JOUNCESHOCK™ TECHNICAL OVERVIEW

INTRODUCTION:

JounceShock™ is Light Racing's term coined originally for the production application of a device known as a "Bumpshock" in the off-road racing arena. Also known as an "Air Bump Stop", these devices have been used in off-road racing since the late 80's, in fact helping to revolutionize the sport as the development of high travel suspensions and position sensitive shocks were initially evolving. While quite effective for off-road racing applications, not much research or characterization had been done until Light Racing began investigating the functional characteristics of the device in the late 90's.

Essentially an air spring with damping control, the **JounceShock** is a critically damped, fixed containment gas spring, which is compressed by the suspension during jounce travel and allowed to separate from the suspension during rebound travel. The closed system provides an exponential Force vs. Displacement (Static) component coupled with a Force vs. Velocity (dynamic) component on the compression stroke, along with critically damped and uncoupled operation during the rebound stroke.

As a supplemental suspension device, typically utilized during the last 1/3 of jounce travel, the JounceShock provides **exponential bottoming protection** and substantial attributes in gross vehicle motion control.

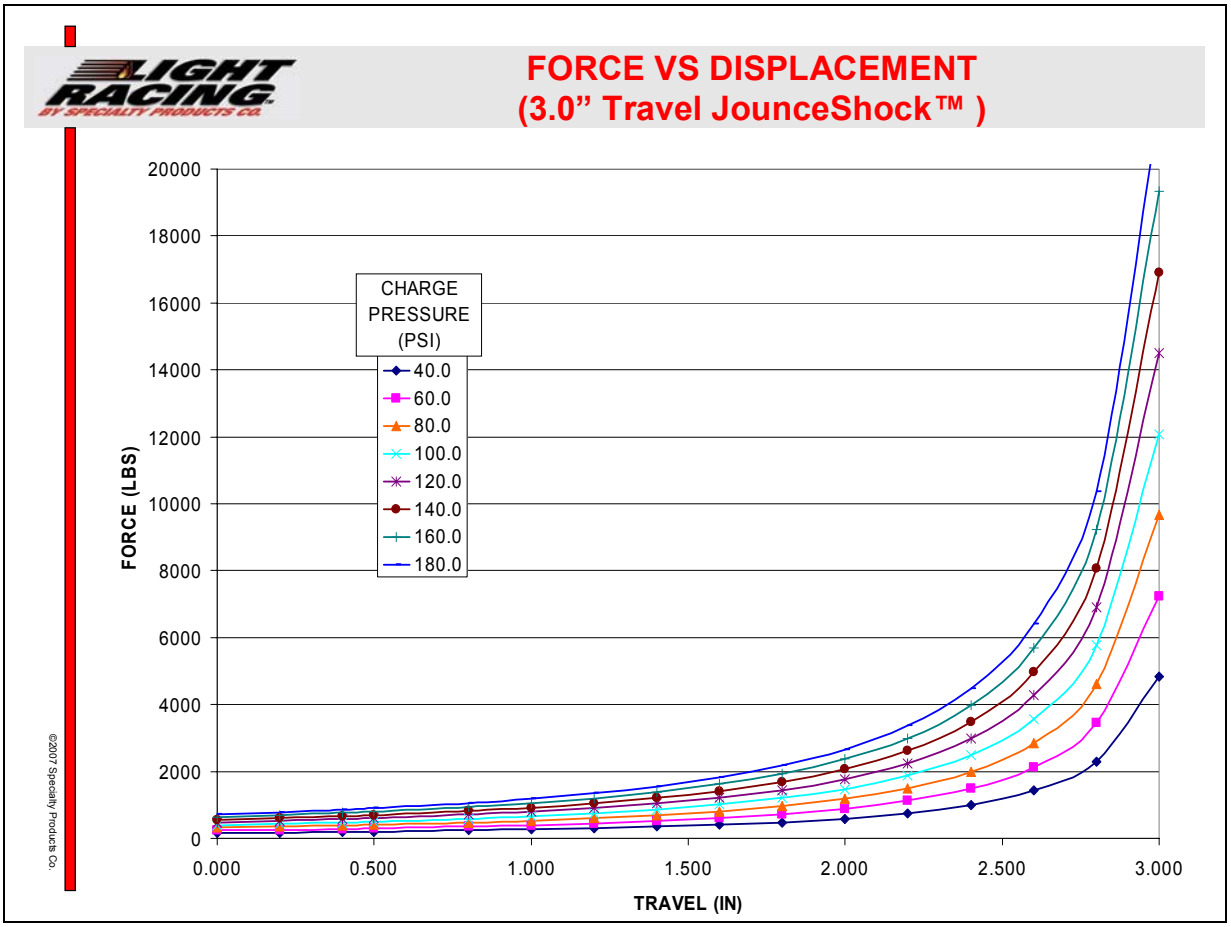
While originally developed for off-road use, the JounceShock has also demonstrated inherent benefits for **on-road use** in various performance areas including roll control and roll damping, gross vehicle motion control, reduced nominal ride rate, payload capacity, and safety. The JounceShock excels in many applications requiring additional capacity and control, from heavily loaded trucks or military vehicles to high performance or lowered street vehicles.

