

## Keep Your Load in the Bucket with HydraForce Pressure-balanced Boom Suspension

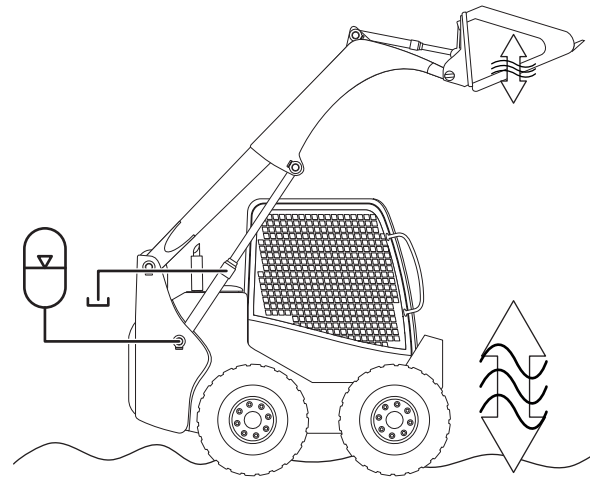
### Overview

Compact wheel loaders, skid-steer loaders, and backhoe-loaders may not be the biggest machines on the construction site, but they often do most of the work, from scooping, lifting, moving and dumping, to minor grading tasks such as scraping and back-dragging.

Due to their compact size, these machines can get into places and do things other construction machines cannot. But one of the shortcomings of compact loaders is the lack of wheel suspension. When you add a large load and elevate it, the center of mass changes. Driving across a jobsite or between jobsites, it can be a challenge to keep from losing the cargo. Efficiency and operator safety demand better performance from today's machines.

For small and mid-size loaders, skid-steer loaders, and tractor/loader/backhoe machines, the rough ride comes with the territory, so to speak. We rely on the operator to adjust working habits to accommodate machine performance. This means working more slowly and deliberately, limiting tight turns, extending braking distances, and avoiding difficult terrain. This is a drag on productivity.

While most loaders do not employ wheel suspension, the larger and more sophisticated machines are often equipped with some form of accumulator-based boom suspension. This system provides damping of the material load through exchange of fluid with a gas-charged accumulator. The compressible gas is able to absorb shock loads and has an overall decoupling effect that allows the vehicle chassis to ride over rough terrain while the boom is able to "float." Without this cushioning, bumps are transmitted to the load and the jarring motion can not only cause loss of material, but the flexing of boom and chassis components can set off unwanted oscillations.



For machines that do feature boom suspension, the challenges are many:

- Cost of additional components
- Engaging the suspension during travel and disengaging for grading tasks
- Adapting the suspension to changing loads
- Load movement as suspension engages
- Load movement due to accumulator discharge



For detailed information and specifications, visit [www.hydraforce.com](http://www.hydraforce.com) or contact your local HydraForce representative at [www.hydraforce.com/distributors/world.htm](http://www.hydraforce.com/distributors/world.htm)

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## Current Suspension Systems

Suspension systems available in the market today suffer from some limitations. Operators often complain that the suspension is either under or over reactive, there are unwanted boom movements, it has mushy performance when digging, or that the load creeps down when travelling over distance with an elevated boom. These issues are primarily related to an application weakness in how the accumulator is charged.

Many of the systems are simply adjunctive, that is to say: they piggy-back onto the existing boom circuit as an afterthought. These suspension systems do not have a pump connection and can only charge while the operator is raising the boom. Normally the accumulator happily absorbs pressure spikes, and this is the desired damping performance of the system. But when the operator drives the vehicle into a pile of material to pick up a load, the resulting pressure rise causes an unwanted boom movement as fluid exits the cylinder and flows into the accumulator. Skid-steer loader operators may experience a familiar "clunk" as the boom drops onto the mechanical stops.

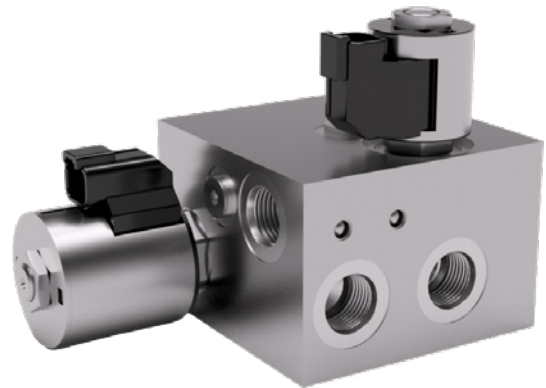
Accumulator charge is critical to suspension performance. The appropriate charge is always equal to the cylinder pressure. Too high or too low a charge can cause a noticeable load movement as the accumulator rebalances when the system is activated. Without a pump connection, these systems are unable to match the load in all operating conditions.

