Overview

With its world headquarters located in Orchard Park, New York, USA, **ITT ENIDINE Inc.** is a world leader in the design and manufacture of standard and custom energy absorption and vibration isolation product solutions within the Industrial, Aerospace, Defense, Marine and Rail markets. Product ranges include shock absorbers, gas springs, rate controls, air springs, wire rope isolators, heavy industry buffers and emergency stops. With facilities strategically located throughout the world and in partnership with our vast global network of distributors, Enidine Incorporated continues to strengthen its presence within marketplace.

Founded in 1966, ITT Enidine Incorporated now has close to 600 employees located throughout the globe in the United States, Germany, France, Japan, China and Korea. With a team of professionals in engineering, computer science, manufacturing, production and marketing our employees provide our customers the very best in service and application solutions.

"ITT Enidine is widely recognized as the preferred source for energy absorption and vibration isolation products."

From Original Equipment Manufacturers (OEM) to aftermarket applications, ITT Enidine offers a unique combination of product selection, engineering excellence and technical support to meet even the toughest energy absorption application requirements.

Global Manufacturing and Sales Facilities offer our customers:

- ***Highly Trained Distribution Network***
- ***State-of-the Art Engineering Capabilities***
- ***Custom Solution Development***
- ***Customer Service Specialists***
- ***Multiple Open Communication Channels***

If you are unsure whether one of our standard products meets your requirements, feel free to speak with one of our technical representatives **toll-free at 1-800-852-8508**, or contact us via **e-mail at techsales@enidine.com**.

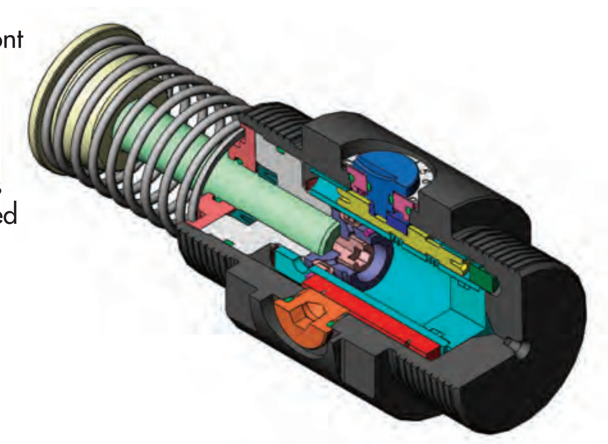
Products/Engineering/Technical Support

ITT Enidine continually strives to provide the widest selection of shock absorbers and rate control products in the global marketplace. Through constant evaluation and testing, we bring our customers the most cost effective products with more features, greater performance and improved ease of use.

New Products and Services

ITT Enidine engineers continue to monitor and influence trends in the motion control industry, allowing us to remain at the forefront of new energy absorption product development such as our new ECO Series shock absorbers and our new HDN Series shock Absorbers.

Our experienced engineering team has designed custom solutions for a wide variety of challenging applications, including automated warehousing systems and shock absorbers for hostile industrial environments such as glass manufacturing, among others. These custom application solutions have proven to be critical to our customers' success. Let ITT Enidine engineers do the same for you.



Custom designs are not an exception at ITT Enidine, they are an integral part of our business. Should your requirements fit outside of our standard product range, Enidine engineers can assist in developing special finishes, components, hybrid technologies and new designs to ensure a "best-fit" product solution customized to your exact specifications.

A talented engineering staff works to design and maintain the most efficient energy absorption product lines available today, using the latest engineering tools:

- ***Solid Modeling***
- ***3-D CAD Drawings***
- ***3-D Soluable Support Technology***
- ***Finite Element Analysis***
- ***Complete Product Verification Testing Facility***

New product designs get to market fast because they can be fully developed in virtual environments before a prototype is ever built. This saves time and lets us optimize the best solution using real performance criteria.

Global Service and Support

ITT Enidine offers its customers a global network of customer service staff technical sales personnel that are available to assist you with all of your application needs.

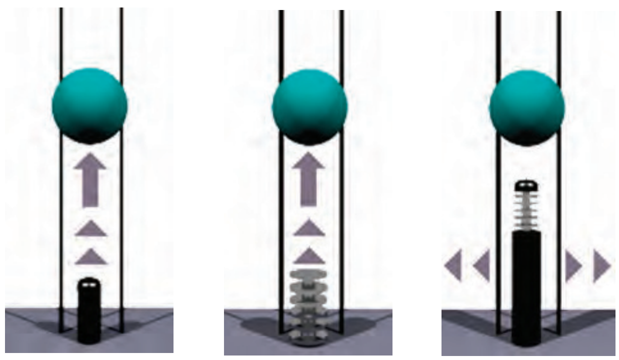
- Operating with lean manufacturing and cellular production, ITT Enidine produces higher quality custom and standard products with greater efficiency and within shorter lead times.
- An authorized Global Distribution Network is trained regularly by ITT Enidine staff on new products and services ensuring they are better able to serve you.
- New Enisize sizing portal provides our customer with the necessary sizing and design tools. www.enisize.com
- Global operations in United States, Germany, France, China, Japan and Korea.
- A comprehensive, website full of application information, technical data, sizing examples and information to assist in selecting the product that's right for you.

Our website also features a searchable worldwide distributor lookup to help facilitate fast, localized service. Contact us today for assistance with all of your application needs.

Our global customer service and technical sales departments are available to assist you find the solution that's right for your application needs. Call us at 1.800.852.8508 or e-mail us at industrialsales@enidine.com and let us get started today.

Overview

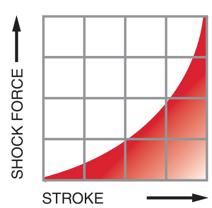
As companies strive to increase productivity by operating machinery at higher speeds, often the results are increased noise, damage to machinery/products, and excessive vibration. At the same time, safety and machine reliability are decreased. A variety of products are commonly used to solve these problems. However, they vary greatly in effectiveness and operation. Typical products used include rubber bumpers, springs, cylinder cushions and shock absorbers. The following illustrations compare how the most common products perform:



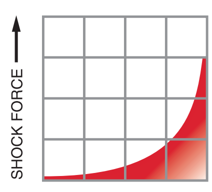
Rubber Bumper | **Metal Spring** | **ITT Enidine Shock Absorber**

All moving objects possess kinetic energy. The amount of energy is dependent upon weight and velocity. A mechanical device that produces forces diametrically opposed to the direction of motion must be used to bring a moving object to rest.

Rubber bumpers and springs, although very inexpensive, have an undesirable recoil effect. Most of the energy absorbed by these at impact is actually stored. This stored energy is returned to the load, producing rebound and the potential for damage to the load or machinery. Rubber bumpers and springs initially provide low resisting force which increases with the stroke.



Cylinder cushions are limited in their range of operation. Most often they are not capable of absorbing energy generated by the system. By design, cushions have a relatively short stroke and operate at low pressures resulting in very low energy absorption. The remaining energy is transferred to the system, causing shock loading and vibration.



Shock absorbers provide controlled, predictable deceleration. These products work by converting kinetic energy to thermal energy. More specifically, motion applied to the piston of a hydraulic shock absorber pressurizes the fluid and forces it to flow through restricting orifices, causing the fluid to heat rapidly. The thermal energy is then transferred to the cylinder body and harmlessly dissipated to the atmosphere.

The advantages of using shock absorbers include:

1. Longer Machine Life – The use of shock absorbers significantly reduces shock and vibration to machinery. This eliminates machinery damage, reduces downtime and maintenance costs, while increasing machine life.

2. Higher Operating Speeds – Machines can be operated at higher speeds because shock absorbers control or gently stop moving objects. Therefore, production rates can be increased.

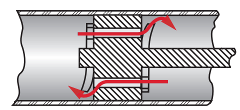
3. Improved Production Quality – Harmful side effects of motion, such as noise, vibration and damaging impacts, are moderated or eliminated so the quality of production is improved. Therefore, tolerances and fits are easier to maintain.

4. Safer Machinery Operation – Shock absorbers protect machinery and equipment operators by offering predictable, reliable and controlled deceleration. They can also be designed to meet specified safety standards, when required.

5. Competitive Advantage – Machines become more valuable because of increased productivity, longer life, lower maintenance costs and safer operation.

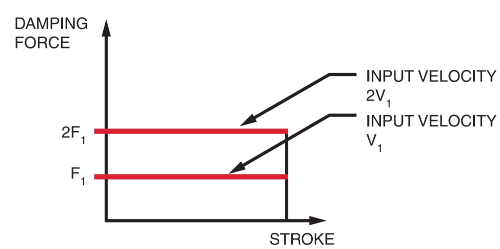
Automotive vs. Industrial Shock Absorbers

It is important to understand the differences that exist between the standard automotive-style shock absorber and the industrial shock absorber.

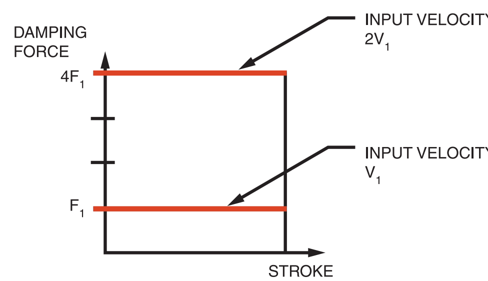


DEFLECTIVE BEAM ORIFICE

The automotive style employs the deflective beam and washer method of orificing. Industrial shock absorbers utilize single orifice, multi-orifice and metering pin configurations. The automotive type maintains a damping force which varies in direct proportion to the velocity of the piston, while the damping force in the industrial type varies in proportion to the square of the piston velocity. In addition, the damping force of the automotive type is independent of the stroke position while the damping force associated with the industrial type can be designed either dependent or independent of stroke position.



AUTOMOTIVE TYPE SHOCK ABSORBER



INDUSTRIAL TYPE SHOCK ABSORBER

Equally as important, automotive-style shock absorbers are designed to absorb only a specific amount of input energy. This means that, for any given geometric size of automotive shock absorber, it will have a limited amount of absorption capability compared to the industrial type.

This is explained by observing the structural design of the automotive type and the lower strength of materials commonly used. These materials can withstand the lower pressures commonly found in this type. The industrial shock absorber uses higher strength materials, enabling it to function at higher damping forces.

Adjustment Techniques

A properly adjusted shock absorber safely dissipates energy, reducing damaging shock loads and noise levels. For optimum adjustment setting see useable adjustment setting graphs. Watching and "listening" to a shock absorber as it functions aids in proper adjustment.

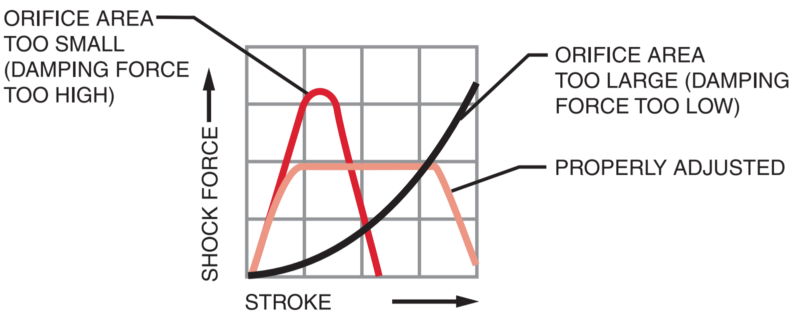
To correctly adjust a shock absorber, set the adjustment knob at zero (0) prior to system engagement. Cycle the mechanism and observe deceleration of the system.

If damping appears too soft (unit strokes with no visual deceleration and bangs at end of stroke), move indicator to next largest number. Adjustments must be made in gradual increments to avoid internal damage to the unit (e.g., adjust from 0 to 1, not 0 to 4).

Increase adjustment setting until smooth deceleration or control is achieved and negligible noise is heard when the system starts either to decelerate or comes to rest.

When abrupt deceleration occurs at the beginning of the stroke (banging at impact), the adjustment setting must be moved to a lower number to allow smooth deceleration.

If the shock absorber adjustment knob is set at the high end of the adjustment scale and abrupt deceleration occurs at the end of the stroke, a larger unit may be required.



Shock Absorber Performance When Weight or Impact Velocity Vary

When conditions change from the original calculated data or actual input, a shock absorber's performance can be greatly affected, causing failure or degradation of performance. Variations in input conditions after a shock absorber has been installed can cause internal damage, or at the very least, can result in unwanted damping performance. Variations in weight or impact velocity can be seen by examining the following energy curves:

Varying Impact Weight: Increasing the impact weight (impact velocity remains unchanged), without reorificing or readjustment will result in increased damping force at the end of the stroke. Figure 1 depicts this undesirable bottoming peak force. This force is then transferred to the mounting structure and impacting load.

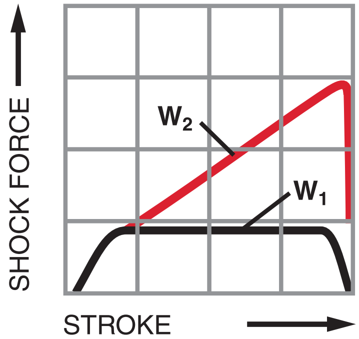


Figure 1

Varying Impact Velocity: Increasing impact velocity (weight remains the same) results in a radical change in the resultant shock force. Shock absorbers are velocity conscious products; therefore, the critical relationship to impact velocity must be carefully monitored. Figure 2 depicts the substantial change in shock force that occurs when the velocity is increased. Variations from original design data or errors in original data may cause damage to mounting structures and systems, or result in shock absorber failure if the shock force limits are exceeded.

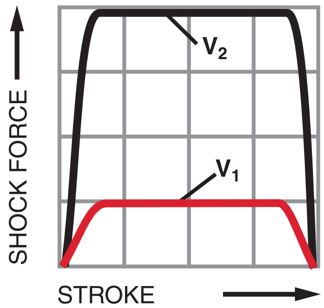


Figure 2

SHOCK ABSORBER SIZING

Follow the next six steps to manually size Enidine shock absorbers:

STEP 1: Identify the following parameters. These must be known for all energy absorption calculations. Variations or additional information may be required in some cases.

A. Weight of the load to be stopped (lbs.)(Kg).
B. Velocity of the load upon impact with the shock absorber (in./sec.)(m/s).
C. External (propelling) forces acting on the load (lbs.)(N), if any.
D. Cyclic frequency at which the shock absorber will operate.
E. Orientation of the application's motion (i.e. horizontal, vertical up, vertical down, inclined, rotary horizontal, rotary vertical up, rotary vertical down).

NOTE: For rotary applications, it is necessary to determine both the radius of gyration (K) and the mass moment of inertia (I). Both of these terms locate the mass of a rotating object with respect to the pivot point. It is also necessary to determine the angular velocity (ω) and the torque (T).

STEP 2: Calculate the kinetic energy of the moving object.

$$E_K = \frac{W}{772} \times V^2 \text{ (linear) or } E_K = \frac{I}{2}\omega^2 \text{ (rotary) or } E_K = \frac{1}{2}MV^2 \text{ (metric)}$$

(Note: 772 = 2 x acceleration due to gravity)

Utilizing the Product Locators for Shock Absorbers located at the beginning of each product family section, select a model, either adjustable or non-adjustable, with a greater energy per cycle capacity than the value just calculated.

STEP 3: Calculate the work energy input from any external (propelling) forces acting on the load, using the stroke of the model selected in Step 2.

$$E_W = F_D \times S \text{ (linear) or } E_W = \frac{T}{R_S} \times S \text{ (rotary)}$$

Caution: The propelling force must not exceed the maximum propelling force listed for the model chosen. If the propelling force is too high, select a larger model and recalculate the work energy.

STEP 4: Calculate the total energy per cycle $E_T = E_K + E_W$

The model selected must have at least this much energy capacity. If not, select a model with greater energy capacity and return to Step 3.

STEP 5: Calculate the energy that must be absorbed per hour. Even though the shock absorber can absorb the energy in a single impact, it may not be able to dissipate the heat generated if the cycle rate is too high.

$$E_TC = E_T \times C$$

The model selected must have an energy per hour capacity greater than this calculated figure. If it is not greater, there are two options:

1. Choose another model that has more energy per hour capacity (because of larger diameter or stroke). Keep in mind that if the stroke changes, you must return to Step 3.
2. Use an Air/Oil Tank. The increased surface area of the tank and piping will increase the energy per hour capacity by 20 percent.

STEP 6: If you have selected an HP, PM, SPM, TK, or PRO Series model, refer to the sizing graph(s) in the appropriate series section to determine the required damping constant. If the point cannot be found in the sizing graph, you must select a larger model or choose a different series. Note that if the stroke changes, you must return to Step 3.

If you have selected an adjustable model (OEM, HP or HDA series), refer to the Useable Adjustment Setting Range graph for the chosen model. The impact velocity must fall within the limits shown on the graph.

RATE CONTROL SIZING

Follow the next five steps to manually size ITT Enidine rate controls:

STEP 1: Identify the following parameters. These must be known for all rate control calculations. Variations or additional information may be required in some cases.

A. Weight of the load to be controlled (lbs.)(Kg)
B. Desired velocity of the load (in/sec.)(m/s)
C. External (propelling) force acting on the load (lbs.)(N), if any.
D. Cyclic frequency at which the rate control will operate.
E. Orientation of the application's motion (i.e. horizontal, vertical up, vertical down, inclined, rotary horizontal, rotary vertical up, rotary vertical down.)
F. Damping direction (i.e., tension [T], compression [C] or both [T and C].
G. Required stroke (in.)(mm)

STEP 2: Calculate the propelling force at the rate control in each direction damping is required. (See sizing examples on page 6-12).

CAUTION: The propelling force in each direction must not exceed the maximum propelling force listed for the chosen model. If the propelling force is too high, select a larger model.

STEP 3: Calculate the total energy per cycle

$$E_T = E_W \text{ (tension)} + E_W \text{ (compression)}$$
$$E_W = F_D \times S$$

STEP 4: Calculate the total energy per hour

$$E_TC = E_T \times C$$

The model selected must have an energy per hour capacity greater than this calculated figure. If not, choose a model with a higher energy per hour capacity.

Compare the damping direction, stroke, propelling force, and total energy per hour to the values listed in the Rate Controls Engineering Data Charts (pages 97-106).

STEP 5: If you have selected a rate control, refer to the sizing graphs in the Rate Controls section to determine the required damping constant.

If you have selected an adjustable model (ADA), refer to the Useable Adjustment Setting Range graph for the chosen model. The desired velocity must fall within the limits shown on the graph.

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Shock Absorber Sizing Examples

Typical Shock Absorber Applications

SYMBOLS

- a = Acceleration (in./sec.^{2})(mls^2)
- A = Width (in.)(m)
- B = Thickness (in.)(m)
- C = Number of cycles per hour
- d = Cylinder bore diameter (in.)(mm)
- D = Distance (in.)(m)
- E_K = Kinetic energy (in-lbs.)(Nm)
- E_T = Total energy per cycle (in-lbs./c)(Nm/c), $E_K + E_W$
- E_TC = Total energy to be absorbed per hour (in-lbs./hr)(Nm/hr)
- E_W = Work or drive energy (in-lbs.)(Nm)
- F_D = Propelling force (lbs.)(N)
- F_P = Shock force (lbs.)(N)
- H = Height (in.)(m)
- Hp = Motor rating (hp)(kw)
- I = Mass moment of inertia (in-lbs./sec^2)(Kgm^2)
- K = Radius of gyration (in.)(m)
- L = Length (in.)(m)
- P = Operating pressure (psi)(bar)
- R_S = Mounting distance from pivot point (in.)(m)
- S = Stroke of shock absorber (in.)(m)
- t = Time (sec.)
- T = Torque (in-lbs.)(Nm)
- V = Impact velocity (in./sec.)(m/s)
- W = Weight (lbs.)(Kg)
- α = Angle of incline (degrees)
- θ = Start point from true vertical 0° (degrees)
- μ = Coefficient of friction
- Ø = Angle of rotation (degrees)
- ω = Angular velocity (radians/sec)

USEFUL FORMULAS

1. To Determine Shock Force

$$F_P = \frac{E_T}{S \times \mathbf{.85}}$$

For PRO and PM Series only, use

$$F_P = \frac{E_T}{S \times \mathbf{.50}}$$

2. To Determine Impact Velocity

A. If there is no acceleration (V is constant) (e.g., load being pushed by hydraulic cylinder or motor driven.) $V = \frac{D}{t}$

B. If there is acceleration. (e.g., load being pushed by air cylinder) $V = \frac{\mathbf{2} \times D}{t}$

3. To Determine Propelling Force Generated by Electric Motor

$$F_D = \frac{\mathbf{19{,}800} \times Hp}{V} \qquad F_D = \frac{\mathbf{3\ 000} \times Hp}{V} \text{ (metric)}$$

4. To Determine Propelling Force of Pneumatic or Hydraulic Cylinders

$F_D = \mathbf{.7854} \times d^2 \times P$ $\quad F_D = \mathbf{0{,}07854} \times d^2 \times P$ (metric)

5. Free Fall Applications

A. Find Velocity for a Free Falling Weight:

$V = \sqrt{\mathbf{772} \times H}$ $\quad V = \sqrt{19{,}6 \times H}$ (metric)

B. Kinetic Energy of Free Falling Weight:

$E_K = W \times H$

6. Deceleration and G Load

A. To Determine Approximate G Load with a Given Stroke

$G = \frac{F_P - F_D}{W}$ $\quad G = \frac{F_P - F_D}{kg \times 9{,}81}$ (metric)

B. To Determine the Approximate Stroke with a Given G Load (Conventional Damping Only)

$$S = \frac{E_K}{GW\ .85 - .15\ F_D}$$

*For PRO/PM and TK Models:

$$S = \frac{E_K}{GW\ .5 - .5\ F_D}$$

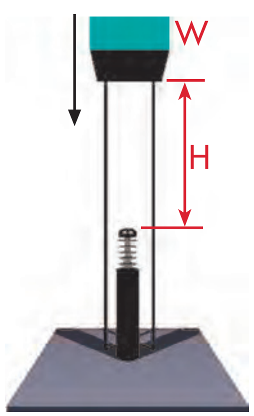
NOTE: Constants are printed in **bold**.

The following examples are shown using Imperial formulas and units of measure.

Shock Absorbers

EXAMPLE 1:

Vertical Free Falling Weight



STEP 1: Application Data

(W) Weight = 3,400 lbs.
(H) Height = 20 in.
(C) Cycles/Hr = 2

STEP 2: Calculate kinetic energy

$E_K = W \times H$
$E_K = 3{,}400 \times 20 = 68{,}000$ in-lbs.

Assume Model OEM 4.0M x 6 is adequate (Page 31).