The Light Racing JounceShock is a highly developed and **Patented** (US 7,140,601 B2 Nov. 28, 2006) new form of bump shock with externally adjustable compression and rebound damping. The modular base unit is threaded on both ends allowing for a wide variety of off-the-shelf or custom end conditions. The fully re-buildable unit allows custom oil fill volumes as well as initial charge pressures, both being critical tuning features for application specific performance tuning.

STATIC FORCE COMPONENT:

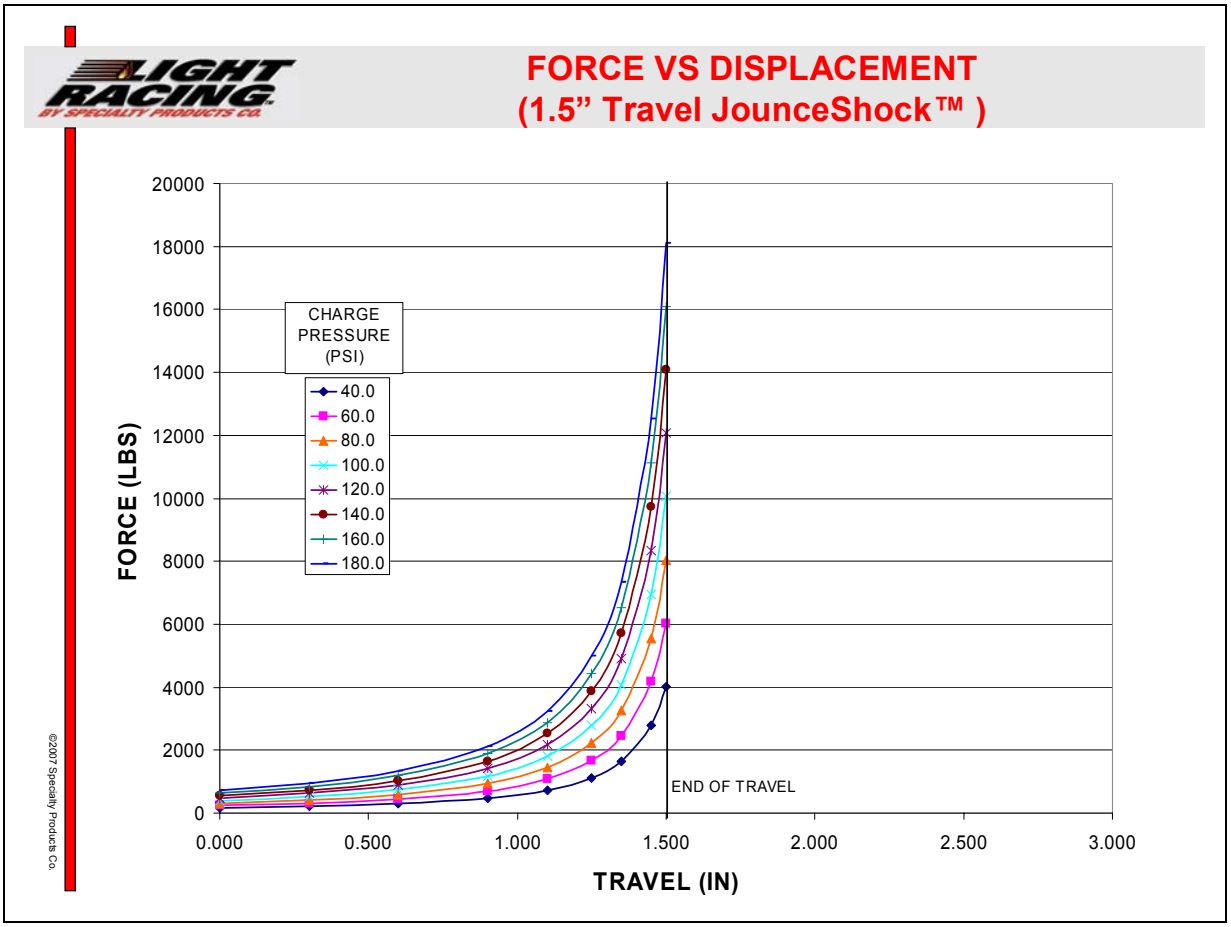
The integral gas spring feature provides a “static” force component during the compression stroke that is a **function of the displacement** of the JounceShock. The large shaft diameter causes the internal pressure and the resulting force required to compress the JounceShock to increase exponentially through its travel.