Finally, valves used to set and maintain the accumulator pressure will all suffer from some amount of leakage. Without a source of makeup flow, this ultimately leads to a creeping load, causing the operator to compensate by adjusting boom elevation.

## Balancing the Pressure

The HydraForce pressure-balanced boom suspension system offers a more responsive load-adaptive control for compact loaders. It works as an integrated system or as an add-on to an existing system to give skid-steer and compact loaders an economical suspension system that competes with larger machines.

At the heart of the system is the patent-pending **PB08 E40** pressure-balanced accumulator charging valve. This valve is an externally piloted pressure reducing/relieving valve designed to regulate accumulator charge. With connections to pump and tank it is able to match pressure in the regulated port to pressure in the pilot port, even when the boom cylinder is disengaged from the accumulator.



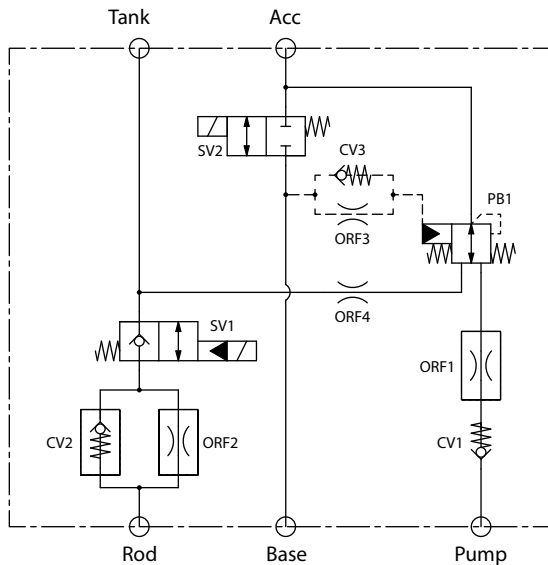
The available proving manifold includes solenoid enable valves to allow the suspension to be deactivated for grading tasks such as scraping and back-dragging. It also includes provision for quickly changing out damping orifices. It can be plumbed directly into the boom circuit for testing. At production time, the optimized circuit can be integrated into the vehicle hydraulic system, or the components can be placed in a custom manifold and remotely mounted.

The primary difference of this system is that, through the use of a pump connection, it is able to maintain the accumulator charge without borrowing oil from the boom cylinder. This means the boom doesn't drop during travel, or jerk suddenly when the system is activated, and operators won't experience mushy performance when digging into a pile of material. It simply performs the way the operator expects.

## Features

- Pressure-balanced accumulator charging
- Load does not move when system is activated
- Leakdown protection
- Charges using pump flow / discharges to reservoir
- Two solenoid enable valves
- Quick system tuning





### Operation

The manifold has connections for pump, tank, accumulator, boom cylinder rod, and boom cylinder base. Solenoid valves enable suspension operation by connecting the cylinder base to the accumulator and the cylinder rod to the tank. The pressure-balanced accumulator charging valve regulates pressure in the accumulator based on a pilot signal from the boom cylinder base. This pilot connection allows accumulator load-balancing even when the suspension is disengaged.

### Performance

HydraForce engineers developed this system to fit a broad range of vehicles and boom configurations. Knowing that although the primary suspension issue is the same for all booms, the differences in vehicle dynamics, hydraulics, and boom geometry require a flexible and adaptable solution. During development, the system was tested on a variety of compact loaders. HydraForce was able to see marked performance improvement in load balancing and leakdown during travel. The ability to observe and document actual machine performance in our Innovation and Technology Center gives HydraForce a distinct advantage in developing components and systems that solve real world problems.

### Proving

Any of the orifices in the system can be changed to tune performance. The system allows control of the following performance characteristics:

- Accumulator charge/discharge rate
- Pilot circuit damping
- Cylinder rod-end metering

### Advantages

Advantages of using a pressure-balanced boom suspension:

- Keep the load in the bucket
- Increase operator comfort
- Increase working efficiency
- Reduce wear on vehicle components
- Increase travel speeds
- Decrease braking distances
- Adapt easily to any system
- Standardized hardware available for proving

### Summary

The HydraForce pressure-balanced boom suspension system offers operators a better overall experience because it performs reliably under all operating conditions. It offers a more responsive load-balanced control that is able to maintain accumulator charge even when the system is disengaged. This means the boom doesn't drop during travel, or jerk suddenly when the system is activated, and operators won't experience mushy performance when digging into a pile of material. Even skid-steer and compact loaders can employ an economical suspension system that competes with larger machines. The HydraForce proving manifold allows anyone to test and precisely performance-tune the system for a specific vehicle. This flexible all-cartridge solution can be mounted close to the boom or integrated into a complete vehicle hydraulic system manifold. Operators are able to work more quickly and efficiently because vehicle stability is greatly improved. Safer and more efficient machines get the job done faster.