STEP 3: Calculate work energy

$E_W = W \times S$
$E_W = 3{,}400 \times 6$
$E_W = 20{,}400$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W$
$E_T = 68{,}000 + 20{,}400$
$E_T = 88{,}400$ in-lbs./c

STEP 5: Calculate total energy per hour

$E_TC = E_T \times C$
$E_TC = 88{,}400 \times 2$
$E_TC = 176{,}800$ in-lbs./hr

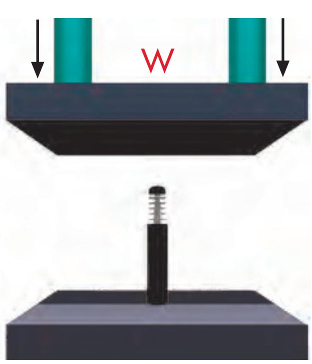
STEP 6: Calculate impact velocity and confirm selection

$V = \sqrt{\mathbf{772} \times H}$
$V = \sqrt{\mathbf{772} \times 20}$
$V = 124$ in./sec.

Model OEM 4.0M x 6 is adequate.

EXAMPLE 2:

Vertical Moving Load with Propelling Force Downward



STEP 1: Application Data

(W) Weight = 3,400 lbs.
(V) Velocity = 80 in./sec.
(d) Cylinder bore dia. = 4 in.
(P) Pressure = 70 psi
(C) Cycles/Hr = 200

STEP 2: Calculate kinetic energy

$E_K = \frac{W}{\mathbf{772}} \times V^2 = \frac{3{,}400}{\mathbf{772}} \times 80^2$
$E_K = 28{,}187$ in-lbs.

Assume Model OEM 4.0M x 4 is adequate (Page 31).

STEP 3: Calculate work energy

$F_D = [\mathbf{.7854} \times d^2 \times P] + W$
$F_D = [\mathbf{.7854} \times 4^2 \times 70] + 3{,}400$
$F_D = 4{,}280$ lbs.
$E_W = F_D \times S$
$E_W = 4{,}280 \times 4$
$E_W = 17{,}120$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W$
$E_T = 28{,}187 + 17{,}120$
$E_T = 45{,}307$ in-lbs./c

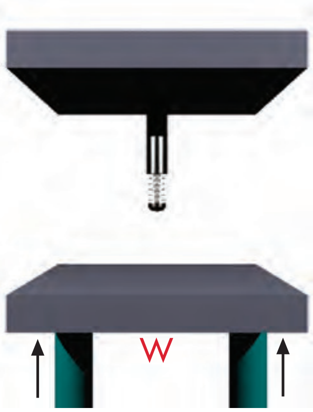
STEP 5: Calculate total energy per hour

$E_TC = E_T \times C$
$E_TC = 45{,}307 \times 200$
$E_TC = 9{,}061{,}400$ in-lbs./hr

Model OEM 4.0M x 4 is adequate.

Shock Absorber Sizing Examples
Typical Shock Absorber Applications

EXAMPLE 3:
Vertical Moving Load with Propelling Force Upward



STEP 1: Application Data
(W) Weight = 3,400 lbs.
(V) Velocity = 80 in./sec.
(d) 2 Cylinders bore dia. = 6 in.
(P) Operating pressure = 70 psi
(C) Cycles/Hr = 200

STEP 2: Calculate kinetic energy

$E_K = \frac{W}{\mathbf{772}} \times V^2 = \frac{3{,}400}{\mathbf{772}} \times 80^2$

$E_K = 28{,}187$ in-lbs.

Assume Model OEM 3.0M x 5 is adequate (Page 31).

STEP 3: Calculate work energy

$F_D = 2 \times [\mathbf{.7854} \times d^2 \times P] - W$

$F_D = 2 \times [\mathbf{.7854} \times 6^2 \times 70] - 3{,}400$

$F_D = 558$ lbs.

$E_W = F_D \times S$

$E_W = 558 \times 5$

$E_W = 2{,}790$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W$

$E_T = 28{,}187 + 2{,}790$

$E_T = 30{,}977$ in-lbs./c

STEP 5: Calculate total energy per hour

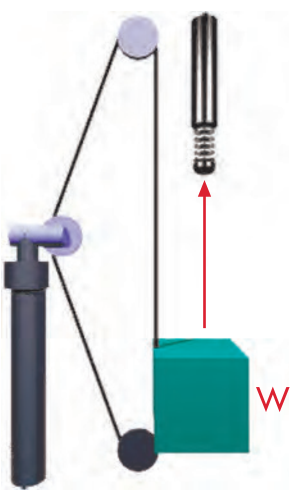
$E_TC = E_T \times C$

$E_TC = 30{,}977 \times 200$

$E_TC = 6{,}195{,}400$ in-lbs./hr

Model OEM 3.0M x 5 is adequate.

EXAMPLE 4:
Vertical Moving Load with Propelling Force from Motor



(e.g., Load Moving Force Up)

STEP 1: Application Data
(W) Weight = 200 lbs.
(V) Velocity = 60 in./sec.
(Hp) Motor horsepower = 1.5 Hp
(C) Cycles/Hr = 100

STEP 2: Calculate kinetic energy

$E_K = \frac{W}{\mathbf{772}} \times V^2 = \frac{200}{\mathbf{772}} \times 60^2$

$E_K = 933$ in-lbs.

CASE A: UP

STEP 3: Calculate work energy

$F_D = \frac{\mathbf{19{,}800} \times Hp}{V} - W$

$F_D = \frac{\mathbf{19{,}800} \times 1.5}{60} - 200$

$F_D = 295$ lbs.

Assume Model OEM 1.25 x 2 is adequate (Page 24).

$E_W = F_D \times S$

$E_W = 295 \times 2$

$E_W = 590$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W$

$E_T = 933 + 590$

$E_T = 1{,}523$ in-lbs./c

STEP 5: Calculate total energy per hour

$E_TC = E_T \times C$

$E_TC = 1{,}523 \times 100$

$E_TC = 152{,}300$ in-lbs./hr

Model OEM 1.25 x 2 is adequate.

CASE B: DOWN

STEP 3: Calculate work energy

$F_D = \frac{\mathbf{19{,}800} \times Hp}{V} + W$

$F_D = \frac{\mathbf{19{,}800} \times 1.5}{60} + 200$

$F_D = 695$ lbs.

Assume Model OEMXT 2.0M x 2 is adequate (Page 29).

$E_W = F_D \times S$

$E_W = 695 \times 2$

$E_W = 1{,}390$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W$

$E_T = 933 + 1{,}390$

$E_T = 2{,}323$ in-lbs./c

STEP 5: Calculate total energy per hour

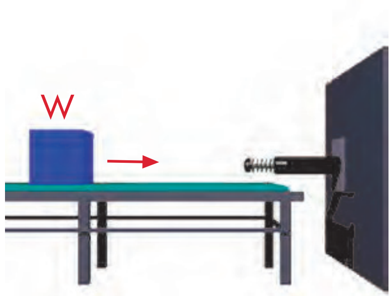
$E_TC = E_T \times C$

$E_TC = 2{,}323 \times 100$

$E_TC = 232{,}300$ in-lbs./hr

Model OEMXT 2.0M x 2 is adequate.

EXAMPLE 5:
Horizontal Moving Load



STEP 1: Application Data
(W) Weight = 1,950 lbs.
(V) Velocity = 60 in./sec.
(C) Cycles/Hr = 200

STEP 2: Calculate kinetic energy

$E_K = \frac{W}{\mathbf{772}} \times V^2$

$E_K = \frac{1950}{\mathbf{772}} \times 60^2$

$E_K = 9{,}093$ in-lbs.

Assume Model OEMXT 2.0M x 2 is adequate (Page 29).

STEP 3: Calculate work energy: N/A

STEP 4: Calculate total energy per cycle

$E_T = E_K = 9{,}093$ in-lbs./c

STEP 5: Calculate total energy per hour

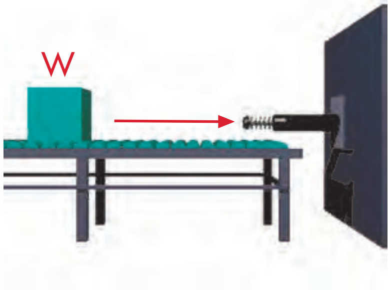
$E_TC = E_T \times C$

$E_TC = 9{,}093 \times 200$

$E_TC = 1{,}818{,}600$ in-lbs./hr

Model OEMXT 2.0M x 2 is adequate.

EXAMPLE 6:
Horizontal Moving Load with Propelling Force



STEP 1: Application Data
(W) Weight = 1,950 lbs.
(V) Velocity = 60 in./sec.
(d) Cylinder bore dia. = 3 in.
(P) Operating pressure = 70 psi
(C) Cycles/Hr = 200

STEP 2: Calculate kinetic energy

$E_K = \frac{W}{\mathbf{772}} \times V^2$

$E_K = \frac{1{,}950}{\mathbf{772}} \times 60^2$

$E_K = 9{,}093$ in-lbs.

Assume Model OEMXT 2.0M x 2 is adequate (Page 29).

STEP 3: Calculate work energy

$F_D = \mathbf{.7854} \times d^2 \times P$

$F_D = \mathbf{.7854} \times 3^2 \times 70$

$F_D = 495$ lbs.

$E_W = F_D \times S$

$E_W = 495 \times 2$

$E_W = 990$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W$

$E_T = 9{,}093 + 990$

$E_T = 10{,}083$ in-lbs./c

STEP 5: Calculate total energy per hour

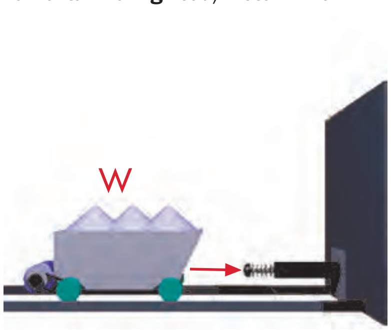
$E_TC = E_T \times C$

$E_TC = 10{,}083 \times 200$

$E_TC = 2{,}016{,}600$ in-lbs./hr

Model OEMXT 2.0M x 2 is adequate.

EXAMPLE 7:
Horizontal Moving Load, Motor Driven



STEP 1: Application Data
(W) Weight = 2,200 lbs.
(V) Velocity = 60 in./sec.
(Hp) Motor horsepower = 1.5 Hp
(C) Cycles/Hr = 120

STEP 2: Calculate kinetic energy

$E_K = \frac{W}{\mathbf{772}} \times V^2$

$E_K = \frac{2{,}200}{\mathbf{772}} \times 60^2$

$E_K = 10{,}259$ in-lbs

Assume Model OEMXT 2.0M x 2 is adequate (Page 29).

STEP 3: Calculate work energy

$F_D = \frac{\mathbf{19{,}800} \times Hp}{V}$

$F_D = \frac{\mathbf{19{,}800} \times 1.5}{60}$

$F_D = 495$ lbs.

$E_W = F_D \times S$

$E_W = 495 \times 2$

$E_W = 990$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W$

$E_T = 10{,}259 + 990$

$E_T = 11{,}249$ in-lbs./c

STEP 5: Calculate total energy per hour

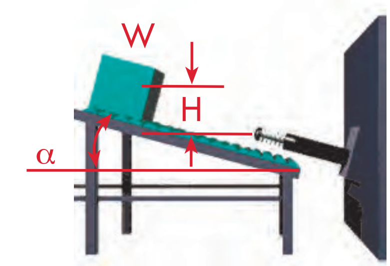
$E_TC = E_T \times C$

$E_TC = 11{,}249 \times 120$

$E_TC = 1{,}349{,}880$ in-lbs./hr

Model OEMXT 2.0M x 2 is adequate.

EXAMPLE 8:
Free Moving Load Down an Inclined Plane



STEP 1: Application Data
(W) Weight = 550 lbs.
(H) Height = 8 in.
(α) Angle of incline = 30°
(C) Cycles/Hr = 250

STEP 2: Calculate kinetic energy

$E_K = W \times H$

$E_K = 550 \times 8$

$E_K = 4{,}400$ in-lbs.

Assume Model OEMXT 1.5M x 3 is adequate (Page 27).

STEP 3: Calculate work energy

$F_D = W \times \sin\alpha$

$F_D = 550 \times .5$

$F_D = 275$ lbs.

$E_W = F_D \times S$

$E_W = 275 \times 3$

$E_W = 825$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W$

$E_T = 4{,}400 + 825$

$E_T = 5{,}225$ in-lbs./c

STEP 5: Calculate total energy per hour

$E_TC = E_T \times C$

$E_TC = 5{,}225 \times 250$

$E_TC = 1{,}306{,}250$ in-lbs./hr

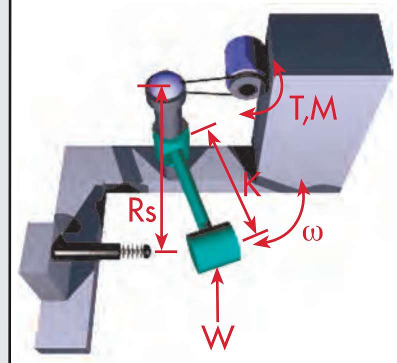
STEP 6: Calculate impact velocity and confirm selection

$V = \sqrt{\mathbf{772} \times H}$

$V = \sqrt{\mathbf{772} \times 8} = 79$ in./sec.

Model OEMXT 1.5M x 3 is adequate.

EXAMPLE 9:
Horizontal Rotating Mass



STEP 1: Application Data
(W) Weight = 200 lbs.
(ω) Angular velocity = 1.5 rad./sec.
(T) Torque = 1,065 in-lbs.
(K) Radius of gyration = 15 in.
(R_S) Mounting radius = 20 in.
(C) Cycles/Hr = 120

STEP 2: Calculate kinetic energy

$I = \frac{W}{\mathbf{386}} \times K^2$

$I = \frac{200}{\mathbf{386}} \times 15^2$

$I = 117$ in-lbs./sec.^{2}

$E_K = \frac{I \times \omega^2}{\mathbf{2}}$

$E_K = \frac{117 \times 1.5^2}{\mathbf{2}}$

$E_K = 132$ in-lbs.

Assume Model STH .5M is adequate (Page 40).

STEP 3 Calculate work energy

$F_D = \frac{T}{R_S}$

$F_D = \frac{1{,}065}{20}$

$F_D = 53$ lbs.

$E_W = F_D \times S$

$E_W = 53 \times .5$

$E_W = 27$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W$

$E_T = 132 + 27$

$E_T = 159$ in-lbs./c

STEP 5: Calculate total energy per hour

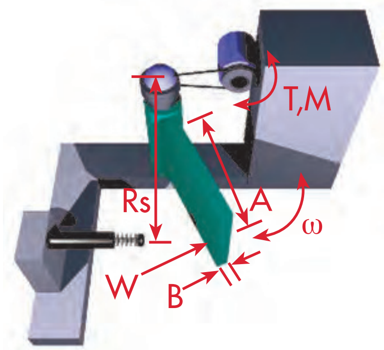
$E_TC = E_T \times C$

$E_TC = 159 \times 120$

$E_TC = 19{,}080$ in-lbs./hr

Model STH .5M is adequate.

EXAMPLE 10:
Horizontal Rotating Door



STEP 1: Application Data
(W) Weight = 50 lbs.
(ω) Angular velocity = 2.5 rad./sec.
(T) Torque = 100 in-lbs.
(R_S) Mounting radius = 20 in.
(A) Width = 40 in.
(B) Thickness = .5 in.
(C) Cycles/Hr = 250

STEP 2: Calculate kinetic energy

$K = .289 \times \sqrt{\mathbf{4} \times A^2 + B^2}$

$K = .289 \times \sqrt{\mathbf{4} \times 40^2 + .5^2}$

$K = 23.12$

$I = \frac{W}{\mathbf{386}} \times K^2$

$I = \frac{50}{\mathbf{386}} \times 23.12^2$

$I = 69$ in-lbs./sec.^{2}

$E_K = \frac{I \times \omega^2}{\mathbf{2}}$

$E_K = \frac{69 \times 2.5^2}{\mathbf{2}}$

$E_K = 216$ in-lbs.

Assume Model OEM .5 is adequate (Page 21).

STEP 3: Calculate work energy

$F_D = \frac{T}{R_S}$

$F_D = \frac{100}{20}$

$F_D = 5$ lbs.

$E_W = F_D \times S = 5 \times .5 = 2.5$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W = 216 + 2.5 = 218.5$ in-lbs./c

STEP 5: Calculate total energy per hour

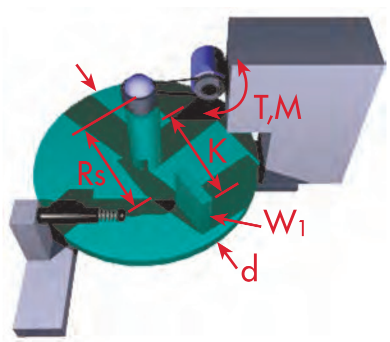
$E_TC = E_T \times C = 218.5 \times 250 = 54{,}625$ in-lbs./hr

STEP 6: Calculate impact velocity and confirm selection

$V = R_S \times \omega = 20 \times 2.5 = 50$ in./sec.

Model OEM .5 is adequate.

EXAMPLE 11:
Horizontal Moving Load, Rotary Table Motor Driven with Additional Load Installed



STEP 1: Application Data
(W) Weight = 440 lbs.
(W_1) Installed load = 110 lbs.
Rotational speed = 10 RPM
(T) Torque = 2,200 in-lbs.
Rotary table dia. = 20 in.
(K_{Load}) Radius of gyration = 8 in.
(R_S) Mounting radius = 8.86 in.
(C) Cycles/Hr = 1
(ω) Direction

Step 2: Calculate kinetic energy

To convert RPM to rad./sec., multiply by **.1047**

$\omega = \text{RPM} \times \mathbf{.1047} = 10 \times \mathbf{.1047} = \mathbf{1.047}$ rad./sec.

$I = \frac{W}{\mathbf{386}} \times K^2$

In this case, the mass moment of inertia of the table and the mass moment of inertia of the load on the table must be calculated.

K_{Table} = Table Radius x **.707**

$K_{Table} = 10 \times \mathbf{.707} = 7.07$ in.

$I_{Table} = \frac{W}{\mathbf{386}} \times K^2_{Table}$

$I_{Table} = \frac{440}{\mathbf{386}} \times 7.07^2 = 57$ in-lbs./sec.^{2}

$I_{Load} = \frac{W_1}{\mathbf{386}} \times K^2_{Load}$

$I_{Load} = \frac{110}{\mathbf{386}} \times 8^2 = 18$ in-lbs./sec.^{2}

$E_K = \frac{(I_{Table} + I_{Load}) \times \omega^2}{\mathbf{2}}$

$E_K = \frac{(57 + 18) \times 1.047^2}{\mathbf{2}} = 41$ in-lbs.

Assume Model ECO 50 is adequate (Page 46).

STEP 3: Calculate work energy

$F_D = \frac{T}{R_S} = \frac{2{,}200}{8.86} = 248$ lbs.

$E_W = F_D \times S = 248 \times .875 = 217$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W = 41 + 217 = 258$ in-lbs./c

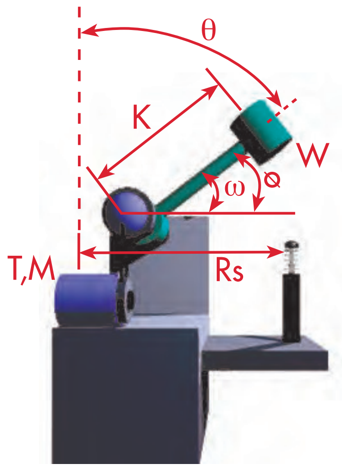
STEP 5: Calculate total energy per hour: not applicable, C = 1

STEP 6: Calculate impact velocity and confirm selection

$V = R_S \times \omega = 8.86 \times 1.047 = 9$ in./sec.

From ECO Sizing Graph.
Model ECO 50 is adequate.

EXAMPLE 12:
Vertical Motor Driven Rotating Arm with Attached Load
CASE A–Load Aided by Gravity



STEP 1: Application Data
(W) Weight = 110 lbs.
(ω) Angular velocity = 2 rad./sec.
(T) Torque = 3,100 in-lbs.
(θ) Starting point of load from true vertical = 20°
(Ø) Angle of rotation at impact = 30°
(K_{Load}) Radius of gyration = 24 in.
(R_S) Mounting radius = 16 in.
(C) Cycles/Hr = 1

STEP 2: Calculate kinetic energy

$I = \frac{W}{386} \times K^2 = \frac{110}{386} \times 24^2$

$I = 164$ in-lbs-sec^2

$E_K = \frac{I \times \omega^2}{2}$

$E_K = \frac{164 \times 2^2}{2}$

$E_K = 328$ in-lbs.

Assume Model OEM 1.0 is adequate (Page 21).

CASE A

STEP 3: Calculate work energy

$F_D = \frac{[T + (W \times K \times \sin(\theta + Ø))]}{R_S}$

$F_D = \frac{[3,100 + (110 \times 24 \times .77)]}{16}$

$F_D = 320.8$ lbs.

$E_W = F_D \times S = 320.8 \times 1 = 320.8$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W = 328 + 320.8$

$E_T = 648.8$ in-lbs./c

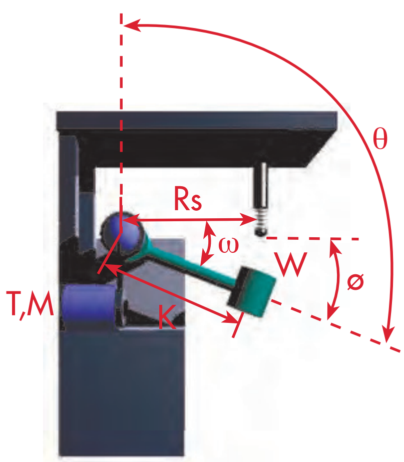
STEP 5: Calculate total energy per hour: not applicable, C = 1

STEP 6: Calculate impact velocity and confirm selection

$V = R_S \times \omega = 16 \times 2 = 32$ in./sec.

Model LROEM 1.0 is adequate. Needed for higher calculated propelling force.

EXAMPLE 13:
Vertical Motor Driven Rotating Arm with Attached Load
CASE B–Load Opposing Gravity



STEP 1: Application Data
(W) Weight = 110 lbs.
(ω) Angular velocity = 2 rad./sec.
(T) Torque = 3,100 in-lbs.
(θ) Starting point of load from true vertical = 30°
(Ø) Angle of rotation at impact = 150°
(K_{Load}) Radius of gyration = 24 in.
(R_S) Mounting radius = 16 in.
(C) Cycles/Hr = 1

STEP 2: Calculate kinetic energy

$I = \frac{W}{386} \times K^2 = \frac{110}{386} \times 24^2$

$I = 164$ in-lbs-sec^2

$E_K = \frac{I \times \omega^2}{2}$

$E_K = \frac{164 \times 2^2}{2}$

$E_K = 328$ in-lbs.

