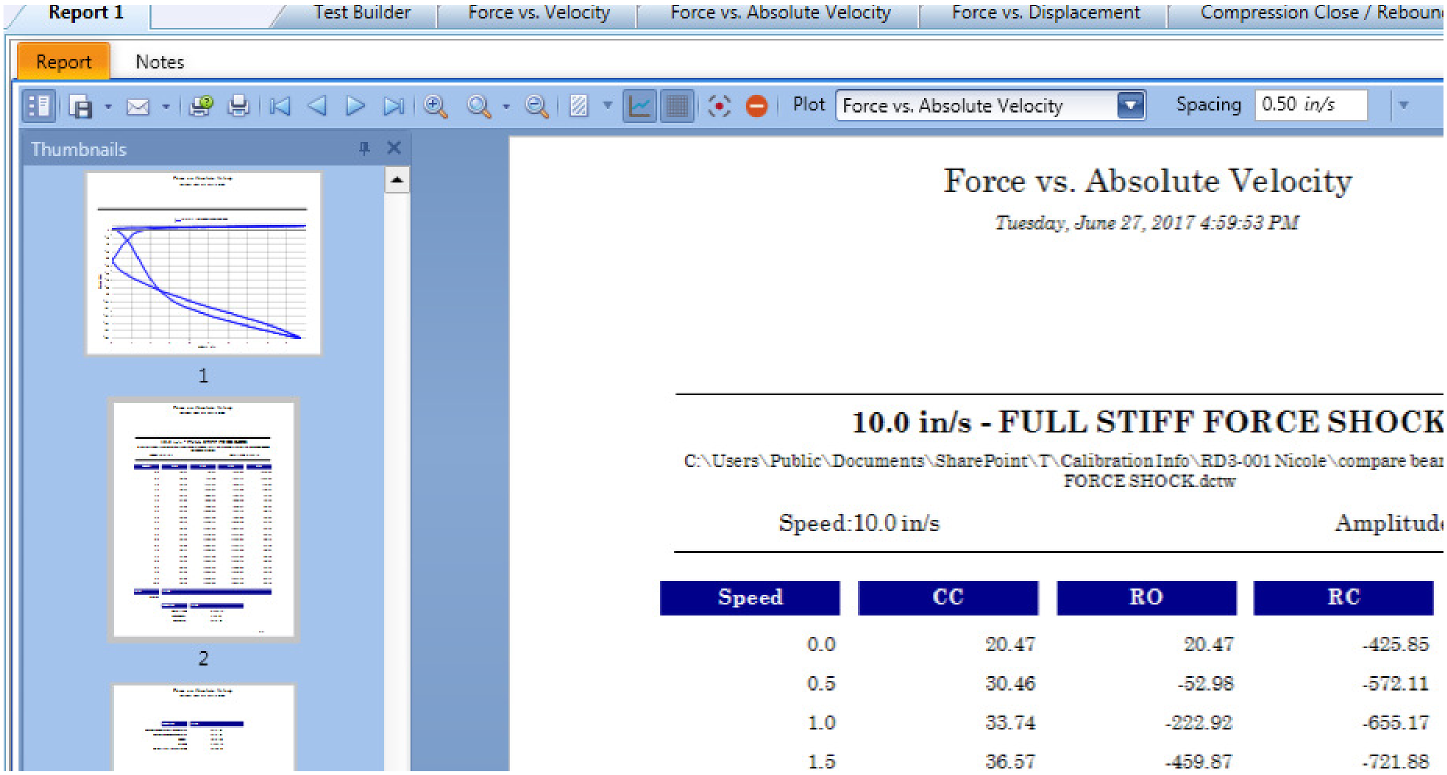
Check for updates - If your computer is connected to the internet you can click on check for updates” in the file pull down menu to find and download any software updates that may be avalible.

Report - Collected data can be displayed as a text report. In the “Test Data” column right click on any open data file’s name. You will be alble to select any or all of the open data files to produce a report. Reports show up as a tabbed page at the top of the screen. If you have a lot of reports open the “thumbnail button at the top of the page will list the page as thumbnails on the left side of the report. You can also export or email the reports from tool bar buttons at the top of the report page. There is also an “Active Report” tab in the default layout that will do the same for any data files that are open or “active”.

Print - Printing is done from the report page using two tool bar buttons at the top of the report page. Quick print will print whatever graph or report you have displayed using the default printer settings. Custom print allows the user to select print features and pages.

If you want to add notes to your printed graph page click on the “notes” tab at the top of the page. Notes will be added above the graph.