The illustration below shows the Force vs. Displacement values for the standard Light Racing **3.0” Travel JounceShock** which uses an oil fill volume of **228 ml**. Normally supplied with an **80 psi** initial charge pressure, the illustration also shows an array of curves at other charge pressures. This demonstrates the tune-ability of the static force component by simply changing the charge pressure.



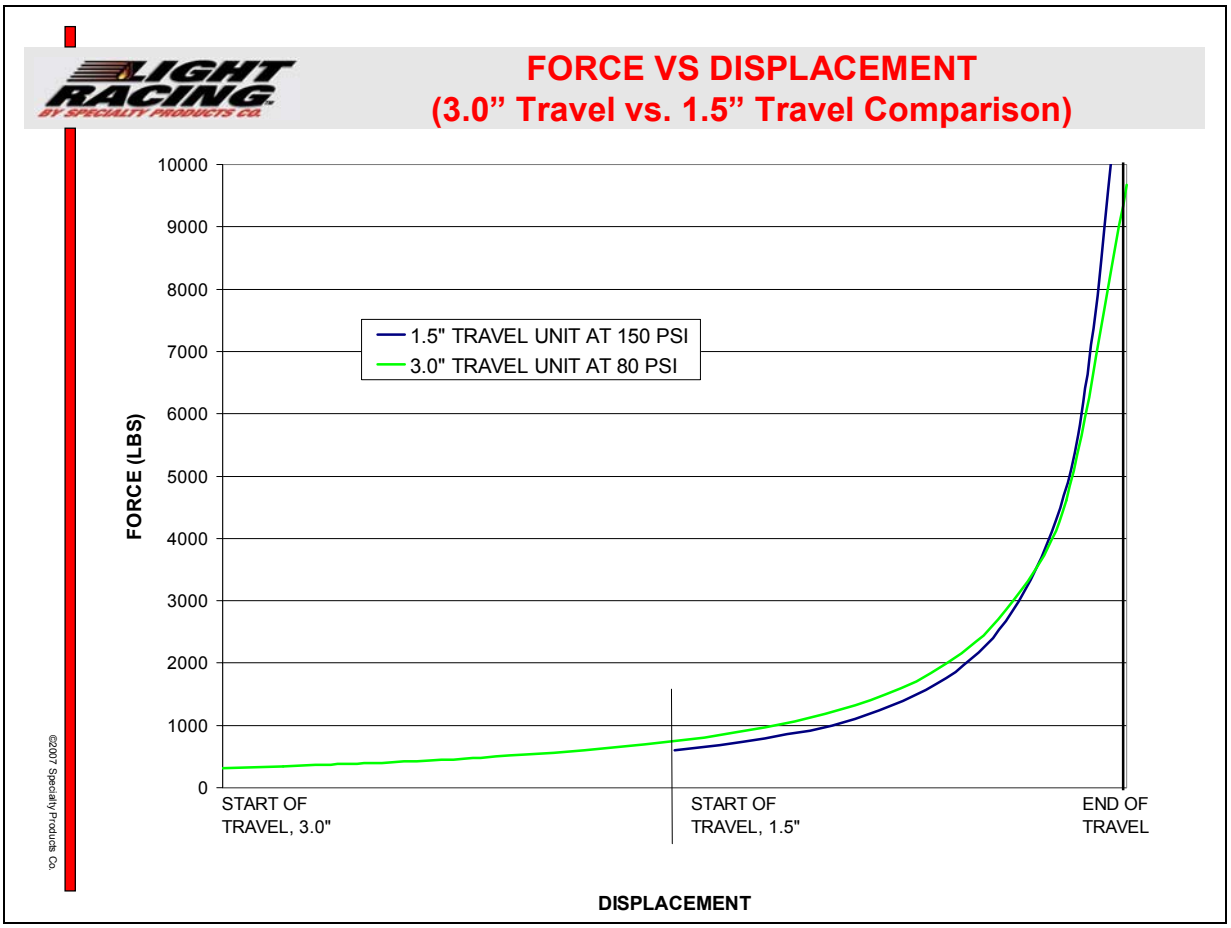
While the range shown includes 40 – 180 psi, it should be noted that higher charge pressures can easily be used, allowing great force variation within the “travel” window for individual applications. **Caution is advised**, depending on the total capability of any particular system to generate high energy, to make sure that you do not exceed the design capability of the JounceShocks. Please consult with the Light Racing engineering staff for custom application design limits.