Assume Model OEM 1.0 is adequate (Page 21).

CASE B

STEP 3: Calculate work energy

$F_D = \frac{[T - (W \times K \times \sin(\theta - Ø))]}{R_S}$

$F_D = \frac{[3,100 - (110 \times 24 \times .77)]}{16}$

$E_W = F_D \times S = 67 \times 1 = 67$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W = 328 + 67$

$E_T = 394.7$ in-lbs./c

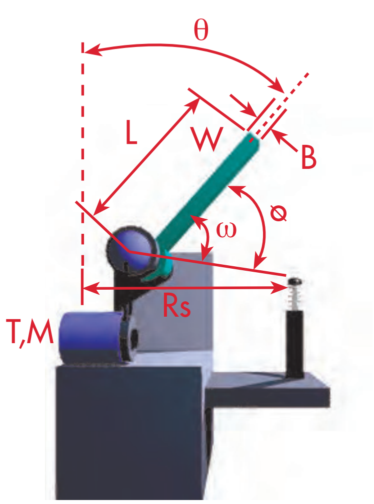
STEP 5: Calculate total energy per hour: not applicable, C = 1

STEP 6: Calculate impact velocityand confirm selection.

$V = R_S \times \omega = 16 \times 2 = 32$ in./sec.

Model OEM 1.0 is adequate.

EXAMPLE 14:
Vertical Rotating Beam



STEP 1: Application Data
(W) Weight = 540 lbs.
(ω) Angular velocity = 3.5 rad./sec.
(T) Torque = 250 in-lbs.
(θ) Starting point of load from true vertical = 20°
(Ø) Angle of rotation at impact = 50°
(R_S) Mounting radius = 20 in.
(B) Thickness = 2.5 in.
(L) Length = 24 in.
(C) Cycles/Hr = 1

STEP 2: Calculate kinetic energy

$K = .289 \times \sqrt{4 \times L^2 + B^2}$

$K = .289 \times \sqrt{4 \times 24^2 + 2.5^2} = 13.89$

$I = \frac{W}{386} \times K^2 = \frac{540}{386} \times 13.89$

$I = 270$ in-lbs./sec.^{2}

$E_K = \frac{I \times \omega^2}{2} = \frac{270 \times 3.5^2}{2} = 1,653$ in-lbs.

Assume Model OEM 1.5M x 2 is adequate (Page 27).

STEP 3: Calculate work energy

$F_D = \frac{T + (W \times K \times \sin(\theta + Ø))}{R_S}$

$F_D = \frac{250 + (540 \times 13.89 \times \sin(20° + 50°))}{20}$

$F_D = 365$ lbs.

$E_W = F_D \times S = 365 \times 2 = 730$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W = 1,653 + 730 = 2,383$ in-lbs./c

STEP 5: Calculate total energy per hour: not applicable, C = 1

STEP 6: Calculate impact velocity and confirm selection

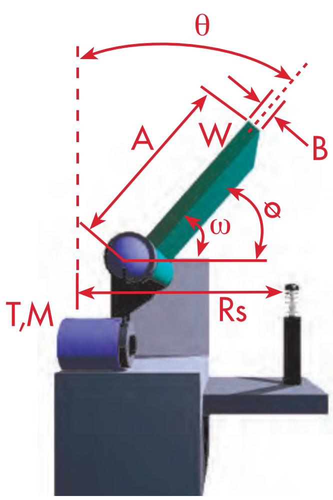
$V = R_S \times \omega = 20 \times 3.5 = 70$ in./sec.

Model OEM 1.5M x 2 is adequate.

Shock Absorber Sizing Examples

Typical Shock Absorber Applications

EXAMPLE 15:
Vertical Rotating Lid



STEP 1: Application Data

(W) Weight = 2,000 lbs.
(ω) Angular velocity = 2 rad./sec.
(Hp) Motor horsepower = .25 Hp
(θ) Starting point of load from true vertical = 30°
(Ø) Angle of rotation at impact = 60°
(R_S) Mounting radius = 30 in.
(A) Width = 60 in.
(B) Thickness = 1 in.
(C) Cycle/Hr = 1

STEP 2: Calculate kinetic energy

$K = .289 \times \sqrt{4 \times A^2 + B^2}$
$K = .289 \times \sqrt{4 \times 60^2 + 1^2} = 34.68$ in.

$I = \frac{W}{386} \times K^2 = \frac{2{,}000}{386} \times 34.68^2$ in.
$I = 6{,}232$ in-lbs./sec.^{2}
$E_K = \frac{I \times \omega^2}{2} = \frac{6{,}232 \times 2^2}{2}$
$E_K = 12{,}464$ in-lbs.
Assume Model OEM 3.0M x 2 is adequate (Page 31).

STEP 3: Calculate work energy

$T = \frac{19{,}800 \times Hp}{\omega}$
$T = \frac{19{,}800 \times .25}{2} = 2{,}475$ in-lbs.
$F_D = \frac{T + (W \times K \times \sin(\theta + Ø))}{R_S}$
$F_D = \frac{2{,}475 + (2{,}000 \times 34.68 \times \sin(30° + 60°))}{30}$
$F_D = 2{,}395$ lbs.
$E_W = F_D \times S = 2{,}395 \times 2 = 4{,}790$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W = 12{,}464 + 4{,}790$
$= 17{,}254$ in-lbs./c

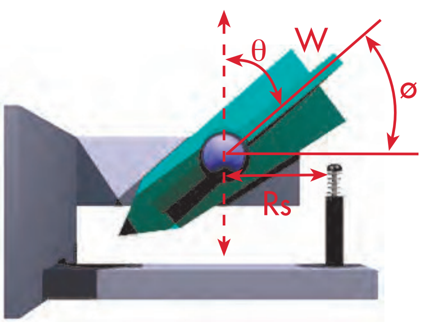
STEP 5: Calculate total energy per hour: not applicable, C = 1

STEP 6: Calculate impact velocity and confirm selection

$V = R_S \times \omega = 30 \times 2 = 60$ in./sec.

Model OEM 3.0M x 2 is adequate.

EXAMPLE 16:
Vertical Rotation with Known Intertia Aided by Gravity



STEP 1: Application Data

(W) Weight = 220.5 lbs
(I) Known Intertia = 885 in-lbs/sec.^{2}
(C/G) Center-of-Gravity = 12 in.
(θ) Starting point from true vertical = 60°
(Ø) Angle of rotation at impact = 30°
(R_S) Mounting radius = 10 in.
(C) Cycles/Hr = 1

STEP 2: Calculate kinetic energy

$H = C/G \times [\cos(\theta) - \cos(Ø + \theta)]$
$H = 12 \times [\cos(60°) - \cos(30° + 60°)]$
$E_K = W \times H$
$E_K = 220.5 \times 6$
$E_K = 1{,}323$ in-lbs.

STEP 3: Calculate work energy

$F_D = (W \times C/G \times \sin(\theta + Ø))/R_S$
$F_D = (220.5 \times 12 \times \sin(60° + 30°))/10$
$F_D = 264.6$ lbs.
$E_W = F_D \times S = 264.6 \times 1 = 264.6$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W = 1{,}323 + 264.6$
$E_T = 1{,}587.6$ in-lbs/cyc.

STEP 5: Calculate total energy per hour: not applicable, C = 1

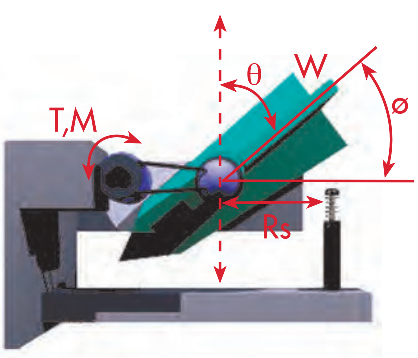
$E_TC = E_T \times C$
$E_TC = 1{,}587.6 \times 1$
$E_TC = 1{,}587.6$ in-lbs/hr.

STEP 6: Calculate impact velocity and confirm selection

$\omega = ((2 \times E_K)/I)\ 0.5$
$\omega = ((2 \times 1{,}323)/885)\ 0.5 = 1.7$
$V = R_S \times \omega = 10 \times 1.7 = 17$ in./sec.

Model OEM 1.15 x 1 is adequate (Page 24).

EXAMPLE 17:
Vertical Rotation with Known Intertia Aided by Gravity (w/Torque)



STEP 1: Application Data

(W) Weight = 220.5 lbs
(ω) Angular Velocity = 2 rad/sec.
(T) Torque = 2,750 in-lbs.
(I) Known Intertia = 885 in-lbs/sec.^{2}
(C/G) Center-of-Gravity = 12 in.
(θ) Starting point from true vertical = 60°
(Ø) Angle of rotation at impact = 30°
(R_S) Mounting radius = 10 in.
(C) Cycles/Hr = 100

STEP 2: Calculate kinetic energy

$E_K = (I \times \omega^2)/2$
$E_K = (885 \times 2^2)/2$
$E_K = 1{,}770$ in-lbs.

STEP 3: Calculate work energy

$F_D = [T - (W \times C/G \times \sin(\theta + Ø)]/R_S$
$F_D = [2{,}750 - (220.5 \times 12 \times \sin(60° + 30°)]/10$
$F_D = 539.6$ lbs.
$E_W = F_D \times S = 539.6 \times 1 = 539.6$ in-lbs.

STEP 4: Calculate total energy per cycle

$E_T = E_K + E_W = 1{,}770 + 539.6$
$E_T = 2{,}309.6$ in-lbs/cyc.

STEP 5: Calculate total energy per hour: not applicable, C = 1

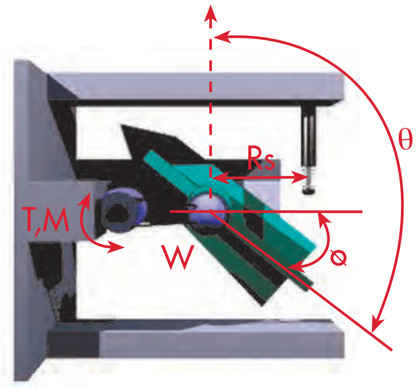
$E_TC = E_T \times C$
$E_TC = 2{,}309.6 \times 1$
$E_TC = 230{,}960$ in-lbs/hr.

STEP 6: Calculate impact velocity and confirm selection

$V = R_S \times \omega = 10 \times 2 = 20$ in./sec.

Model OEM 1.15 x 1 is adequate (Page 24).

EXAMPLE 18:
Vertical Rotation with Known Intertia Aided by Gravity (w/Torque)



STEP 1: Application Data
(W) Weight = 220.5 lbs
(ω) Angular Velocity = 2 rad/sec.
(T) Torque = 2,750 in-lbs.
(I) Known Inertia = 885 in-lbs/sec.^{2}
(C/G) Center-of-Gravity = 12 in.
(θ) Starting point from true vertical = 120°
(Ø) Angle of rotation at impact = 30°
(R_S) Mounting radius = 10 in.
(C) Cycles/Hr = 100

STEP 2: Calculate kinetic energy
$E_K = (I \times \omega^2)/2$
$E_K = (885 \times 2^2)/2$
$E_K = 1{,}770$ in-lbs.

STEP 3: Calculate work energy
$F_D = [T - (W \times C/G \times \sin(\theta - Ø))]/R_S$
$F_D = [2{,}750 - (220.5 \times 12 \times \sin(120° - 30°))]/10$
$F_D = 10.4$ lbs.
$E_W = F_D \times S = 10.4 \times 1 = 10.4$ in-lbs.

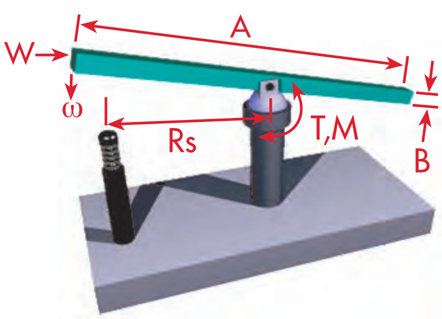
STEP 4: Calculate total energy per cycle
$E_T = E_K + E_W = 1{,}770 + 10.4$
$E_T = 1{,}780.4$ in-lbs/cyc.

STEP 5: Calculate total energy per hour: not applicable, C = 1
$E_TC = E_T \times C$
$E_TC = 1{,}780.4 \times 100$
$E_TC = 178{,}040$ in-lbs/hr.

STEP 6: Calculate impact velocity and confirm selection
$V = R_S \times \omega = 10 \times 2 = 20$ in./sec.

Model OEMXT 1.5M x 1 is adequate (Page 27).

EXAMPLE 19:
Vertical Roation Pinned at Center (w/Torque)



STEP 1: Application Data
(W) Weight = 220.5 lbs.
(ω) Angular velocity = 2 rad./sec.
(T) Torque = 2,750 in-lbs.
(A) Length = 40 in.
(R_S) Mounting radius = 10 in.
(B) Thickness = 2 in.
(C) Cycles/Hr = 100

STEP 2: Calculate kinetic energy
$K = .289 \times (A^2 + B^2)^{0.5}$
$K = .289 \times (40^2 + 2^2)^{0.5} = 11.6$ in.
$I = (W/386) \times K^2$
$I = (220.5/386) \times 11.6^2 = 76.9$ in-lb/sec^2
$E_K = (I \times \omega^2)/2$
$E_K = (76.9 \times 2^2)/2$
$E_K = 153.8$ in-lbs.

Assume Model OEM 1.0 is adequate (Page 21).

STEP 3: Calculate work energy
$F_D = T/R_S$
$F_D = 2{,}750/10$
$F_D = 275$ lbs.
$E_W = F_D \times S = 275 \times 1 = 275$ in-lbs.

STEP 4: Calculate total energy per cycle
$E_T = E_K + E_W = 153.8 + 275$
$E_T = 428.8$ in-lbs./cycle

STEP 5: Calculate total energy per hour
$E_TC = E_T \times C$
$E_TC = 428.8 \times 100$
$E_TC = 42{,}880$ in-lbs./hr.

STEP 6: Calculate impact velocity and confirm selection
$V = R_S \times \omega = 10 \times 2 = 20$ in./sec.

Model OEM 1.0 is adequate.

Shock Absorber Sizing Examples

Typical Shock Absorber and Crane Applications

Overview

Calculaions assume worst case scenario of 90% trolley weight over one rail.

Crane A		Per Buffer
Propelling Force Crane	lbs.	
Propelling Force Trolley	lbs.	
Weight of Crane (W_a)	lbs.	
Weight of Trolley (W_{ta})	lbs.	
Crane Velocity (V_a)	in./sec.	
Trolley Velocity (V_{ta})	in./sec.	

Crane B		Per Buffer
Propelling Force Crane	lbs.	
Propelling Force Trolley	lbs.	
Weight of Crane (W_b)	lbs.	
Weight of Trolley (W_{tb})	lbs.	
Crane Velocity (V_b)	in./sec.	
Trolley Velocity (V_{tb})	in./sec.	

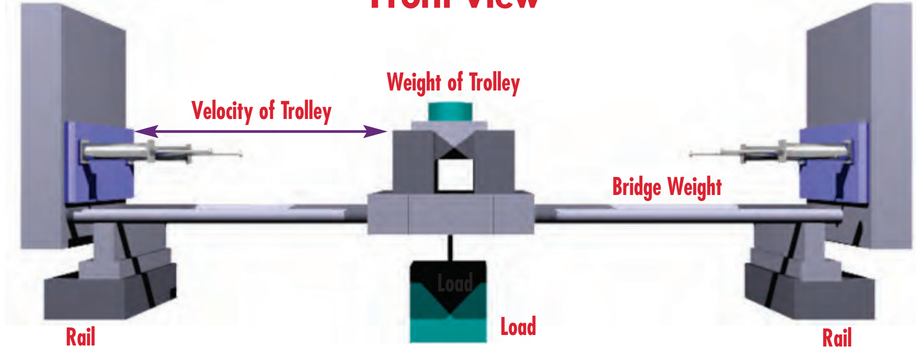
Crane C		Per Buffer
Propelling Force Crane	lbs.	
Propelling Force Trolley	lbs.	
Weight of Crane (W_c)	lbs.	
Weight of Trolley (W_{tc})	lbs.	
Crane Velocity (V_c)	in./sec.	
Trolley Velocity (V_{tc})	in./sec.	

Please note:

Unless instructed otherwise, ITT Enidine will always calculate with:

- 100% velocity v, and
- 100% propelling force F_D

Front View



Plan Views

Application 1

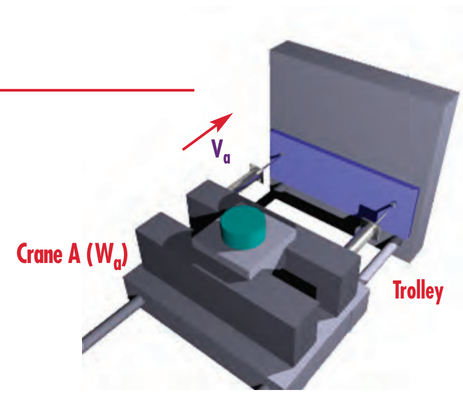
Crane A against Solid Stop

Velocity:

$V_r = V_a$

Impact weight per buffer:

$$W_d = \frac{Wa + (1.8)\ Wta}{\text{Total Number of Shocks}}$$



Application 2

Crane A against Crane B

Velocity:

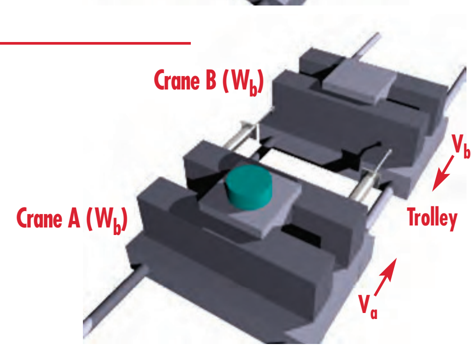
$V_r = V_a + V_b$

Impact weight per buffer:

$W_1 = Wa + (1.8)\ Wta$

$W_2 = Wb + (1.8)\ Wtb$

$$W_d = \frac{W_1\ W_2}{(W_1 + W_2)(\text{Total Number of Shocks})}$$



Application 3

Crane B against Crane C

Velocity:

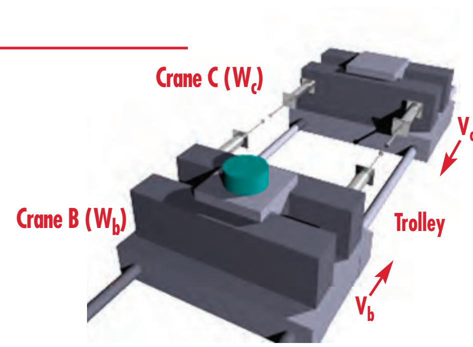
$$V_r = \frac{V_b + V_c}{2}$$

Impact weight per buffer:

$W_1 = Wb + (1.8)\ Wtb$

$W_2 = Wc + (1.8)\ Wtc$

$$W_d = \frac{2\ W_1\ W_2}{(W_1 + W_2)(\text{Number of Shocks Per Rail})}$$



Application 4

Crane C against Solid Stop with Buffer

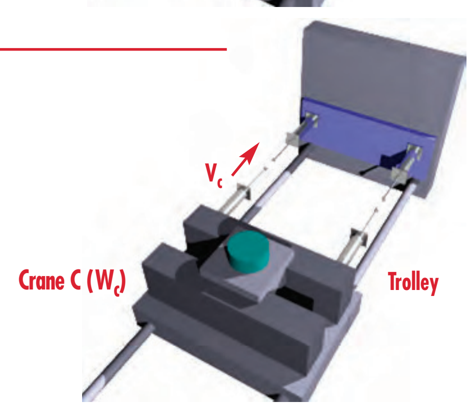
Velocity:

$$V_r = \frac{V_c}{2}$$

Impact weight per buffer:

$W_1 = W_c + 1.8\ (W_{tc})$

$$W_d = \frac{2\ W_1}{\text{Number of Shocks Per Rail}}$$



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Overview

Calculation Example for Harbor Cranes as Application 1

Please note that this example is not based on any particular standard. The slung load can swing freely, and is therefore not taken into account in the calculation.

Given Values

Bridge Weight:	**837,750 lbs.**
Weight of Trolley:	**99,200 lbs.**
Crane Velocity:	**60 in./sec.**
Required Stroke:	**24 in.**
Trolley Velocity:	**160 in./sec.**
Required Stroke:	**40 in.**

Determination of the Maximum Impact Weight W_d per Buffer

$$W_d = \frac{Wa + (1.8)\ Wta}{\text{Total Number of Shocks}}$$

$$W_d = \frac{837{,}750 + (1.8)(99{,}200)}{2}$$

$$\mathbf{W_d = 508{,}155\ lbs.}$$

Determine Size of Shock Absorber for Crane

$$E_K = \frac{W_d}{772} \bullet V_r^2$$

$$E_K = \frac{508{,}155\ \text{lbs.}}{772} \bullet (60\ \text{in./sec.})^2$$

$$\mathbf{E_K = 2{,}369{,}635\ in\text{-}lbs.}$$

$V_r = V_a$ (Application 1)

E_K = Kinetic Energy

η = Efficiency

Selecting for required 24-inch stroke:

HD 5.0 x 24, maximum shock force ca. 116,159 lbs = $F_s = \frac{E_K}{s \bullet \eta}$

Determine Size of Shock Absorber for Trolley

W_t = Trolley Weight per Shock Absorber

$$W_t = \frac{99{,}200\ \text{lbs.}}{2}$$

$$\mathbf{W_t = 49{,}600\ lbs.}$$

$$E_K = \frac{W_t}{772} \bullet V_t^2$$

$$E_K = \frac{49{,}600\ \text{lbs.}}{772} \bullet (160\ \text{in./sec.})^2$$

$$\mathbf{E_K = 1{,}644{,}767\ in\text{-}lbs.}$$

Selecting for required 40-inch stroke:

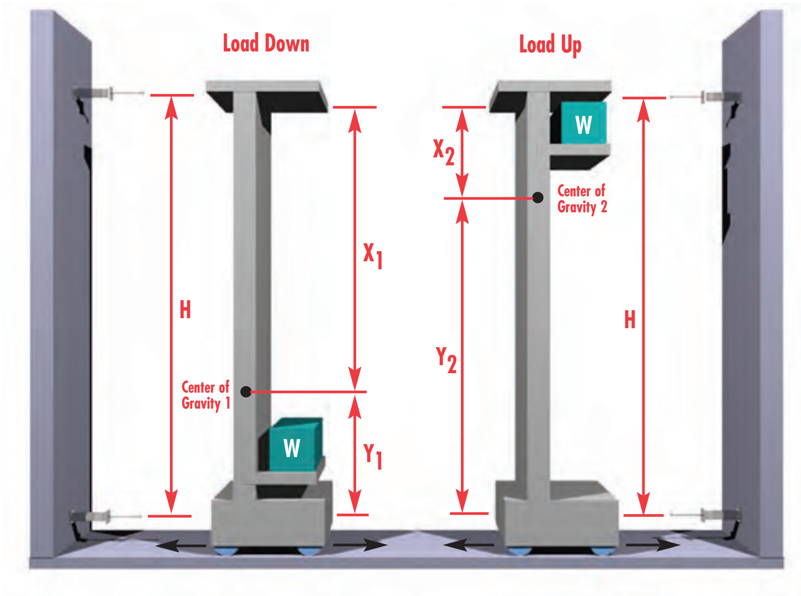
HDN 4.0 x 40, maximum shock force ca. 48,376 lbs. = $F_s = \frac{E_K}{s \bullet \eta}$

Shock Absorber Sizing Examples

Typical Shock Absorber and Crane Applications

Overview

Application 1	Value
Buffer Distance H	ft.
Distance X_1	ft.
Distance Y_1	ft.
Distance X_2	ft.
Distance Y_2	ft.
Total Weight	lbs.
$W_{max\ d}$	lbs.
$W_{min\ d}$	lbs.
$W_{max\ u}$	lbs.
$W_{min\ u}$	lbs.