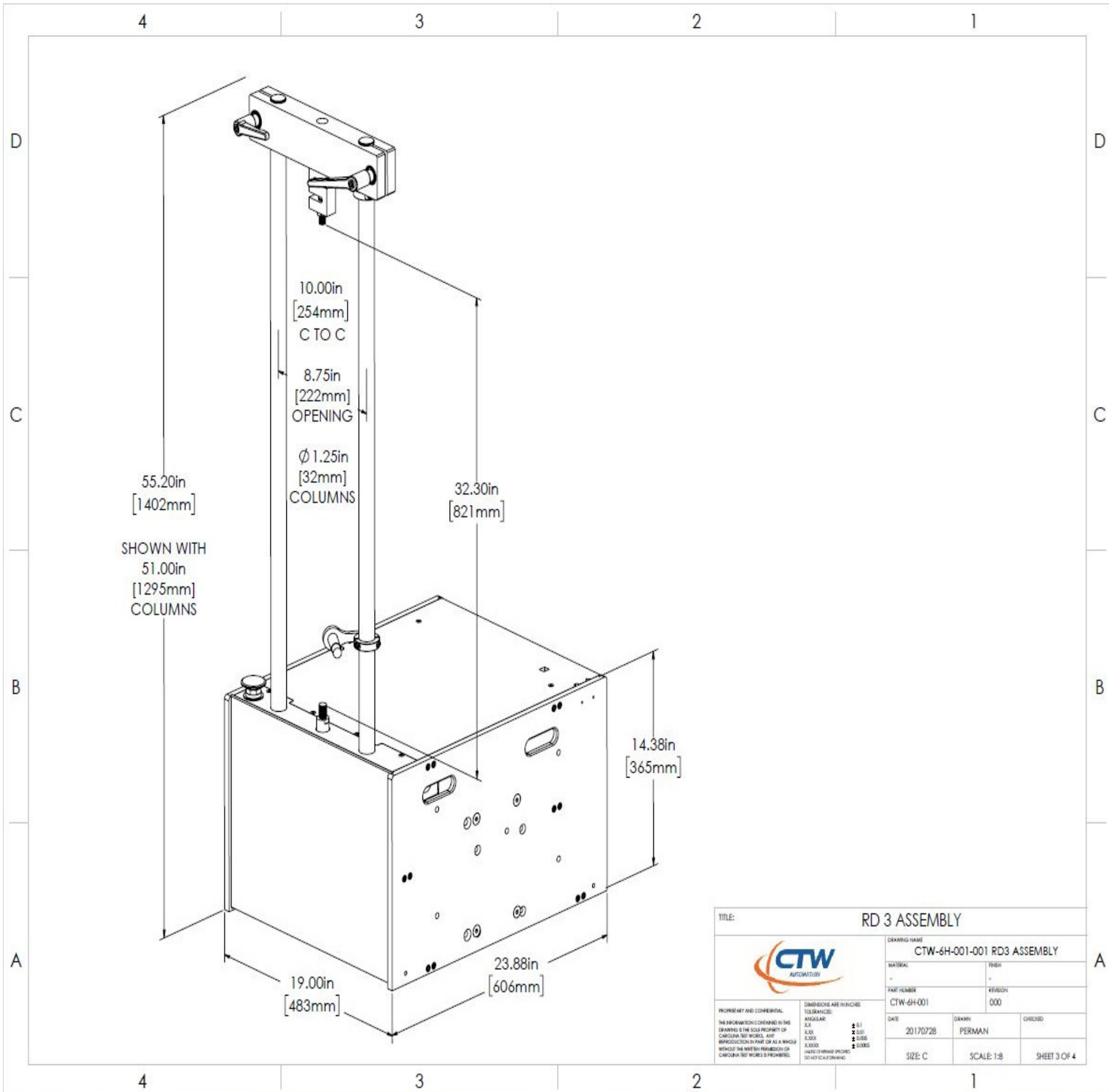
Add logo - The add logo tool bar button allows the user to import their company or team logo to print on the reports.



Report and print page

CTW POWER REQUIREMENTS

Dyno Model	Input Voltage/Phase	Amperage in
RD2	200-240VAC/Single Phase (only)	17.8
RD3	200-240VAC/Single Phase	24
RD3	200-240VAC/3 Phase	14.9
RD3	380-500VAC/3 Phase	8.8
RD5	200-240VAC/Single Phase	?
RD5	200-240VAC/3 Phase	23.8
RD5	380-500VAC/3 Phase	?
RD7.5	200-240VAC/3 Phase	?
RD7.5	380-500VAC/3 Phase	20.7
RD10	200-240VAC/3 Phase	46.1
RD10	380-500VAC/3 Phase	26.6



General Dimensional Outline of RD2 and RD3