The 3.0” travel JounceShock is typically used in 1:1 motion ratio suspension configurations. It can also be used for leveraged motion ratios for higher suspension travel applications if desired. More commonly, the Light Racing 1.5” travel JounceShock is perfect for the higher motion ratio configurations such as in the typical stock bump stop location of an independent SLA (double wish bone) type suspension. Normally supplied with a **150 psi** initial charge pressure, the Illustration below shows the same array of Force vs. Displacement curves for the **1.5” Travel JounceShock** at various charge pressures.



The shorter travel and shorter overall length of the 1.5” travel unit make it an ideal choice for limited real estate scenarios. By using this JounceShock with an appropriate motion ratio (commonly 2.5 to 1 and up to even 4:1), similar results can be obtained as would be achieved with a lower motion ratio position, by using the correct location and settings. The next figure illustrates how both the 1.5” travel and the 3.0” travel JounceShocks can provide a very similar function for a given suspension and motion ratio with differential

settings. In this case, if the room wasn't available, you could achieve a similar function with the smaller unit. On the other hand, if the room were available, the longer unit allows the potential for more dynamic response over a longer portion of the suspension travel.



It should be noted that varying the initial charge pressure is generally considered the most effective (and therefore primary) tuning adjustment for the JounceShock.

DYNAMIC FORCE COMPONENT:

In addition to the "static" force generated by the gas spring, the internal damping of the JounceShock creates a "dynamic" force component that is **velocity dependent**. On the compression stroke, the static and dynamic force components combine to produce the total force opposing the suspension movement based on both the position and velocity of the JounceShock at any given point in time.

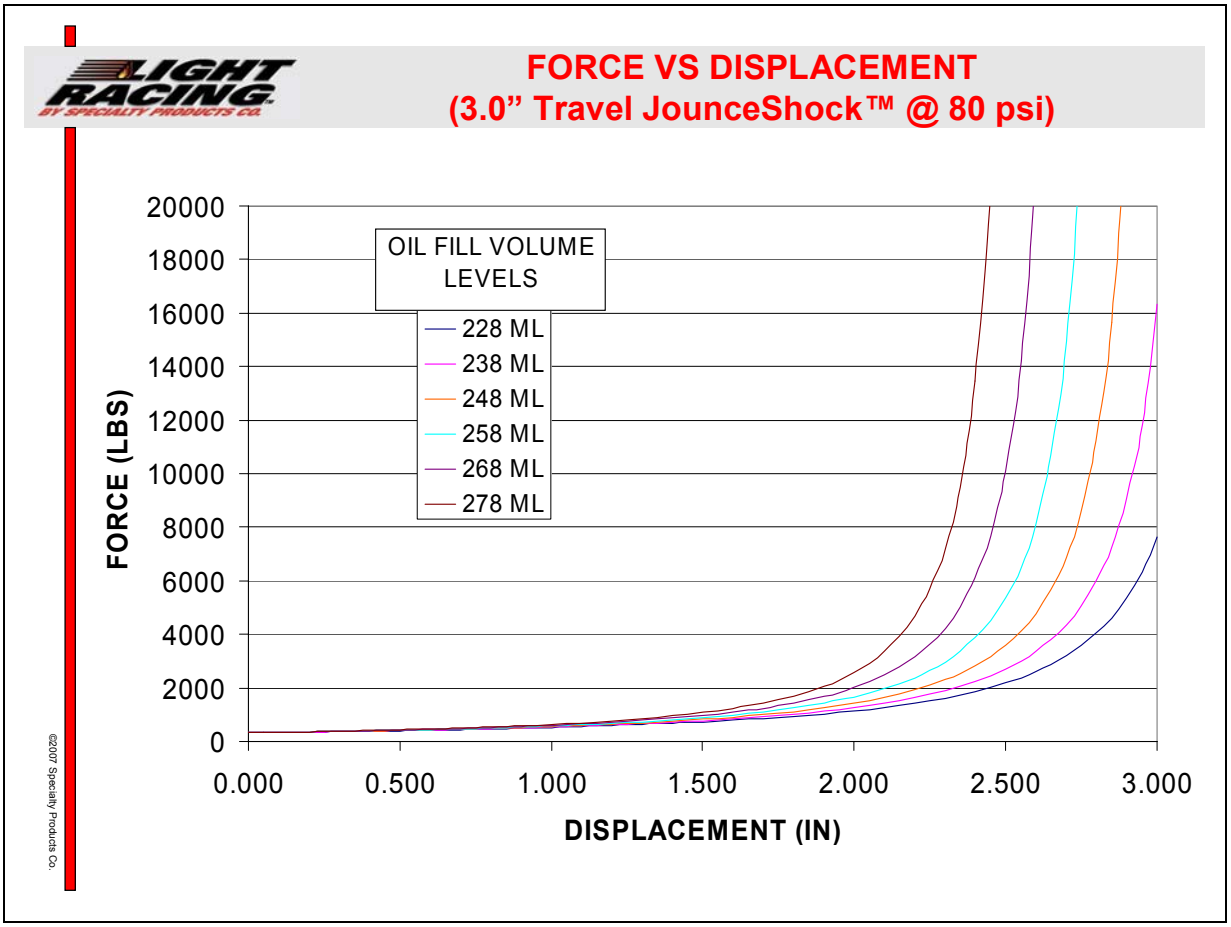
The magnitude of the dynamic force component in compression can easily dominate the total force by 2, 3 or even many times the magnitude of the static force component. This is dependent on an infinite array of input combinations. The external adjustability of the compression bleed circuit on the Light Racing JounceShocks allows about a 50% variation in the nominal dynamic compression force.