Calculation Example Stacker Cranes

Please note that this example shows how to calculate the maximum impact weight on the upper and lower shock absorbers for a stacker crane.

Given Values

Distance Between Buffers:	H = 60 ft.
Distance to C of G1 - Upper:	X_1 = 45 ft.
Distance to C of G1 - Lower:	Y_1 = 15 ft.
Distance to C of G2 - Upper:	X_2 = 21 ft.
Distance to C of G1 - Lower:	Y_2 = 39 ft.
Total Weight:	W = 40,000 lbs.

Calculation for Lower Shock Absorbers

$$W_{max\ d} = \frac{X_1}{H} \bullet W \qquad\qquad W_{max\ d} = \frac{X_2}{H} \bullet W$$

$$W_{max\ d} = \frac{15\ m}{20\ m} \bullet 20\ t \qquad\qquad W_{max\ d} = \frac{21\ ft.}{60\ ft.} \bullet 40{,}000\ lbs.$$

$$W_{max\ d} = 15\ t \qquad\qquad W_{max\ d} = 14{,}000\ lbs.$$

Calculation for Upper Shock Absorbers

$$W_{max\ d} = \frac{Y_1}{H} \bullet W \qquad\qquad W_{max\ d} = \frac{Y_2}{H} \bullet W$$

$$W_{max\ d} = \frac{5\ m}{20\ m} \bullet 20\ t \qquad\qquad W_{max\ d} = \frac{39\ ft.}{60\ ft.} \bullet 40{,}000\ lbs.$$

$$W_{max\ d} = 5\ t \qquad\qquad W_{max\ d} = 26{,}000\ lbs.$$

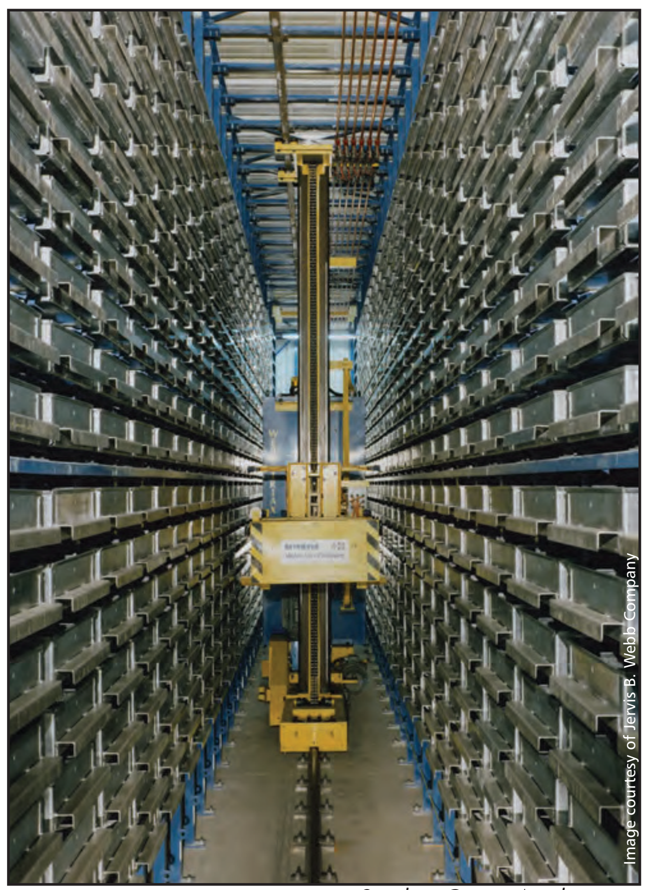
Shock Absorber Selection

Using the value for W_{max} obtained above, the kinetic energy can be calculated, and a shock absorber selected.

Typical Applications

Overhead Crane Applications

Cargo Crane Applications



Stacker Crane Applications

Shock Absorber and Rate Controls Quick Selection Guide

Typical Selections

Technical Data

Use this **ITT Enidine Product Quick Selection Guide** to quickly locate potential shock absorber models most suited for your requirements. Models are organized in order of smallest to largest energy capacity per cycle within their respective product families.

ITT Enidine Adjustable Shock Absorbers

Catalog No. (Model)	(S) Stroke (in.)	(E_T) Max. in.-lbs./cycle	(E_TC) Max. in.-lbs./hour	Damping Type	Page No.
	1 in. = 25,4mm	1 in.-lb. = .11 Nm			
OEM 0.1M (B)	0.28	62	120,000	D	21
ECO OEM .15M (B)	0.38	62	185,000	D	21
ECO OEM .25 (B)	0.38	62	195,000	D	21
ECO LROEM .25 (B)	0.38	62	195,000	D	21
ECO OEM .35 (B)	0.50	170	331,000	D	21
ECO LROEM .35 (B)	0.50	170	331,000	D	21
ECO OEM .5 (B)	0.50	275	311,000	D	21
ECO LROEM .5 (B)	0.50	275	311,000	D	21
ECO OEM 1.0 (B)	1.00	715	681,000	C	21
ECO LROEM 1.0 (B)	1.00	715	681,000	C	21
ECO OEM 1.15 X 1	1.00	1,900	737,000	C	24
ECO LROEM 1.15 X 1	1.00	1,900	737,000	C	24
ECO OEM 1.15 X 2	2.00	3,750	963,000	C	24
ECO LROEM 1.15 X 2	2.00	3,750	963,000	C	24
ECO OEM 1.25 x 1	1.00	1,900	886,000	C	24
ECO LROEM 1.25 x 1	1.00	1,900	886,000	C	24
ECO OEM 1.25 x 2	2.00	3,750	1,084,000	C	24
ECO LROEM 1.25 x 2	2.00	3,750	1,084,000	C	24
LROEMXT ¾ x 1	1.00	3,750	1,120,000	C	27
OEMXT ¾ x 1	1.00	3,750	1,120,000	C	27
LROEMXT 1.5M x 1	1.00	3,750	1,120,000	C	27
OEMXT 1.5M x 1	1.00	3,750	1,120,000	C	27
LROEMXT ¾ x 2	2.00	7,500	1,475,000	C	27
OEMXT ¾ x 2	2.00	7,500	1,475,000	C	27
LROEMXT 1.5M x 2	2.00	7,500	1,475,000	C	27
OEMXT 1.5M x 2	2.00	7,500	1,475,000	C	27
OEMXT ¾ x 3	3.00	11,500	1,775,000	C	27
OEMXT 1.5M x 3	3.00	11,500	1,775,000	C	27
LROEMXT 1⅛ x 1	1.00	6,000	2,000,000	C	27
LROEMXT 1⅛ x 2	2.00	20,000	2,400,000	C	29
OEMXT 1⅛ x 2	2.00	20,000	2,400,000	C	29
LROEMXT 2.0M x 2	2.00	20,000	2,400,000	C	29
OEMXT 2.0M x 2	2.00	20,000	2,400,000	C	29
OEM 3.0M x 2	2.00	20,000	3,290,000	C	31
OEMXT 1⅛ x 4	4.00	40,000	3,200,000	C	29
OEMXT 2.0M x 4	4.00	40,000	3,200,000	C	29
OEM 4.0M x 2	2.00	34,000	13,300,000	C	31
OEM 3.0M x 3.5	3.50	35,000	5,770,000	C	31
OEMXT 1⅛ x 6	6.00	60,000	3,730,000	C	29
OEMXT 2.0M x 6	6.00	60,000	3,730,000	C	29
OEM 3.0M x 5	5.00	50,000	8,260,000	C	31
OEM 3.0M x 6.5	6.50	65,000	10,750,000	C	31
OEM 4.0M x 4	4.00	68,000	16,000,000	C	31
OEM 4.0M x 6	6.00	102,000	18,600,000	C	31
OEM 4.0M x 8	8.00	136,000	21,300,000	C	31
OEM 4.0M x 10	10.00	170,000	24,000,000	C	31

Key for Damping Type:
D – Dashpot
C – Conventional
P – Progressive
SC – Self-compensating

ITT Enidine Non-Adjustable Shock Absorbers

Catalog No. (Model)	(S) Stroke (in.)	(E_T) Max. in.-lbs./cycle	(E_TC) Max. in.-lbs./hour	Damping Type	Page No.
	1 in. = 25,4mm	1 in.-lb. = .11 Nm			
TK 6	0.25	9	31,863	D	39
TK 8	0.25	50	42,480	D	39
TK 21	0.25	20	36,000	D	40
ECO 8	0.25	35	55,000	SC	47
TK 10M	0.25	50	115,000	D	40
ECO 10	0.28	62	120,700	SC	47
ECO 15	0.41	106	275,000	SC	47
STH .25M	0.25	100	39,000	D	41
ECO 25	0.50	265	389,000	SC	47
ECOS 50	0.50	285	440,000	SC	47
ECO 50	0.88	550	523,000	SC	47
STH .5M	0.50	585	390,000	D	41
ECO 100	1.00	930	681,500	SC	47
PRO 110	1.56	1,860	743,500	P	50
ECO 120	1.00	1,640	743,000	SC	50
ECO 125	1.00	1,640	920,500	SC	50
PMXT 1525	1.00	3,250	1,120,000	SC	59
STH .75M	0.75	2,150	780,000	D	41
ECO 220	2.00	3,100	911,600	SC	50
ECO 225	2.00	3,100	1,124,000	SC	50
PMXT 1550	2.00	6,500	1,475,000	SC	59
STH 1.0M	1.00	4,400	1,300,000	D	41
PMXT 1575	3.00	10,000	1,775,000	SC	59
STH 1.0M x 2	2.00	8,800	2,100,000	D	41
PMXT 2050	2.00	16,500	2,400,000	SC	59
STH 1.5M x 1	1.00	10,200	2,200,000	D	41
PMXT 2100	4.00	33,000	3,200,000	SC	59
STH 1.5M x 2	2.00	20,400	3,200,000	D	41
PMXT 2150	6.00	50,000	3,730,000	SC	59

Key for Damping Type:
D – Dashpot
C – Conventional
P – Progressive
SC – Self-compensating

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Heavy Duty Shock Absorbers
HDN, HDA Series

Overview

ITT Enidine Heavy Duty Series large-bore hydraulic shock absorbers protect equipment from large impacts in applications such as automated storage and retrieval systems, as well as overhead bridge and trolley cranes. They are available in a wide variety of stroke lengths and damping characteristics to increase equipment life and meet stringent deceleration requirements.

HDN Series

Custom-orificed design accommodates specified damping requirements. Computer generated output performance simulation is used to optimize the orifice configuration. Available in standard bore dimensions of up to 4 in. (100mm) and strokes over 60 in. (1524mm).

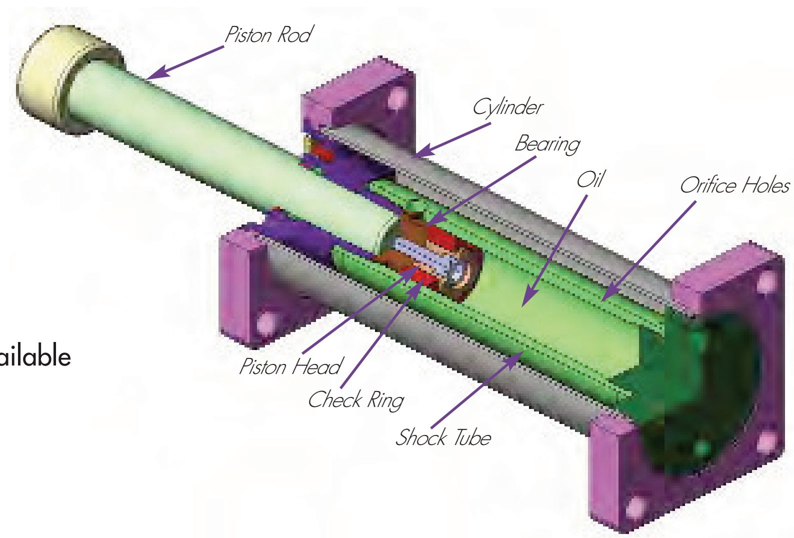
HDA Series

Adjustable units enable the user to modify shock absorber resistance to accommodate load velocity variations, with strokes up to 12in. (305mm). Standard adjustable configurations available.


HDN Series

Features and Benefits HDN, HDA

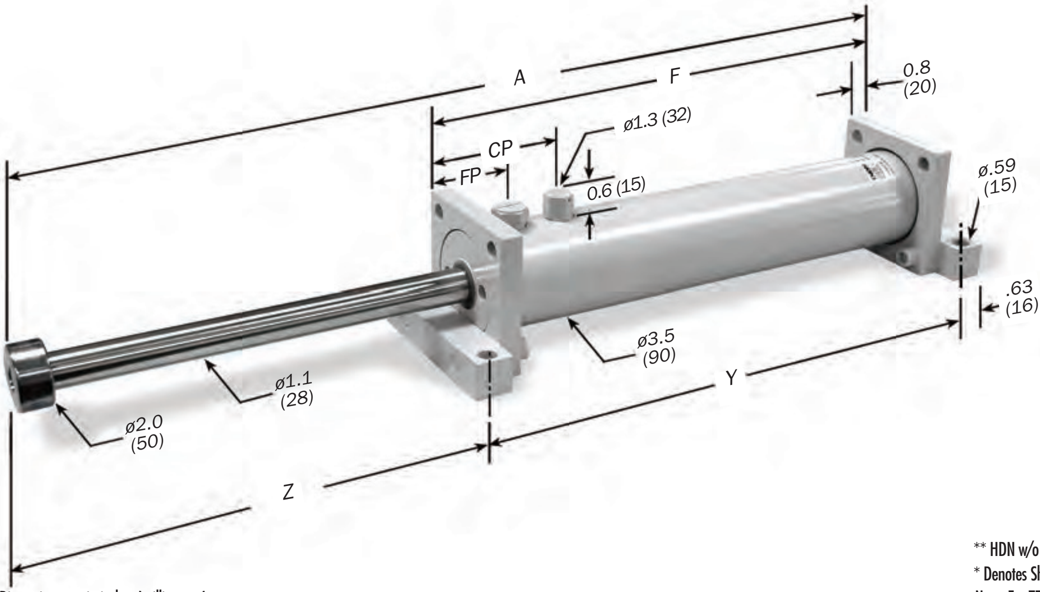
- Designed with Environmentally friendly materials and fluids
- Compact design smoothly and safely decelerates large energy capacity loads up to 3,000,000 in-lbs. per cycle (330 000 Nm)
- Internal charged air/oil accumulator replaces mechanical return springs, providing shorter overall length and reduced weight. **Optional** Bladder Accumulator (BA) for higher cycle rates also available.
- Engineered to meet OSHA, AISE, CMAA and other safety specifications such as DIN and FEM.
- Wide variety of optional configurations including bellows, clevis mounts and safety cables.
- Zinc plated external components provide excellent corrosion protection.
- Epoxy painting and special rod materials are available for use in highly corrosive environments.
- All sizes are fully field repairable.
- Piston rod extension sensor systems available for re-use safety requirements.
- Incorporating optional fluids and seal packages can expand standard operating temperature range from 15°F to 140°F (-10°C to 60°C) to -30°F to 210°F (-35°C to 100°C)

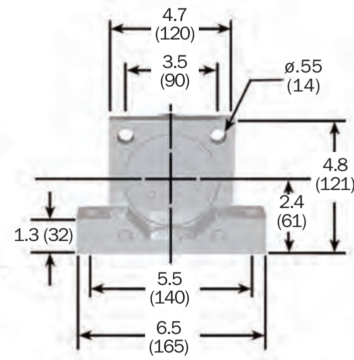


Heavy Duty Shock Absorbers
HDN 1.5 Series

Technical Data

HDN 1.5 x 2 → HDN 1.5 x 32 Series





** HDN w/o BA option contains only a single charge/fill port.
* Denotes Shock Absorber Bladder Accumulator Option.
Note: For TF, FF and FR mounting, delete front foot and dimensions.

Dimensions are in inches (millimeters).

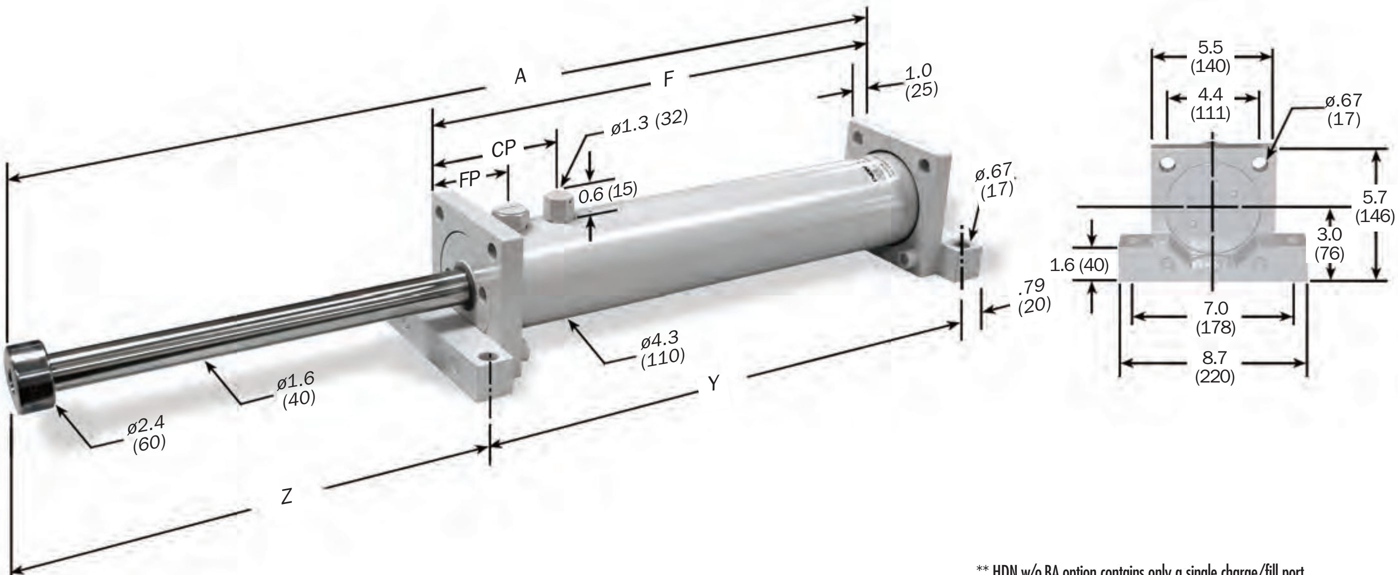
Catalog No./ Model	(S) Stroke in. (mm)	(E_T) Max. in.-lbs./cycle (Nm/cycle)	(E_TC) Max. in.-lbs./hour (Nm/hr)	(F_P) Max. Shock Force lbs. (N)	Nominal Return Force BA* lbs. (N)	Nominal Return Force w/o BA* lbs. (N)	A in. (mm)	F in. (mm)	Y in. (mm)	Z in. (mm)	With BA: CP BA* in. (mm)	With BA: FP BA* in. (mm)	CP** w/o BA* in. (mm)	Model Weight lbs. (Kg)
HDN 1.5 x 2	2 (50)	27,900 (3 200)	1,676,000 (189 000)	15,750 (70 060)	50 (220)	70 (320)	12.2 (310)	8.2 (208)	9.4 (240)	3.4 (86)	5.5 (139)	3.4 (86)	1.6 (41)	22 (10)
HDN 1.5 x 4	4 (100)	54,200 (6 100)	3,257,300 (368 000)	15,750 (70 060)	50 (220)	90 (410)	16.1 (410)	10.2 (258)	11.4 (290)	5.4 (136)	5.5 (139)	3.4 (86)	1.6 (41)	24 (12)
HDN 1.5 x 6	6 (150)	80,600 (9 100)	4,838,500 (546 700)	15,750 (70 060)	50 (220)	100 (450)	20.1 (510)	12.1 (308)	13.4 (340)	7.3 (186)	5.5 (139)	3.4 (86)	1.6 (41)	26 (12)
HDN 1.5 x 8	8 (200)	108,000 (12 200)	6,482,900 (732 500)	15,750 (70 060)	50 (220)	120 (525)	24.1 (613)	14.2 (360)	15.4 (392)	9.3 (237)	5.5 (139)	3.4 (86)	1.6 (41)	29 (13)
HDN 1.5 x 10	10 (250)	134,900 (15 200)	6,912,000 (781 000)	15,750 (70 060)	50 (220)	135 (600)	28.2 (715)	16.2 (411)	17.4 (443)	11.3 (288)	5.5 (139)	3.4 (86)	1.6 (41)	31 (14)
HDN 1.5 x 12	12 (300)	161,800 (18 300)	7,769,700 (877,900)	15,750 (70 060)	50 (220)	210 (920)	32.2 (817)	18.2 (462)	19.4 (494)	13.3 (339)	5.5 (139)	3.4 (86)	1.6 (41)	35 (16)
HDN 1.5 x 14	14 (350)	185,100 (20 900)	8,610,500 (972,900)	15,750 (70 060)	50 (220)	250 (1 120)	36.1 (918)	20.2 (512)	21.4 (544)	15.4 (390)	5.5 (139)	3.4 (86)	1.6 (41)	37 (17)
HDN 1.5 x 16	16 (400)	208,300 (23 300)	9,468,200 (1 069 800)	13,500 (60 060)	50 (220)	250 (1 120)	40.1 (1 019)	22.2 (563)	23.4 (595)	17.3 (440)	5.5 (139)	3.4 (86)	1.6 (41)	40 (18)
HDN 1.5 x 18	18 (450)	224,300 (25 300)	10,325,900 (1 166 700)	10,750 (47 820)	50 (220)	250 (1 120)	44.1 (1 121)	24.2 (614)	25.4 (646)	19.3 (491)	5.5 (139)	3.4 (86)	1.6 (41)	42 (19)
HDN 1.5 x 20	20 (500)	240,300 (27 200)	11,183,600 (1 263 600)	8,750 (38 920)	50 (220)	250 (1 120)	48.2 (1 223)	26.2 (665)	27.4 (697)	21.4 (542)	5.5 (139)	3.4 (86)	1.6 (41)	44 (20)
HDN 1.5 x 24	24 (600)	269,600 (30 500)	12,899,000 (1 457 400)	6,250 (27 800)	50 (220)	250 (1 120)	56.2 (1 427)	30.2 (767)	31.5 (799)	21.3 (644)	5.5 (139)	3.4 (86)	1.6 (41)	50 (23)
HDN 1.5 x 28	28 (713)	297,000 (33 600)	14,597,600 (1 649 300)	4,750 (21,130)	50 (220)	250 (1 120)	64.1 (1 629)	34.2 (868)	35.4 (900)	29.3 (745)	5.5 (139)	3.4 (86)	1.6 (41)	56 (25)
HDN 1.5 x 32	32 (813)	322,800 (36 500)	16,279,300 (1 839 300)	3,700 (16 460)	50 (220)	250 (1 120)	72.0 (1 830)	38.1 (968)	39.4 (1 000)	33.3 (846)	5.5 (139)	3.4 (86)	1.6 (41)	62 (28)

Notes: 1. HDN shock absorbers will function satisfactorily at 5% of their maximum rated energy per cycle. If less than these values, a smaller model should be specified.
2. It is recommended that the customer consult ITT Enidine for safety-related overhead crane applications.
3. The energy data listed is for ideal linear impacts only. If side load conditions exist in the application, contact ITT Enidine for sizing assistance.
4. Rear flange mounting of 12 inch (300 mm) strokes and longer not recommended. Front and rear flange or foot mount configurations are recommended.
5. Maximum cycle rate is 60 cycles/hr. for HDN with BA (Bladder Accumulator) option and 30 cycles/hr. without BA option.
6. For impact velocities over 180 in./sec. (4.5 m/s), consult factory.

Heavy Duty Series Shock Absorber
HDN 2.0 Series

Technical Data

HDN 2.0 x 6 → HDN 2.0 x 56 Series



** HDN w/o BA option contains only a single charge/fill port.
* Denotes Shock Absorber Bladder Accumulator Option.
Note: For TF, FF and FR mounting, delete front foot and dimensions.

Dimensions are in inches (millimeters).

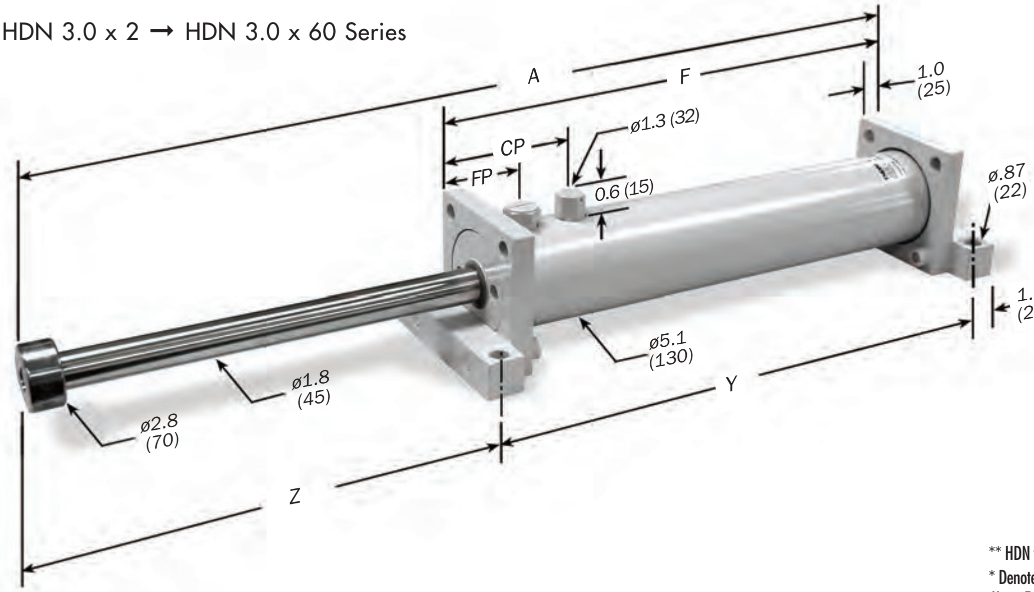
Catalog No./ Model	(S) Stroke in. (mm)	(E_T) Max. in.-lbs./cycle (Nm/cycle)	(E_TC) Max. in.-lbs./hour (Nm/hr)	(F_P) Max. Shock Force lbs. (N)	Nominal Return Force BA* lbs. (N)	Nominal Return Force w/o BA* lbs. (N)	A in. (mm)	F in. (mm)	Y in. (mm)	Z in. (mm)	With BA: CP BA* in. (mm)	With BA: FP BA* in. (mm)	CP** w/o BA* in. (mm)	Model Weight lbs. (Kg)
HDN 2.0 x 6	6 (152)	127,200 (14 400)	7,629,900 (862 100)	25,000 (111 200)	120 (535)	200 (870)	21.8 (553)	13.3 (339)	14.9 (379)	7.6 (194)	6.9 (176)	3.8 (96)	1.8 (46)	42 (19)
HDN 2.0 x 8	8 (203)	169,800 (19 200)	8,086,900 (913 700)	25,000 (111 200)	120 (535)	235 (1 040)	25.8 (655)	15.4 (390)	16.9 (430)	9.6 (245)	6.9 (176)	3.8 (96)	1.8 (46)	46 (20)
HDN 2.0 x 10	10 (250)	212,500 (24 000)	9,144,400 (1 033 200)	25,000 (111 200)	120 (535)	300 (1 340)	29.8 (757)	17.4 (441)	18.9 (481)	11.7 (296)	6.9 (176)	3.8 (96)	1.8 (46)	51 (23)
HDN 2.0 x 12	12 (300)	253,200 (28 600)	10,201,900 (1 152 700)	25,000 (111 200)	120 (535)	515 (2 290)	33.8 (859)	19.4 (492)	20.9 (532)	13.7 (347)	6.9 (176)	3.8 (96)	1.8 (46)	55 (25)
HDN 2.0 x 14	14 (350)	285,900 (32 300)	11,259,500 (1 272 100)	25,000 (111 200)	120 (535)	515 (2 290)	37.8 (960)	21.4 (543)	23.0 (583)	15.6 (397)	6.9 (176)	3.8 (96)	1.8 (46)	60 (27)
HDN 2.0 x 16	16 (400)	318,700 (36 000)	12,317,000 (1 391 600)	25,000 (111 200)	120 (535)	515 (2 290)	41.8 (1 062)	23.4 (594)	25.0 (634)	17.6 (448)	6.9 (176)	3.8 (96)	1.8 (46)	64 (29)
HDN 2.0 x 18	18 (450)	351,500 (39 700)	13,374,500 (1 511 100)	25,000 (111 200)	120 (535)	515 (2 290)	45.8 (1 164)	25.4 (645)	27.0 (685)	19.6 (499)	6.9 (176)	3.8 (96)	1.8 (46)	68 (31)
HDN 2.0 x 20	20 (500)	383,600 (43 300)	14,411,300 (1 628 300)	25,000 (111 200)	120 (535)	515 (2 290)	49.8 (1 265)	27.4 (695)	28.9 (735)	21.7 (550)	6.9 (176)	3.8 (96)	1.8 (46)	73 (33)
HDN 2.0 x 24	24 (600)	449,100 (50 700)	16,526,300 (1 867 200)	25,000 (111 200)	120 (535)	515 (2 290)	57.8 (1 469)	31.4 (797)	33.0 (837)	25.7 (652)	6.9 (176)	3.8 (96)	1.8 (46)	79 (36)
HDN 2.0 x 28	28 (700)	514,678 (58 200)	18,641,400 (2 106 200)	25,000 (111 200)	120 (535)	515 (2 290)	65.8 (1 672)	35.4 (899)	37.0 (939)	29.6 (753)	6.9 (176)	3.8 (96)	1.8 (46)	93 (42)
HDN 2.0 x 32	32 (800)	625,600 (70 700)	22,373,800 (2 527 900)	25,000 (111 200)	120 (535)	515 (2 290)	76.9 (1 953)	42.5 (1 079)	44.1 (1 119)	33.6 (854)	10.1 (256)	6.9 (176)	1.8 (46)	108 (49)
HDN 2.0 x 36	36 (900)	689,500 (77 900)	24,447,300 (2 762 200)	22,500 (100 000)	120 (535)	515 (2 290)	84.7 (2 151)	46.4 (1 179)	48.0 (1 219)	37.5 (952)	10.1 (256)	6.9 (176)	1.8 (46)	117 (53)
HDN 2.0 x 40	40 (1 000)	746,700 (84,400)	26,520,900 (2 996 500)	19,000 (84 500)	120 (535)	515 (2 290)	92.6 (2 351)	50.4 (1 279)	51.9 (1 319)	41.4 (1 052)	10.1 (256)	6.9 (176)	1.8 (46)	124 (56)
HDN 2.0 x 48	48 (1 200)	844,100 (95 400)	30,668,000 (3 465 000)	13,500 (60 000)	120 (535)	515 (2 290)	108.3 (2 751)	58.2 (1 479)	59.8 (1 519)	49.3 (1 252)	10.1 (256)	6.9 (176)	1.8 (46)	141 (64)
HDN 2.0 x 56	56 (1 400)	922,300 (104 200)	35,022,500 (3 957 000)	7,900 (35 100)	120 (535)	515 (2 290)	124.8 (3 171)	66.5 (1 689)	68.1 (1 729)	57.6 (1 462)	10.1/38.4** (256)/(975)	6.9 (176)	1.8 (46)	161 (73)

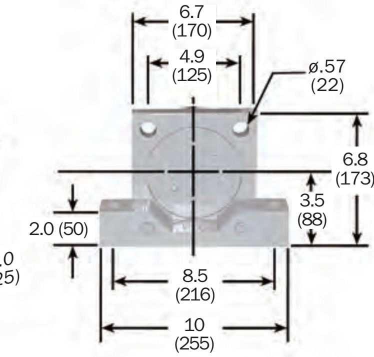
Notes: 1. HDN shock absorbers will function satisfactorily at 5% of their maximum rated energy per cycle. If less than these values, a smaller model should be specified.
2. It is recommended that the customer consult ITT Enidine for safety-related overhead crane applications.
3. The energy data listed is for ideal linear impacts only. If side load conditions exist in the application, contact ITT Enidine for sizing assistance.
4. Rear flange mounting of 12 inch (300 mm) strokes and longer not recommended. Front and rear flange or foot mount configurations are recommended.
5. Maximum cycle rate is 60 cycles/hr. for HDN with BA (Bladder Accumulator) option and 30 cycles/hr. without BA option.
6. For impact velocities over 180 in./sec. (4.5 m/s), consult factory.
7. ** HDN 2.0 x 56 has two charge ports.

Heavy Duty Series Shock Absorber
HDN 3.0 Series

Technical Data

HDN 3.0 x 2 → HDN 3.0 x 60 Series





** HDN w/o BA option contains only a single charge/fill port.
* Denotes Shock Absorber Bladder Accumulator Option.
Note: For TF, FF and FR mounting, delete front foot and dimensions.

Dimensions are in inches (millimeters).

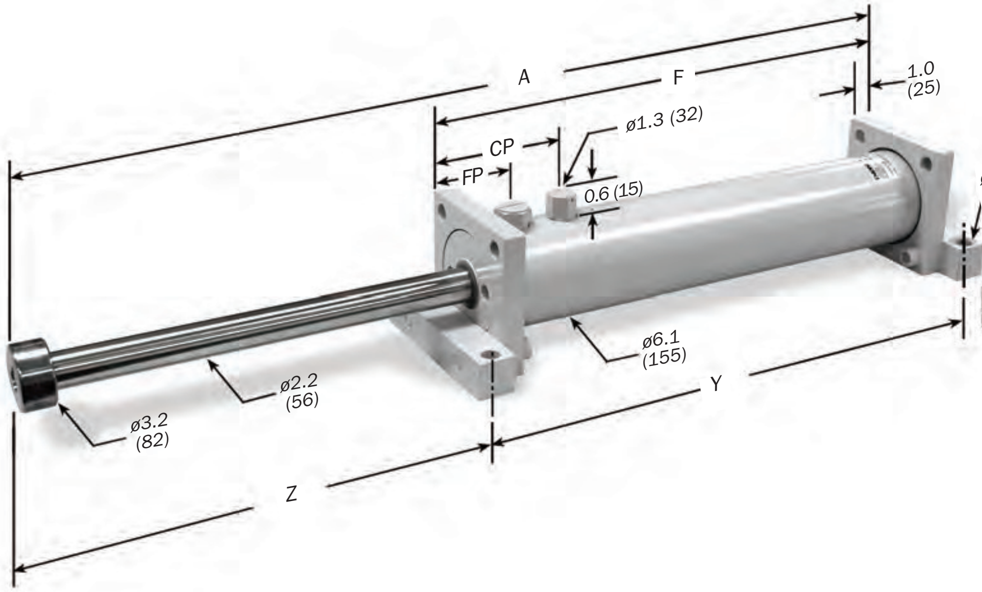
Catalog No./ Model	(S) Stroke in. (mm)	(E_T) Max. in.-lbs./cycle (Nm/cycle)	(E_TC) Max. in.-lbs./hour (Nm/hr)	(F_P) Max. Inital Shock Force lbs. (N)	Nominal Return Force BA* lbs. (N)	Nominal Return Force w/o BA* lbs. (N)	A in. (mm)	F in. (mm)	Y in. (mm)	Z in. (mm)	With BA CP BA* in. (mm)	With BA FP BA* in. (mm)	CP** w/o BA* in. (mm)	Model Weight lbs. (Kg)
HDN 3.0 x 2	2 (50)	85,300 (9 600)	5,120,100 (578 500)	50,000 (222 400)	150 (670)	255 (1 130)	13.2 (336)	8.0 (203)	10.0 (253)	4.3 (108)	5.0 (128)	2.4 (61)	1.8 (46)	40 (21)
HDN 3.0 x 3	3 (75)	128,800 (14 600)	5,832,300 (659 000)	50,000 (222 400)	160 (710)	405 (1 810)	15.2 (387)	9.0 (229)	11.0 (279)	5.2 (133)	5.0 (128)	2.4 (61)	1.8 (46)	42 (22)
HDN 3.0 x 5	5 (125)	214,200 (24 200)	7,131,200 (805 700)	50,000 (222 400)	165 (735)	650 (2 895)	19.3 (489)	11.0 (280)	13.0 (330)	7.2 (184)	5.0 (128)	2.4 (61)	1.8 (46)	48 (25)
HDN 3.0 x 8	8 (200)	316,100 (35 700)	9,041,400 (1 021 500)	50,000 (222 400)	170 (755)	650 (2 895)	25.2 (640)	14.0 (355)	15.9 (405)	10.2 (260)	5.0 (128)	2.4 (61)	1.8 (46)	57 (29)
HDN 3.0 x 10	10 (250)	382,600 (43 200)	10,340,300 (1 168 300)	50,000 (222 400)	175 (780)	650 (2 895)	29.2 (742)	16.0 (406)	18.0 (456)	12.2 (311)	5.0 (128)	2.4 (61)	1.8 (46)	64 (32)
HDN 3.0 x 12	12 (300)	449,100 (50 700)	11,639,200 (1 315 000)	50,000 (222 400)	175 (780)	650 (2 895)	33.2 (844)	18.0 (457)	20.0 (507)	14.3 (362)	5.0 (128)	2.4 (61)	1.8 (46)	71 (35)
HDN 3.0 x 14	14 (350)	556,500 (62 900)	14,211,500 (1 605 700)	50,000 (222 400)	180 (800)	650 (2 895)	39.2 (995)	22.0 (558)	23.9 (608)	16.2 (412)	7.0 (178)	4.4 (111)	1.8 (46)	88 (43)
HDN 3.0 x 16	16 (400)	623,000 (70 400)	15,510,400 (1 752 400)	50,000 (222 400)	180 (800)	650 (2 895)	43.2 (1 097)	24.0 (609)	25.9 (659)	18.2 (463)	7.0 (178)	4.4 (111)	1.8 (46)	93 (45)
HDN 3.0 x 18	18 (450)	689,400 (77 900)	16,809,300 (1 899 200)	50,000 (222 400)	180 (800)	650 (2 895)	47.2 (1 199)	26.0 (660)	28.0 (710)	20.2 (514)	7.0 (178)	4.4 (111)	1.8 (46)	99 (48)
HDN 3.0 x 20	20 (500)	755,900 (85 400)	18,108,200 (2 046 000)	50,000 (222 400)	180 (800)	650 (2 895)	51.2 (1 301)	28.0 (711)	30.0 (761)	22.2 (565)	7.0 (178)	4.4 (111)	1.8 (46)	106 (51)
HDN 3.0 x 24	24 (600)	887,600 (100 300)	20,680,500 (2 336 600)	50,000 (222 400)	180 (800)	650 (2 895)	59.2 (1 504)	32.0 (812)	33.9 (862)	26.3 (667)	7.0 (178)	4.4 (111)	1.8 (46)	119 (57)
HDN 3.0 x 28	28 (700)	1,020,600 (115 300)	23,278,300 (2 630 100)	50,000 (222 400)	180 (800)	650 (2 895)	67.2 (1 707)	36.0 (914)	38.0 (964)	30.2 (768)	7.0 (178)	4.4 (111)	1.8 (46)	130 (62)
HDN 3.0 x 32	32 (800)	1,152,200 (130 200)	25,850,700 (2 920 700)	40,500 (180 200)	180 (800)	650 (2 895)	75.2 (1 910)	40.0 (1 015)	41.9 (1 065)	34.3 (870)	7.0 (178)	6.3 (161)	1.8 (46)	143 (68)
HDN 3.0 x 36	36 (900)	1,307,100 (147 700)	29,645,500 (3 349 500)	36,000 (160 100)	180 (800)	650 (2 895)	84.9 (2 156)	45.8 (1 164)	47.8 (1 214)	38.1 (967)	9.0 (228)	6.3 (161)	1.8 (46)	163 (77)
HDN 3.0 x 40	40 (1 000)	1,412,700 (159 600)	32,192,300 (3 637 200)	31,500 (140 000)	180 (800)	650 (2 895)	92.8 (2 356)	49.8 (1 264)	51.7 (1 314)	42.0 (1 067)	9.0 (228)	6.3 (161)	1.8 (46)	176 (85)
HDN 3.0 x 48	48 (1 200)	1,590,700 (179 700)	37,286,100 (4 212 800)	21,500 (95 600)	185 (825)	650 (2 895)	108.5 (2 756)	57.6 (1 464)	59.6 (1 514)	49.9 (1 267)	9.0 (228)	6.3 (161)	1.8 (46)	200 (94)
HDN 3.0 x 56	56 (1 400)	1,741,300 (196 700)	42,379,800 (4 788 300)	12,500 (55 600)	185 (825)	650 (2 895)	124.3 (3 156)	65.5 (1 664)	67.5 (1 714)	57.8 (1 467)	9.0/37.3** (228)/(947)	6.3 (161)	1.8 (46)	235 (106)
HDN 3.0 x 60	60 (1 500)	1,830,400 (206 800)	45,283,200 (5 116 300)	11,950 (53 200)	185 (825)	650 (2 895)	133.2 (3 384)	70.0 (1 778)	72.0 (1 828)	62.2 (1 581)	9.0/39.5** (228)/(1004)	6.3 (161)	1.8 (46)	235 (106)
HDN 3.0 x 64	64 (1 629)	1,921,500 (217 100)	46,116,000 (5 210 400)	11,950 (53 200)	185 (825)	650 (2 895)	145.2 (3 688)	78.0 (1 980)	79.9 (2 030)	66.3 (1 683)	12.9/60.1 (328)/(1 527)	10.2 (260)	1.8 (46)	245 (110)
HDN 3.0 x 72	72 (1 830)	2,106,500 (238 000)	55,245,000 (6 242 000)	11,950 (53 200)	185 (825)	650 (2 895)	158.0 (4 012)	82.5 (2 092)	84.5 (2 142)	74.6 (1 895)	17.3/68.0 (439)/(1 727)	10.2 (260)	1.8 (46)	260 (118)

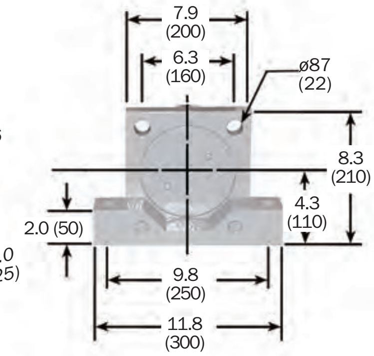
Notes: 1. HDN shock absorbers will function satisfactorily at 5% of their maximum rated energy per cycle. If less than these values, a smaller model should be specified.
2. It is recommended that the customer consult ITT Enidine for safety-related overhead crane applications.
3. The energy data listed is for ideal linear impacts only. If side load conditions exist in the application, contact ITT Enidine for sizing assistance.
4. Rear flange mounting of 12 inch (300 mm) strokes and longer not recommended. Front and rear flange or foot mount configurations are recommended.
5. Maximum cycle rate is 60 cycles/hr. for HDN with BA option and 30 cycles/hr. without BA (Bladder Accumulator) option.
6. For impact velocities over 180 in./sec. (4.5 m/s), consult factory.
7. ** HDN 3.0 x 56 and HDN 3.0 x 60 have 2 charge ports.

Heavy Duty Series Shock Absorber
HDN 3.5 Series

Technical Data

HDN 3.5 x 2 → HDN 3.5 x 56 Series





** HDN w/o BA option contains only a single charge/fill port.
* Denotes Shock Absorber Bladder Accumulator Option.
Note: For TF, FF and FR mounting, delete front foot and dimensions.

Dimensions are in inches (millimeters).