During the rebound stroke, the suspension is capable of decoupling from the JounceShock, which means that the dynamic force component in rebound is only resisting the extension of the JounceShock as the stored spring energy is released. The rate of release can greatly affect the ride frequency ratios of the vehicle, which in turn can be tuned to enhance the flat ride capability of the vehicle as well as other ride and handling performance attributes.

OIL FILL VOLUME EFFECTS:

All of the Light Racing JounceShocks are filled with a standard oil fill volume that attempts to precisely limit the maximum pressure capable of being generated before coming in metal-to-metal contact at full compression. This limit is based on the “static” force component only, as the velocity of the JounceShock (and therefore the dynamic force component) is approaching zero at this maximum travel point.

It is important, however, to understand the effects of the oil fill volume so that it may be maintained properly, and in some cases, used to enhance the performance tuning of the system. In the next illustration, the static Force vs. Displacement curves for a 3.0” travel JounceShock are again plotted, only this time the initial charge pressure is held at a constant 80 psi, while the oil fill volume is varied.



Note that the standard curve with the oil fill volume at 228 ml hits the maximum displacement of 3.0" at a corresponding maximum force of around 6800 lbs. (In the 1.5" travel unit, the oil fill is 154 ml and the max load is just over 15,000 lbs.) As more oil is added, the asymptote of the exponential curve shifts left towards a lower displacement value.

This asymptote can be used as an **artificial travel limit**, where the JounceShock effectively gets to the "hydraulic lock" condition, or extremely high force values. In some cases, this can be used to advantage as long as the vehicle and/or use conditions can't put so much energy into the JounceShock as to exceed its design limits. Again, please consult with the Light Racing engineering staff for custom application design limits.

On the other end of the spectrum, it is critical to maintain the minimum oil fill volumes for maximum performance. A relatively small loss of oil or incorrect oil fill will quickly diminish the capacity of the static force component resulting in metal-to-metal bottoming of the JounceShock.

OTHER DESIGN NOTES / RELATED INFORMATION:

- In most racing applications, the contact foot of the JounceShock is made of plastic (nylon or equivalent) for extreme durability. These harder end types can be noisy when they initially contact the suspension. For OEM production and street use, much of the contact noise can be managed by optimizing the placement of the JounceShocks with regard to the nominal contact gap and other integration strategies. In addition to this, Light Racing is continually developing **new end conditions** for the ever expanding system applications. We have recently added both domed and cupped noise attenuating rubber contact feet in two different hardness's.

- Please reference our website **WWW.LIGHTRACING.COM** for more details regarding JounceShock technical specifications and information. Many application pictures, dimensions, and other details are also illustrated in the Light Racing Catalog.

- For **supplemental information** related specifically to this technical overview, check out the instruction sheets for the JounceShock™ Custom Application (Part No. 25710 – 1.5" Travel & Part No. 25715 – 3.0" Travel) as well as the instruction sheet for the JounceShock™ Rebuild Kit (Part No. – 25712). These can be found on the website as well.