Catalog No./ Model	(S) Stroke in. (mm)	(E_T) Max. in.-lbs./cycle (Nm/cycle)	(E_TC) Max. in.-lbs./hour (Nm/hr)	(F_P) Max. Shock Force lbs. (N)	Nominal Return Force BA* lbs. (N)	Nominal Return Force w/o BA* lbs. (N)	A in. (mm)	F in. (mm)	Y in. (mm)	Z in. (mm)	With BA: CP BA* in. (mm)	With BA: FP BA* in. (mm)	CP** w/o BA* in. (mm)	Model Weight lbs. (Kg)
HDN 3.5 x 2	2 (50)	115,200 (13 000)	6,912,100 (781 000)	67,500 (300 250)	215 (960)	455 (2 020)	13.9 (354)	9.6 (244)	11.6 (294)	3.3 (85)	5.3 (134)	3.0 (77)	2.1 (52)	73 (33)
HDN 3.5 x 4	4 (100)	230,400 (26 000)	8,793,200 (993 500)	67,500 (300 250)	230 (1 020)	610 (2 710)	18.0 (456)	11.6 (295)	13.6 (345)	5.4 (136)	5.3 (134)	3.0 (77)	2.1 (52)	82 (37)
HDN 3.5 x 6	6 (150)	343,300 (38 800)	10,283,600 (1 161 900)	67,500 (300 250)	260 (1 160)	1,010 (4 480)	21.9 (556)	13.6 (345)	15.6 (395)	7.3 (186)	5.3 (134)	3.0 (77)	2.1 (52)	90 (41)
HDN 3.5 x 8	8 (200)	450,300 (50 900)	11,803,800 (1 333 600)	67,500 (300 250)	265 (1 180)	1,010 (4 480)	25.9 (658)	15.6 (396)	17.6 (446)	9.3 (237)	5.3 (134)	3.0 (77)	2.1 (52)	99 (45)
HDN 3.5 x 10	10 (250)	538,400 (60 800)	13,324,000 (1 505 400)	67,500 (300 250)	270 (1 200)	1,010 (4 480)	29.9 (760)	17.6 (447)	19.6 (497)	11.3 (288)	5.3 (134)	3.0 (77)	2.1 (52)	108 (49)
HDN 3.5 x 12	12 (300)	626,500 (70 800)	14,844,100 (1 677 200)	67,500 (300 250)	270 (1 200)	1,010 (4 480)	33.9 (862)	19.6 (498)	21.6 (548)	13.3 (339)	5.3 (134)	3.0 (77)	2.1 (52)	117 (53)
HDN 3.5 x 16	16 (400)	801,000 (90 500)	17,854,700 (2 017 300)	67,500 (300 250)	275 (1 225)	1,010 (4 480)	41.9 (1 064)	23.6 (599)	25.6 (649)	17.3 (440)	5.3 (134)	3.0 (77)	2.1 (52)	132 (60)
HDN 3.5 x 20	20 (500)	1,051,800 (118 800)	22,534,500 (2 546 100)	67,500 (300 250)	275 (1 225)	1,010 (4 480)	52.0 (1 323)	29.8 (756)	31.8 (806)	21.2 (542)	7.4 (189)	5.2 (132)	2.1 (52)	163 (74)
HDN 3.5 x 24	24 (600)	1,228,000 (138 700)	25,574,800 (2 889 600)	67,500 (300 250)	280 (1 250)	1,010 (4 480)	60.1 (1 527)	33.8 (858)	35.8 (908)	25.3 (644)	7.4 (189)	5.2 (132)	2.1 (52)	179 (81)
HDN 3.5 x 28	28 (700)	1,402,500 (158 500)	28,585,400 (3 229 700)	67,500 (300 250)	280 (1 250)	1,010 (4 480)	68.0 (1 729)	37.8 (959)	39.8 (1 009)	29.2 (745)	7.4 (189)	5.2 (132)	2.1 (52)	196 (89)
HDN 3.5 x 32	32 (800)	1,578,700 (178 400)	31,625,800 (3 573 200)	67,500 (300 250)	280 (1 250)	1,010 (4 480)	76.1 (1 933)	41.8 (1 061)	43.8 (1 111)	33.2 (847)	7.4 (189)	5.2 (132)	2.1 (52)	214 (97)
HDN 3.5 x 36	36 (900)	1,754,900 (198 300)	34,666,100 (3 916 800)	58,500 (260 200)	280 (1 250)	1,010 (4 480)	84.1 (2 137)	45.8 (1 163)	47.8 (1 213)	37.3 (949)	7.4 (189)	5.2 (132)	2.1 (52)	231 (105)
HDN 3.5 x 40	40 (1 000)	1,918,600 (216 800)	37,676,700 (4 256 900)	48,500 (215 700)	280 (1 250)	1,010 (4 480)	92.1 (2 339)	49.8 (1 264)	51.8 (1 314)	41.3 (1 050)	7.4 (189)	5.2 (132)	2.1 (52)	247 (112)
HDN 3.5 x 48	48 (1 200)	2,188,000 (247 200)	43,638,200 (4 930 500)	35,000 (155 700)	280 (1 250)	1,010 (4 480)	107.8 (2 739)	57.6 (1 464)	59.6 (1 514)	49.2 (1 250)	7.4 (189)	5.2 (132)	2.1 (52)	282 (128)
HDN 3.5 x 56	56 (1 400)	2,418,600 (273 300)	49,599,700 (5 604 000)	25,300 (112 500)	470 (2 100)	1,010 (4 480)	123.6 (3 139)	65.5 (1 665)	67.5 (1 715)	57.1 (1 450)	7.4/48.6** (1 894)/(1 233)	5.2 (132)	2.1 (52)	317 (144)

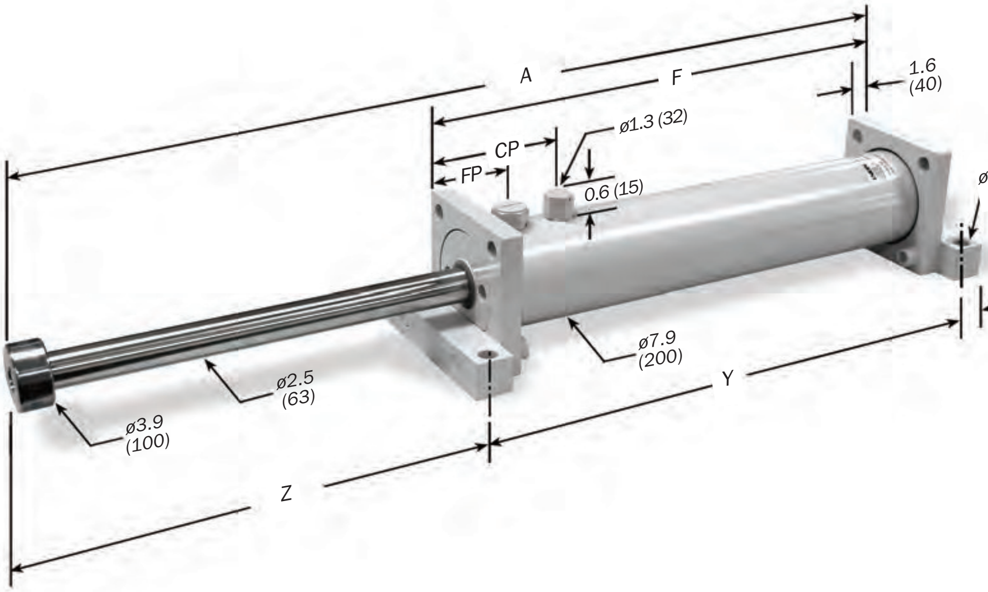
Notes: 1. HDN shock absorbers will function satisfactorily at 5% of their maximum rated energy per cycle. If less than these values, a smaller model should be specified.
2. It is recommended that the customer consult ITT Enidine for safety-related overhead crane applications.
3. The energy data listed is for ideal linear impacts only. If side load conditions exist in the application, contact ITT Enidine for sizing assistance.
4. Rear flange mounting of 12 inch (300 mm) strokes and longer not recommended. Front and rear flange or foot mount configurations are recommended.
5. Maximum cycle rate is 60 cycles/hr. for HDN with BA option and 30 cycles/hr. without BA option.
6. For impact velocities over 180 in./sec. (4.5 m/s), consult factory.
7. ** HDN 3.5 x 56 has two charge ports.

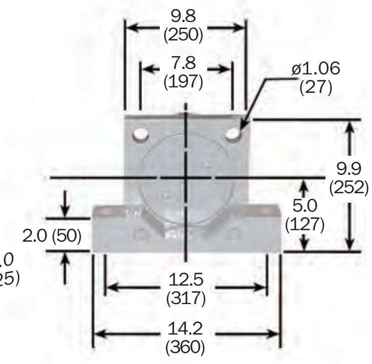
ENIDINE www.enidine.com Email: industrialsales@enidine.com Tel.: 1-800-852-8508 Fax: 1-716-662-0406

Heavy Duty Series Shock Absorber
HDN 4.0 Series

Technical Data

HDN 4.0 x 2 → HDN 4.0 x 48 Series





** HDN w/o BA option contains only a single charge/fill port.
* Denotes Shock Absorber Bladder Accumulator Option.
Note: For TF, FF and FR mounting, delete front foot and dimensions.

Dimensions are in inches (millimeters).

Catalog No./ Model	(S) Stroke in. (mm)	(E_T) Max. in.-lbs./cycle (Nm/cycle)	(E_TC) Max. in.-lbs./hour (Nm/hr)	(F_P) Max. Inital Shock Force lbs. (N)	Nominal Return Force BA* lbs. (N)	Nominal Return Force w/o BA* lbs. (N)	A in. (mm)	F in. (mm)	Y in. (mm)	Z in. (mm)	With BA CP BA* in. (mm)	With BA FP BA* in. (mm)	CP** w/o BA* in. (mm)	Model Weight lbs. (Kg)
HDN 4.0 x 2	2 (50)	139,200 (15 700)	8,352,800 (943 700)	80,000 (355 900)	250 (1 100)	425 (1 900)	16.9 (430)	11.6 (294)	13.5 (344)	4.4 (111)	8.1 (206)	4.3 (108)	2.5 (64)	141 (64)
HDN 4.0 x 4	4 (100)	275,700 (31 200)	13,579,600 (1 534 300)	80,000 (355 900)	270 (1 200)	485 (2 160)	20.9 (532)	13.6 (345)	15.6 (395)	6.4 (162)	8.1 (206)	4.3 (108)	2.5 (64)	154 (70)
HDN 4.0 x 6	6 (150)	409,606 (46 279)	15,547,700 (1 756 700)	80,000 (355 900)	270 (1 200)	690 (3 050)	24.9 (632)	15.6 (395)	17.5 (445)	8.3 (212)	8.1 (206)	4.3 (108)	2.5 (64)	168 (76)
HDN 4.0 x 8	8 (200)	548,800 (62 000)	17,594,400 (1 987 900)	80,000 (355 900)	270 (1 200)	980 (4 370)	28.9 (735)	17.6 (447)	19.6 (497)	10.4 (263)	8.1 (206)	4.3 (108)	2.5 (64)	181 (82)
HDN 4.0 x 10	10 (250)	682,700 (77,100)	19,562,500 (2 210 300)	80,000 (355 900)	270 (1 200)	1,230 (5 465)	32.9 (836)	19.6 (497)	21.5 (547)	12.4 (314)	8.1 (206)	4.3 (108)	2.5 (64)	192 (87)
HDN 4.0 x 12	12 (300)	819,200 (92 600)	25,269,900 (1 855 100)	80,000 (355 900)	275 (1 225)	1,000 (4 440)	40.6 (1 032)	25.3 (642)	27.2 (692)	14.4 (365)	11.8 (300)	8.0 (202)	2.5 (64)	238 (108)
HDN 4.0 x 16	16 (400)	1,089,600 (123,100)	29,245,400 (3 304 300)	80,000 (355 900)	275 (1 225)	1,270 (5 650)	48.6 (1 234)	29.3 (743)	31.2 (793)	18.3 (466)	11.8 (300)	8.0 (202)	2.5 (64)	265 (120)
HDN 4.0 x 20	20 (500)	1,362,700 (154 000)	33,260,200 (3 757 900)	80,000 (355 900)	280 (1 245)	1,155 (5 145)	56.6 (1 438)	33.3 (845)	35.2 (895)	22.4 (568)	11.8 (300)	8.0 (202)	2.5 (64)	290 (131)
HDN 4.0 x 24	24 (600)	1,635,700 (184 800)	37,275,000 (4 211 500)	80,000 (355 900)	280 (1 245)	1,275 (5 675)	64.6 (1 642)	37.3 (947)	39.3 (997)	26.4 (670)	11.8 (300)	8.0 (202)	2.5 (64)	317 (144)
HDN 4.0 x 28	28 (700)	1,904,200 (215 100)	41,250,500 (4 660 700)	80,000 (355 900)	280 (1 245)	1,275 (5 675)	72.6 (1 844)	41.3 (1 048)	43.2 (1 098)	30.4 (771)	11.8 (300)	8.0 (202)	2.5 (64)	346 (157)
HDN 4.0 x 32	32 (800)	2,128,700 (240 500)	45,265,400 (5 114 300)	80,000 (355 900)	280 (1 245)	1,275 (5 675)	80.6 (2 048)	45.3 (1 150)	47.2 (1 200)	34.4 (873)	11.8 (300)	8.0 (202)	2.5 (64)	375 (170)
HDN 4.0 x 36	36 (900)	2,353,200 (265 900)	49,280,200 (5 567 900)	80,000 (355 900)	280 (1 245)	1,275 (5 675)	88.7 (2 252)	49.3 (1 252)	51.3 (1 302)	38.4 (975)	11.8 (300)	8.0 (202)	2.5 (64)	403 (183)
HDN 4.0 x 40	40 (1 000)	2,566,000 (289 900)	53,255,700 (6 017 100)	80,000 (355 900)	280 (1 245)	1,275 (5 675)	96.6 (2 454)	53.3 (1 353)	55.2 (1 403)	42.4 (1 076)	11.8 (300)	8.0 (202)	2.5 (64)	430 (195)
HDN 4.0 x 48	48 (1 200)	2,914,200 (329 300)	61,246,000 (6 919 900)	45,000 (200 000)	280 (1 245)	1,275 (5 675)	112.4 (2 854)	61.3 (1 556)	63.2 (1 606)	50.1 (1 273)	11.8 (300)	8.0 (202)	2.5 (64)	485 (220)

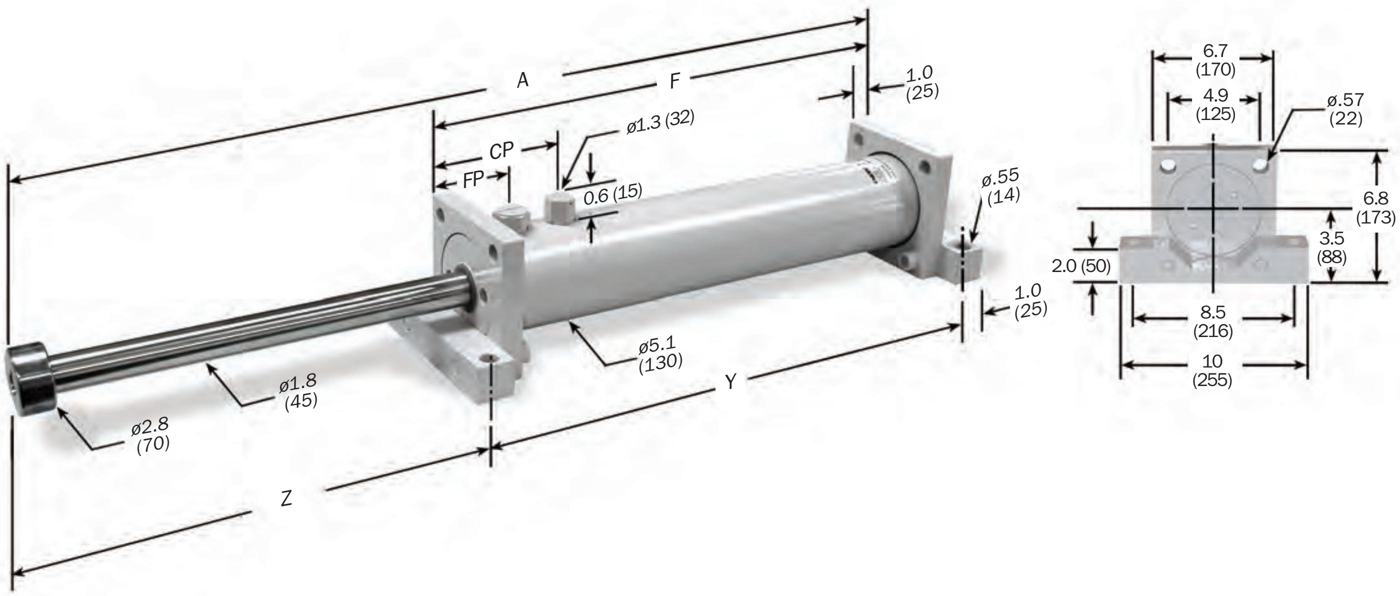
Notes: 1. HDN shock absorbers will function satisfactorily at 5% of their maximum rated energy per cycle. If less than these values, a smaller model should be specified.
2. It is recommended that the customer consult ITT Enidine for safety-related overhead crane applications.
3. The energy data listed is for ideal linear impacts only. If side load conditions exist in the application, contact ITT Enidine for sizing assistance.
4. Rear flange mounting of 12 inch (300 mm) strokes and longer not recommended. Front and rear flange or foot mount configurations are recommended.
5. Maximum cycle rate is 60 cycles/hr. for HDN with BA option and 30 cycles/hr. without BA option.
6. For impact velocities over 180 in./sec. (4.5 m/s), consult factory.

Heavy Duty Adjustable Series Shock Absorber

HDA 3.0 Series

Technical Data

HDA 3.0 x 2 → HDA 3.0 x 12 Series



Dimensions are in inches (millimeters).

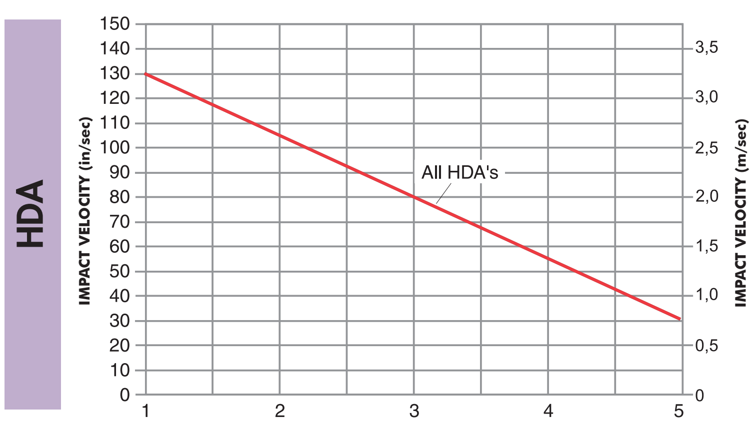
Note: For TF, FF and FR mounting, delete front foot and dimensions.

Catalog No./ Model	(S) Stroke in. (mm)	(E_T) Max. in.-lbs./cycle (Nm/cycle)	(E_TC) Max. in.-lbs./hour (Nm/hr)	(F_P) Max. End Shock Force lbs. (N)	Nominal Return Force BA* lbs. (N)	A in. (mm)	F in. (mm)	Y in. (mm)	Z in. (mm)	With BA CP* in. (mm)	With BA FP* in. (mm)	Model Weight lbs. (Kg)
HDA 3.0 x 2	2 (50)	40,000 (4 500)	2,400,000 (271 200)	50,000 (222 400)	150 (660)	13.2 (336)	8.4 (213)	10.4 (263)	3.9 (98)	4.4 (112)	2.4 (61)	40 (21)
HDA 3.0 x 3	3 (75)	60,000 (6 800)	3,600,000 (406 700)	50,000 (222 400)	160 (710)	15.2 (387)	9.4 (239)	11.4 (289)	4.8 (123)	4.4 (112)	2.4 (61)	42 (22)
HDA 3.0 x 5	5 (125)	100,000 (11 300)	6,000,000 (677 900)	50,000 (222 400)	165 (730)	19.3 (489)	11.4 (290)	13.4 (340)	6.9 (174)	4.4 (112)	2.4 (61)	48 (25)
HDA 3.0 x 8	8 (200)	160,000 (18 100)	9,296,000 (1 050 300)	50,000 (222 400)	170 (765)	25.2 (640)	14.4 (365)	16.3 (415)	9.8 (250)	4.4 (112)	2.4 (61)	57 (29)
HDA 3.0 x 10	10 (250)	200,000 (22 600)	10,594,500 (1 197 100)	50,000 (222 400)	175 (775)	29.2 (742)	16.4 (416)	18.3 (466)	11.9 (301)	4.4 (112)	2.4 (61)	64 (32)
HDA 3.0 x 12	12 (300)	240,000 (27 200)	11,893,800 (1 343 800)	50,000 (222 400)	175 (775)	33.2 (844)	18.4 (467)	20.4 (517)	13.8 (352)	4.4 (112)	2.4 (61)	71 (35)

Notes: 1. HDA shock absorbers will function satisfactorily at 5% of their maximum rated energy per cycle. If less than these values, a smaller model should be specified.
2. It is recommended that the customer consult ITT Enidine for safety-related overhead crane applications.
3. The energy data listed is for ideal linear impacts only. If side load conditions exist in the application, contact ITT Enidine for sizing assistance.
4. Rear flange mounting of 12 inch (300 mm) strokes and longer not recommended. Front and rear flange or foot mount configurations are recommended.
5. Maximum cycle rate is 60 cycles/hr.
6. HDA models which have an impact velocity below 30 in./sec. (.8 m/sec.), please contact ITT Enidine for assistance.
7. Maximum allowable applied propelling force: 25,000 lbs. (111 200 N)

Adjustment Techniques

Useable Adjustment Setting Range



After properly sizing an HDA shock absorber, the useable range of adjustment settings can be determined:

1. Locate the intersection point of the application's impact velocity and the HDA model graph line.
2. The intersection is the maximum adjustment setting to be used. Adjustments exceeding this setting could overload the shock absorber.
3. The useable adjustment setting range is from setting 1 to the MAXIMUM adjustment setting as determined in step 2.

EXAMPLE: HDA Series

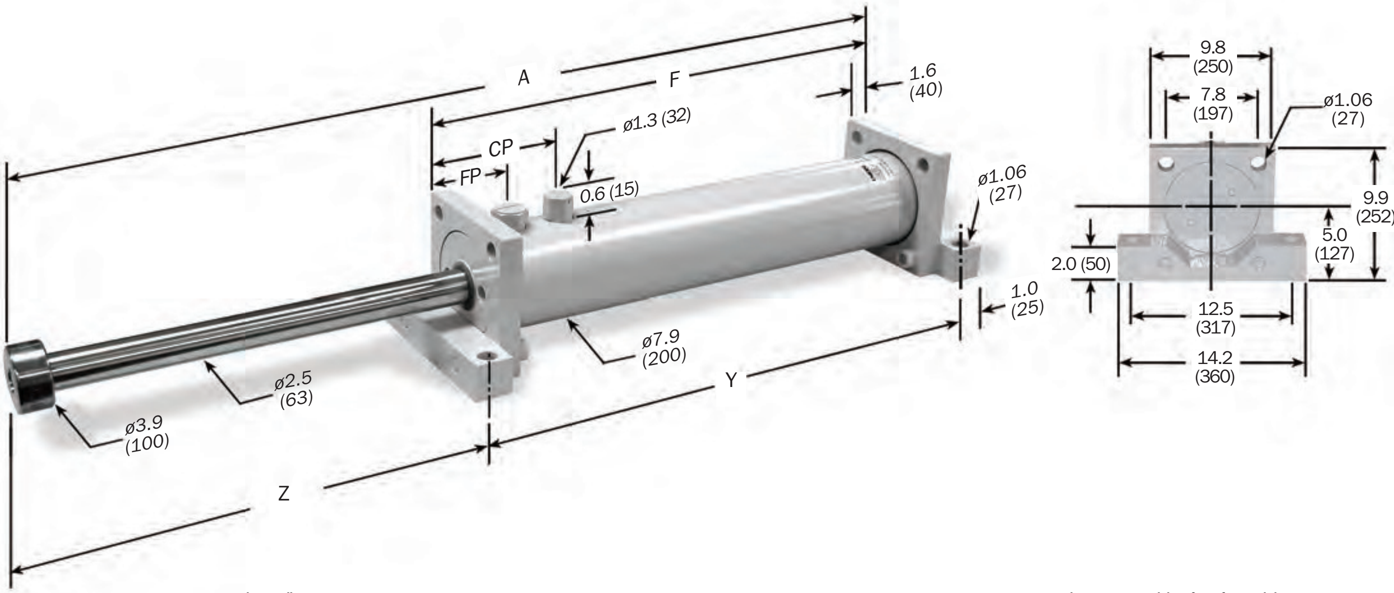
1. Impact Velocity:	80 in./sec. (2 m/s)
2. Intersection Point:	Adjustment Setting 3
3. Useable Adjustment Setting Range:	1 to 3

Heavy Duty Adjustable Series Shock Absorber

HDA 4.0 Series

Technical Data

HDA 4.0 x 2 ➞ HDA 4.0 x 10 Series



Dimensions are in inches (millimeters).

Note: For TF, FF and FR mounting, delete front foot and dimensions.

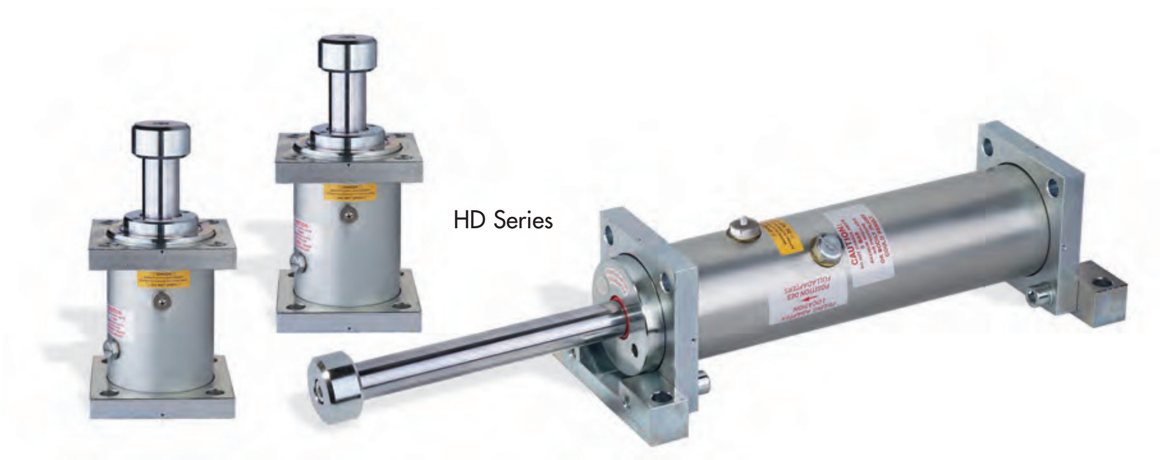
Catalog No./ Model	(S) Stroke in. (mm)	(E_T) Max. in.-lbs./cycle (Nm/cycle)	(E_TC) Max. in.-lbs./hour (Nm/hr)	(F_P) Max. End Shock Force lbs. (N)	Nominal Return Force BA* lbs. (N)	A in. (mm)	F in. (mm)	Y in. (mm)	Z in. (mm)	With BA CP* in. (mm)	With BA FP* in. (mm)	Model Weight lbs. (Kg)
HDA 4.0 x 2	2 (50)	120,000 (13 600)	7,200,000 (813 500)	80,000 (355 900)	250 (1 125)	16.9 (430)	12.0 (304)	13.9 (354)	4.0 (101)	7.1 (180)	4.3 (108)	141 (64)
HDA 4.0 x 4	4 (100)	240,000 (27 100)	13,973,200 (1 578 800)	80,000 (355 900)	250 (1 125)	20.9 (532)	14.0 (355)	15.9 (405)	6.0 (152)	7.1 (180)	4.3 (108)	154 (70)
HDA 4.0 x 6	6 (150)	360,000 (40 700)	15,941,300 (1 801 100)	80,000 (355 900)	250 (1 125)	24.9 (632)	15.9 (405)	17.9 (455)	8.0 (202)	7.1 (180)	4.3 (108)	168 (76)
HDA 4.0 x 8	8 (200)	480,000 (54 200)	17,988,100 (2 032 400)	80,000 (355 900)	250 (1 125)	28.9 (735)	18.0 (457)	20.0 (507)	10.0 (253)	7.1 (180)	4.3 (108)	181 (82)
HDA 4.0 x 10	10 (250)	600,000 (67 800)	19,956,100 (2 254 700)	80,000 (355 900)	250 (1 125)	32.9 (836)	20.0 (507)	21.9 (557)	12.0 (304)	7.1 (180)	4.3 (108)	192 (87)

Notes: 1. HDA shock absorbers will function satisfactorily at 5% of their maximum rated energy per cycle. If less than these values, a smaller model should be specified.
2. It is recommended that the customer consult ITT Enidine for safety-related overhead crane applications.
3. The energy data listed is for ideal linear impacts only. If side load conditions exist in the application, contact ITT Enidine for sizing assistance.
4. Rear flange mounting of 12 inch (300 mm) strokes and longer not recommended. Front and rear flange or foot mount configurations are recommended.
5. Maximum cycle rate is 60 cycles/hr.
6. HDA models which have an impact velocity below 30 in./sec. (.8 m/sec.), please contact ITT Enidine for assistance.
7. Maximum allowable applied propelling force: 40,000 (177 900 N)

Heavy Duty Series Shock Absorber
HD Series

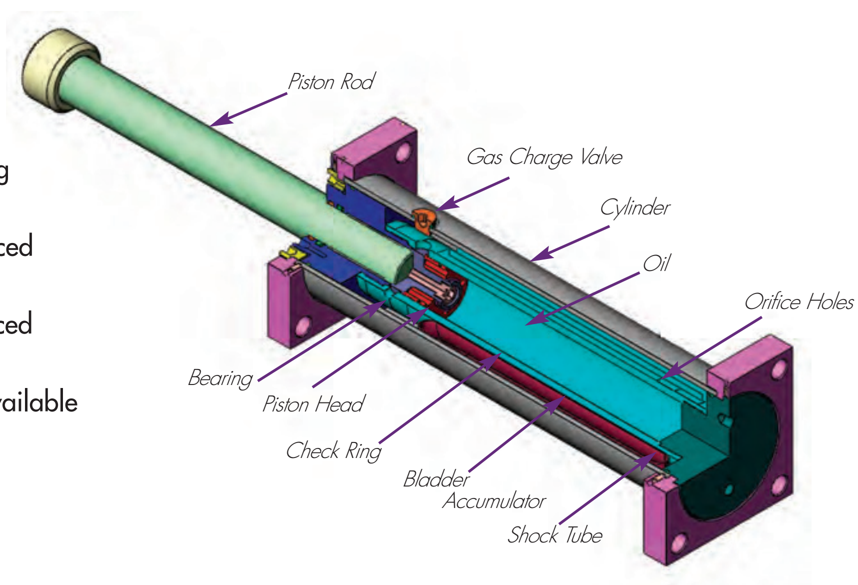
Overview

HD Series
Custom-orificed design accommodates specified damping requirements. Computer generated output performance simulation is used to optimize the orifice configuration. Available in standard bore dimensions of up to 5 in. (125mm) and 6 in. (156mm) with strokes over 60 in. (1525mm).



Features and Benefits HD

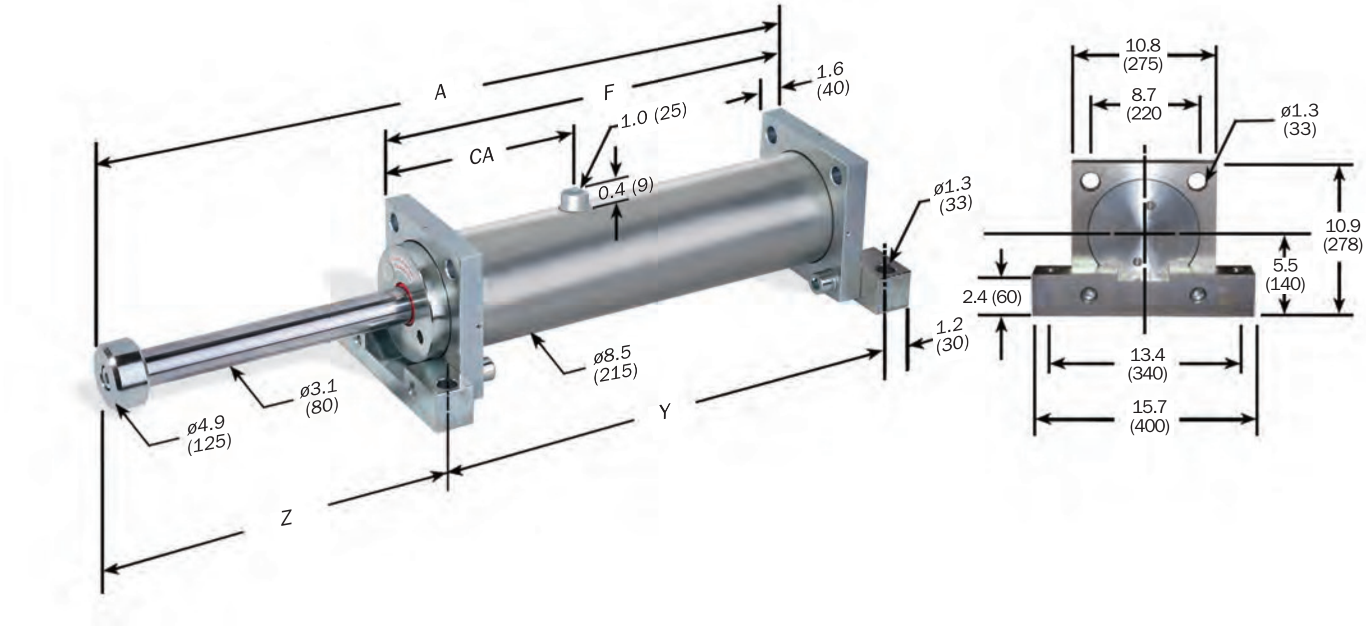
- Compact design smoothly and safely decelerates large energy capacity loads up to 8,000,000 in-lbs. per cycle (900 000 Nm)
- Engineered to meet OSHA, AISE, CMAA and other safety specifications such as DIN and FEM.
- Internal air charged bladder accumulator replaces mechanical return springs, providing shorter overall length and reduced weight.
- Wide variety of optional configurations including bellows, clevis mounts and safety cables.
- Available in standard adjustable or custom-orificed non-adjustable models.
- Zinc plated external components provide enhanced corrosion protection.
- Epoxy painting and special rod materials are available for use in highly corrosive environments.
- All sizes are fully field repairable.
- Piston rod extension sensor systems available for reuse safety requirements.
- Incorporating optional fluids and seal packages can expand standard operating temperature range from 15°F to 140°F to -30°F to 210°F (-10°C to 60°C) to (-35°C to 100°C)



Heavy Duty Series Shock Absorber
HD 5.0 Series

Technical Data

HD 5.0 x 4 → HD 5.0 x 48 Series



Dimensions are in inches (millimeters).

Note: For TF, FF and FR mounting, delete front foot and dimensions.

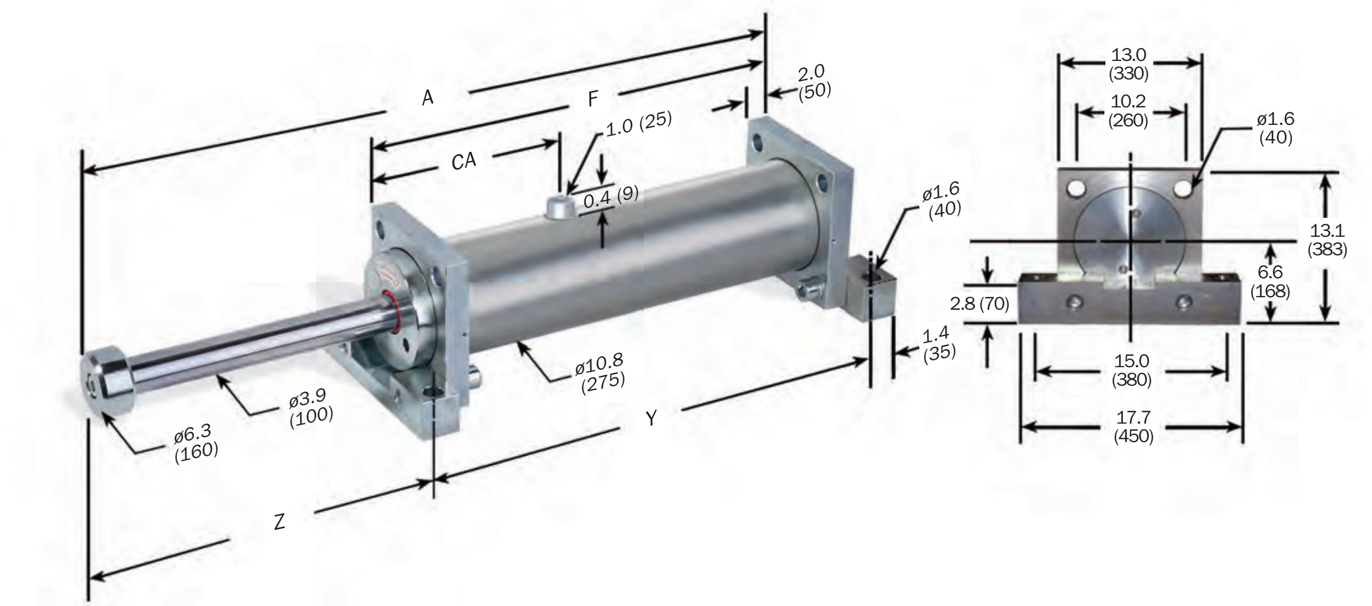
Catalog No./ Model	(S) Stroke in. (mm)	(E_T) Max. in.-lbs./cycle (Nm/cycle)	(E_TC) Max. in.-lbs./hour (Nm/hr)	(F_P) Max. Shock Force lbs. (N)	Nominal Return Force BA* lbs. (N)	A in. (mm)	F in. (mm)	Y in. (mm)	Z in. (mm)	CA in. (mm)	Model Weight lbs. (Kg)
HD 5.0 x 4	4 (100)	414,000 (46 700)	16,000,000 (1 762 621)	124,000 (550 000)	400 (1 760)	23.3 (591)	14.8 (37.5)	17.1 (435)	7.4 (186)	9.1 (230)	192 (87)
HD 5.0 x 6	6 (150)	620,000 (70 000)	17,720,000 (2 002 337)	124,000 (550 000)	400 (1 760)	27.3 (693)	16.8 (426)	19.1 (486)	9.4 (237)	9.1 (230)	207 (94)
HD 5.0 x 8	8 (200)	828,000 (93 500)	19,841,000 (2 242 053)	124,000 (550 000)	400 (1 760)	31.3 (795)	18.8 (477)	21.1 (537)	11.4 (288)	9.1 (230)	223 (101)
HD 5.0 x 10	10 (250)	1,036,000 (117 000)	21,921,000 (2 477 070)	124,000 (550 000)	400 (1 760)	35.3 (895)	20.8 (527)	23.1 (587)	13.4 (338)	9.1 (230)	238 (108)
HD 5.0 x 12	12 (300)	1,239,000 (140 000)	24,042,000 (2 716 786)	124,000 (550 000)	400 (1 760)	39.3 (997)	22.8 (578)	25.1 (638)	15.4 (389)	9.1 (230)	251 (114)
HD 5.0 x 16	16 (400)	1,655,000 (187 000)	28,285,000 (3 196 219)	124,000 (550 000)	400 (1 760)	47.3 (1 201)	26.8 (680)	29.1 (740)	19.4 (491)	9.1 (230)	282 (128)
HD 5.0 x 20	20 (500)	2,071,000 (234 000)	36,688,000 (4 145 684)	124,000 (550 000)	400 (1 760)	59.2 (1 504)	34.7 (882)	37.1 (942)	23.3 (592)	13.0 (230)	348 (158)
HD 5.0 x 24	24 (600)	2,478,000 (280 000)	40,930,000 (4 625 117)	124,000 (550 000)	400 (1 760)	67.2 (1 708)	38.7 (984)	41.1 (1 044)	27.3 (694)	13.0 (230)	377 (171)
HD 5.0 x 28	28 (700)	2,894,000 (327 000)	45,132,000 (5 099 849)	124,000 (550 000)	400 (1 760)	75.2 (1 910)	42.7 (1 085)	45.1 (1 145)	31.3 (795)	13.0 (230)	407 (185)
HD 5.0 x 32	32 (800)	3,310,000 (374 000)	49,374,000 (5 579 282)	124,000 (550 000)	400 (1 760)	83.2 (2 114)	46.7 (1 187)	49.1 (1 247)	35.3 (897)	13.0 (230)	437 (198)
HD 5.0 x 40	40 (1 000)	4,133,000 (467 000)	57,818,000 (6 533 447)	124,000 (550 000)	400 (1 760)	99.2 (2 520)	54.7 (1 390)	57.1 (1 450)	43.3 (1 100)	13.0 (231)	496 (225)
HD 5.0 x 48	48 (1 200)	4,750,000 (535 800)	66,262,000 (7 487 613)	92,000 (410 000)	400 (1 760)	115.0 (2 920)	62.6 (1 590)	65.0 (1 650)	51.6 (1 300)	13.0 (230)	534 (242)

Notes: 1. HD shock absorbers will function satisfactorily at 5% of their maximum rated energy per cycle.
HDA models will function satisfactorily at 10% of their maximum rated energy per cycle. If less than these values, a smaller model should be specified.
2. It is recommended that the customer consult ITT Enidine for safety-related overhead crane applications.
3. The energy data listed is for ideal linear impacts only. If side load conditions exist in the application, contact ITT Enidine for sizing assistance.
4. Rear flange mounting of 12 inch (300 mm) strokes and longer not recommended. Front and rear flange or foot mount configurations are recommended.
5. Maximum cycle rate is 60 cycles/hr.
6. For impact velocities over 180 in./sec. (4.5 m/s), consult factory.

Heavy Duty Series Shock Absorber
HD 6.0 Series

Technical Data

HD 6.0 x 4 → HD 6.0 x 48 Series



Dimensions are in inches (millimeters).

Note: For TF, FF and FR mounting, delete front foot and dimensions.

Catalog No./ Model	(S) Stroke in. (mm)	(E_T) Max. in.-lbs./cycle (Nm/cycle)	(E_TC) Max. in.-lbs./hour (Nm/hr)	(F_P) Max. Shock Force lbs. (N)	Nominal Return Force BA* lbs. (N)	A in. (mm)	F in. (mm)	Y in. (mm)	Z in. (mm)	CA in. (mm)	Model Weight lbs. (Kg)
HD(A) 6.0 x 4	4 (100)	677,000 (76 500)	21,280,000 (2 404 568)	202,250 (900 000)	625 (2 750)	25.1 (637)	15.4 (391)	18.2 (461)	8.3 (211)	7.8 (197)	362 (164)
HD(A) 6.0 x 6	6 (150)	1,010,000 (114 000)	23,933,000 (2 704 389)	202,250 (900 000)	625 (2 750)	29.1 (737)	17.4 (441)	20.2 (511)	10.3 (261)	7.8 (197)	386 (175)
HD(A) 6.0 x 8	8 (200)	1,354,000 (153 000)	26,586,000 (3 004 211)	202,250 (900 000)	625 (2 750)	33.1 (839)	19.4 (492)	22.2 (562)	12.3 (312)	7.8 (197)	410 (186)
HD(A) 6.0 x 10	10 (250)	1,690,000 (191 000)	29,345,000 (3 316 025)	202,250 (900 000)	625 (2 750)	37.1 (941)	21.4 (543)	24.2 (613)	14.3 (363)	7.8 (197)	432 (196)
HD(A) 6.0 x 12	12 (300)	1,982,000 (224 000)	32,052,000 (3 621 843)	202,250 (900 000)	625 (2 750)	41.1 (1 043)	23.4 (594)	26.2 (664)	16.3 (414)	7.8 (197)	456 (207)
HD 6.0 x 16	16 (400)	2,708,000 (306 000)	37,465,000 (4 233 478)	202,250 (900 000)	625 (2 750)	49.1 (1 246)	27.4 (696)	30.2 (766)	20.3 (515)	7.8 (197)	503 (228)
HD 6.0 x 20	20 (500)	3,380,000 (382 000)	42,877,000 (4 845 114)	202,250 (900 000)	625 (2 750)	57.1 (1 450)	31.4 (798)	34.2 (868)	24.3 (617)	7.8 (197)	551 (250)
HD 6.0 x 24	24 (600)	4,062,000 (459 000)	53,862,000 (6 086 375)	202,250 (900 000)	625 (2 750)	69.7 (1 769)	40.0 (1 015)	42.7 (1 085)	28.4 (719)	12.3 (312)	681 (309)
HD 6.0 x 30	30 (750)	5,070,000 (573 000)	61,928,000 (6 997 832)	202,250 (900 000)	625 (2 750)	81.6 (2 073)	46.0 (1 167)	48.7 (1 237)	34.3 (871)	12.3 (312)	752 (341)
HD 6.0 x 36	36 (900)	6,093,000 (688 500)	70,047,000 (7 915 285)	202,250 (900 000)	625 (2 750)	93.7 (2 379)	52.0 (1 320)	54.7 (1 390)	40.4 (1 024)	12.3 (312)	822 (373)
HD 6.0 X 42	42 (1 050)	7,106,000 (803 000)	78,113,000 (8 826 743)	202,250 (900 000)	625 (2 750)	105.6 (2 683)	58.0 (1 472)	60.7 (1 542)	46.3 (1 176)	12.3 (312)	893 (405)
HD 6.0 x 48	48 (1 200)	8,000,000 (898 200)	86,232,000 (9 744 196)	178,00 (790 000)	625 (2 750)	117.7 (2 989)	64.0 (1 625)	66.7 (1 695)	52.4 (1 329)	12.3 (312)	966 (438)

Notes: 1. HD shock absorbers will function satisfactorily at 5% of their maximum rated energy per cycle.
HDA models will function satisfactorily at 10% of their maximum rated energy per cycle. If less than these values, a smaller model should be specified.
2. It is recommended that the customer consult ITT Enidine for safety-related overhead crane applications.
3. The energy data listed is for ideal linear impacts only. If side load conditions exist in the application, contact ITT Enidine for sizing assistance.
4. Rear flange mounting of 12 inch (300 mm) strokes and longer not recommended. Front and rear flange or foot mount configurations are recommended.
5. HDA models which have an impact velocity below 30 in./sec (.8 m/sec.), please contact ITT Enidine for sizing assistance.
6. Maximum cycle rate is 60 cycles/hr.
7. For impact velocities over 180 in./sec. (4.5 m/s), consult factory.

Heavy Duty Series Shock Absorber
Mounting and Accessories for HDN, HD, HDA Series

Mounting and Accessories

Typical mounting methods are shown below. Special mounting requirements can be accommodated upon request.

TM: Rear Flange Front Foot Mount

FM: Front and Rear Foot Mount
Also shown is optional safety cable, typically used in overhead applications.

TF: Front and Rear Flanges

FF: Front Flange

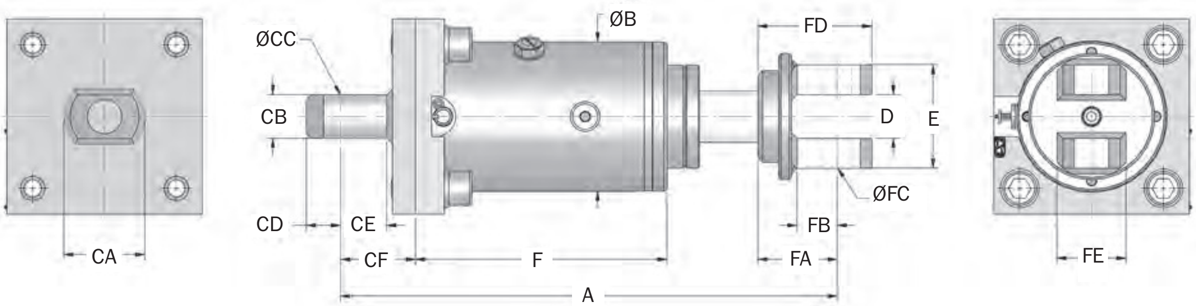
CM: Clevis Mount

FR: Rear Flange

Note: Rear flange mounting not recommended for stroke lengths above 12 inches. (300 mm)

HD(A) 3.0 x 2 ➞ HD(A) 4.0 x 10 Series

Clevis Mounts (CM)



Dimensions are in inches (millimeters).

Note: Piston clevis dimensions are typical both ends on HD(A) 4.0 models.

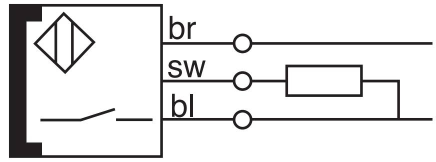
Catalog No./ Model	A in. (mm)	B in. (mm)	D in. (mm)	E in. (mm)	HD/HDN F in. (mm)	HDA F in. (mm)	Cylinder Clevis Dimensions CA in. (mm)	CB in. (mm)	CC in. (mm)	CD in. (mm)	CE in. (mm)	CF in. (mm)	Piston Clevis Dimensions FA in. (mm)	FB in. (mm)	FC in. (mm)	FD in. (mm)	FE in. (mm)
HD(A) 3.0 x 2	17.0 (432)	5.1 (130)	1.5 (38)	3.5 (90)	8.0 (202)	9.3 (235)	2.4 (60)	1.5 (38)	1.0 (25)	1.2 (30)	1.5 (37)	2.6 (65)	2.7 (69)	1.3 (32)	1.0 (25)	3.9 (99)	2.0 (50)
HD(A) 3.0 x 3	19.0 (483)	5.1 (130)	1.5 (38)	3.5 (90)	9.0 (229)	10.3 (261)	2.4 (60)	1.5 (38)	1.0 (25)	1.2 (30)	1.5 (37)	2.6 (65)	2.7 (69)	1.3 (32)	1.0 (25)	3.9 (99)	2.0 (50)
HD(A) 3.0 x 5	23.0 (585)	5.1 (130)	1.5 (38)	3.5 (90)	11.0 (280)	12.3 (312)	2.4 (60)	1.5 (38)	1.0 (25)	1.2 (30)	1.5 (37)	2.6 (65)	2.7 (69)	1.3 (32)	1.0 (25)	3.9 (99)	2.0 (50)
HD(A) 3.0 x 8	29.0 (736)	5.1 (130)	1.5 (38)	3.5 (90)	14.0 (355)	15.2 (387)	2.4 (60)	1.5 (38)	1.0 (25)	1.2 (30)	1.5 (37)	2.6 (65)	2.7 (69)	1.3 (32)	1.0 (25)	3.9 (99)	2.0 (50)
HD(A) 3.0 x 10	330 (838)	5.1 (130)	1.5 (38)	3.5 (90)	16.0 (406)	17.2 (438)	2.4 (60)	1.5 (38)	1.0 (25)	1.2 (30)	1.5 (37)	2.6 (65)	2.7 (69)	1.3 (32)	1.0 (25)	3.9 (99)	2.0 (50)
HD(A) 3.0 x 12	37.0 (940)	5.1 (130)	1.5 (38)	3.5 (90)	18.0 (457)	19.3 (489)	2.4 (60)	1.5 (38)	1.0 (25)	1.2 (30)	1.5 (37)	2.6 (65)	2.7 (69)	1.3 (32)	1.0 (25)	3.9 (99)	2.0 (50)
HD(A) 4.0 x 2	22.4 (570)	7.9 (200)	2.6 (65)	5.5 (140)	11.6 (294)	12.0 (304)	– –	– –	– –	– –	– –	3.5 (90)	3.9 (100)	2.4 (60)	2.0 (50)	5.9 (150)	3.9 (100)
HD(A) 4.0 x 4	26.4 (672)	7.9 (200)	2.6 (65)	5.5 (140)	13.6 (345)	14.0 (355)	– –	– –	– –	– –	– –	3.5 (90)	3.9 (100)	2.4 (60)	2.0 (50)	5.9 (150)	3.9 (100)
HD(A) 4.0 x 6	30.4 (772)	7.9 (200)	2.6 (65)	5.5 (140)	15.6 (395)	15.9 (405)	– –	– –	– –	– –	– –	3.5 (90)	3.9 (100)	2.4 (60)	2.0 (50)	5.9 (150)	3.9 (100)
HD(A) 4.0 x 8	34.4 (875)	7.9 (200)	2.6 (65)	5.5 (140)	17.6 (477)	18.0 (457)	– –	– –	– –	– –	– –	3.5 (90)	3.9 (100)	2.4 (60)	2.0 (50)	5.9 (150)	3.9 (100)
HD(A) 4.0 x 10	38.4 (976)	7.9 (200)	2.6 (65)	5.5 (140)	19.6 (497)	20.0 (507)	– –	– –	– –	– –	– –	3.5 (90)	3.9 (100)	2.4 (60)	2.0 (50)	5.9 (150)	3.9 (100)

Heavy Duty Series Shock Absorber
Mounting and Accessories for HDN, HD, HDA Series

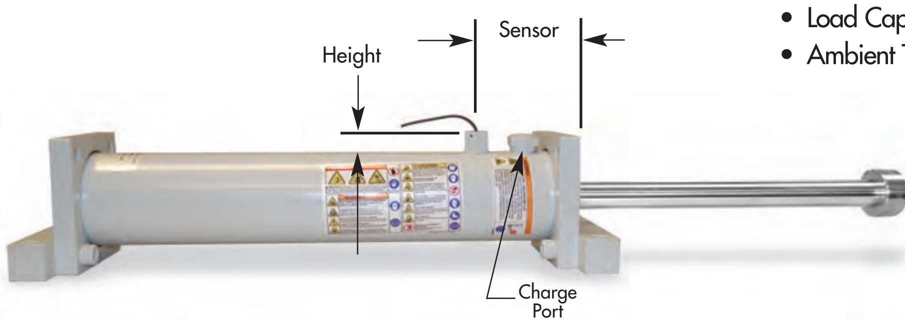
Optional Piston Rod Return Sensor

- Magnetic proximity sensor indicates complete piston rod return with 10-foot (3 m) long cable.
- If complete piston rod does not return the circuit remains open. This can be used to trigger a system shut-off.
- Contact ITT Enidine for other available sensor types.
- Sensor port in line with charge port on models HDN 1.5, 2.0 and 4.0. Location offset 90° for models HDN 3.0 and 3.5.

Sensor Specifications

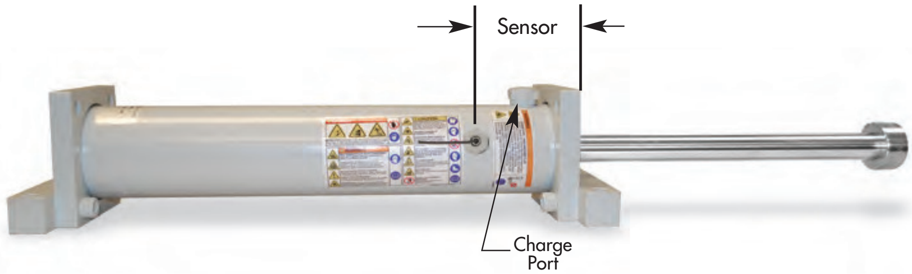


- Voltage 10 - 30V
- Load Current ≤ 200 mA
- Leakage Current ≤ 80 mA
- Load Capacitance ≤ 1.0 mF
- Ambient Temperature: -15° to 160°F (-26° to 71°C)



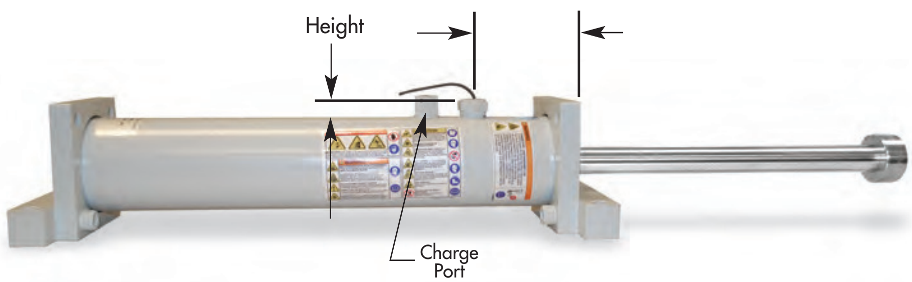
HDN 1.5, 2.0 and 4.0

Model	Sensor in. (mm)	Height in. (mm)
HDN 1.5	3.4 (86)	0.79 (20)
HDN 2.0 x 6-28	3.8 (96)	0.63 (16)
HDN 2.0 x 32-56	6.9 (176)	
HDN 4.0 x 2-10	4.3 (108)	0.35 (9)
HDN 4.0 x 12-48	8.0 (202)	



HDN 3.0 and 3.5

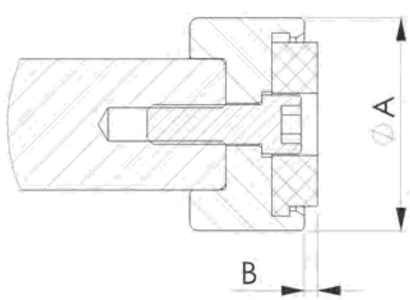
Model	Sensor in. (mm)	Height in. (mm)
HDN 3.0 x 2-12	2.4 (61)	0.59 (15)
HDN 3.0 x 14-32	4.4 (111)	
HDN 3.0 x 36-60	6.3 (161)	
HDN 3.5 x 2-16	3.0 (77.4)	0.35 (9)
HDN 3.5 x 20-56	5.2 (132.4)	



HDN 1.5, 2.0, 3.0, 3.5 and 4.0 BA

Model	Sensor in. (mm)	Height in. (mm)
HDN 1.5	3.4 (86)	0.79 (20)
HDN 2.0 x 6-28	3.8 (96)	0.63 (16)
HDN 2.0 x 32-56	6.9 (176)	
HDN 3.0 x 2-12	2.4 (61)	0.59 (15)
HDN 3.0 x 14-32	4.4 (111)	
HDN 3.0 x 36-60	6.3 (161)	
HDN 3.5 x 2-16	3.0 (77.4)	0.25 (9)
HDN 3.5 x 20-56	5.2 (132.4)	
HDN 4.0 x 2-10	4.3 (108)	
HDN 4.0 x 12-48	8.0 (202)	

Urethane Cap



Model	Dia. A (mm)	Dia A (in.)	B (mm)	B (in.)
HDN 1.5	60	2.36	4	0.16
HDN 2.0	65	2.56	4	0.16
HDN 3.0	70	2.76	4	0.16

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Ordering Example

Note: HDN/HD/HDA models are custom-orificed, therefore all information must be provided to ITT Enidine for unique part number assignment.

4	–	HDN	2.0 x 24	–	TM	–	C	–	APPLICATION DATA
1		2	3		4		5		

Ordering Code Example for Heavy Duty Shock Absorbers

1 - Quantity

2 - Model Selection
HDN (Non-Adjustable)
HD (Non-Adjustable)
HDA (Adjustable)

3 - Model Size
Select Size from Engineering Data Chart
HDN - 1.5, 2.0, 3.0, 3.5, 4.0 Bore Sizes (pages. 8-12)
HDA - 3.0, 4.0 Bore Sizes (pages. 13-14)
HD - 5.0, 6.0 Bore Sizes (pages. 16-17)

4 - Mounting Method
TM (Rear flange front foot mount)
FM (Front and rear foot mount)
TF (Front and rear flanges)
FF (Front flange)
FR (Rear flange)
CM (Metric clevis mount)

5 - Options
C (Sensor cable)
P (Sensor plug) - See Page 18
SC (Safety cable)
BA (Bladder Accumulator)
UC (Urethane Cap)

Application Data (Required for HDN/HD Models)
See Worksheet page 20
Vertical or horizontal motion
Weight
Impact velocity
Propelling force (if any)
Cycles/Hr
Other (temperature or other environmental conditions, safety standards, etc.)

Notes

Heavy Industry Shock Absorbers
HI Series

Overview

ITT Enidine's **Heavy Industry (HI) Series** buffers safely protect heavy machinery and equipment during the transfer of materials and movement of products. The large-bore, high-capacity buffers are individually designed to decelerate moving loads under various conditions and in compliance with industry mandated safety standards. Control of bridge cranes, trolley platforms, large container transfer and transportation safety stops are typical installation examples. Industry-proven design technologies, coupled with the experience of a globally installed product base, ensure deliverable performance that exceeds customer expectations.

Prior to HI Series buffer manufacture, computer-simulated response curves are generated to model actual conditions, verify product performance, confirm damping characteristics and generate unique custom-orificed designs that accommodate multi-condition or specific damping requirements.

Characteristics of the HI Series include a nitrogen-charged return system that allows for soft deceleration and positive return in a maintenance-free package. The oversize bore area results in optimal energy absorption capabilities and increased internal safety factors. State-of-the-art testing facilities ensure integrity of design and product performance.

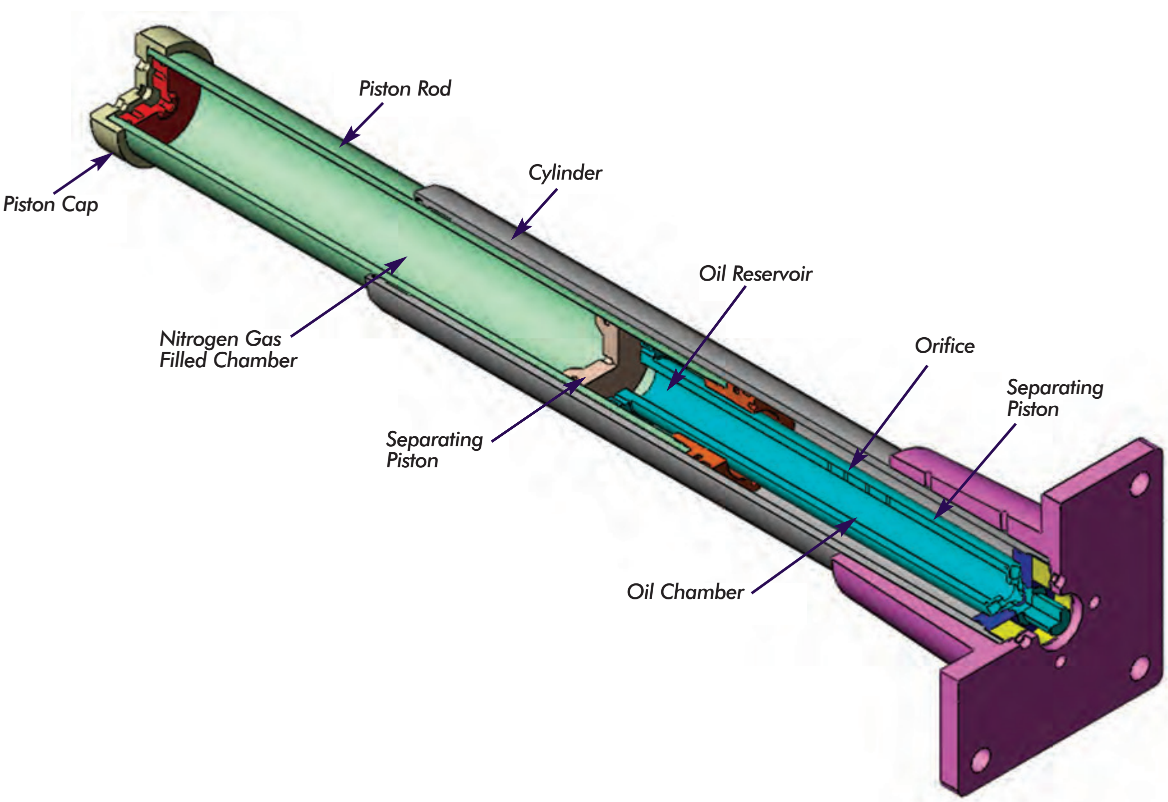
HI Series

Features and Benefits

- Compact design smoothly and safely decelerates large energy capacity loads up to 4 million in-lbs. per cycle with standard stroke lengths.
- Engineered to meet OSHA, AISE, CMMA and other safety specifications such as DIN and FEM.
- Nitrogen-charged return system allows for soft deceleration and positive return in a maintenance-free package.
- Wide variety of optional configurations including protective bellows and safety cables.
- Available in custom-orificed non-adjustable models.
- Special epoxy painting and rod materials are available for use in highly corrosive environments.
- Surface treatment (Sea water resistant)
  Housing: gray color, three-part epoxy
  Piston Rod: hard-chrome plated steel
- Incorporating optional fluids and seal packages available to expand standard operating temperature range from (0°F to 175°F) to (-30°F to 250°F) (-10°C to 60°C) to (-35°C to 100°C)

Ordering Information

ITT Enidine Heavy Industry (HI) Series Buffers



ITT Enidine's Heavy Industry Series (HI) buffers safely protect heavy machinery and equipment during the transfer of materials and movement of products. The large-bore, high-capacity buffers are individually designed to decelerate moving loads under various conditions and in compliance with industry mandated safety standards. Control of bridge cranes, trolley platforms, large container transfer and transportation safety stops are typical installation examples. Industry-proven design technologies, coupled with the experience of a globally installed product base, ensure deliverable performance that exceeds customer expectations.

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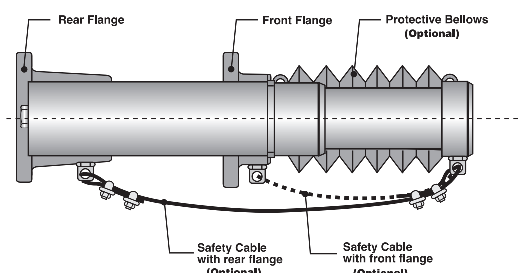
Ordering Example

Mounting bracket flange:
Standard: Rear or Front mount

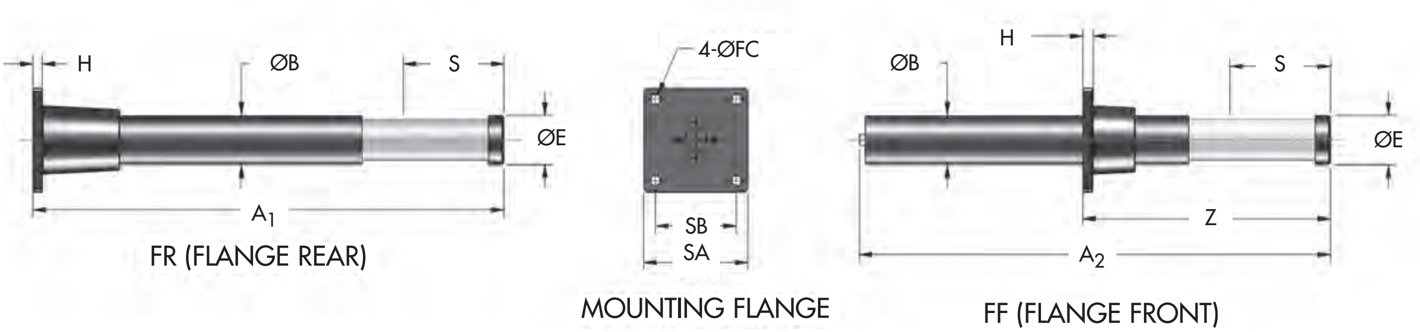


Example:

4	HI 120 x 100	FR	B	APPLICATION DATA
Select quantity	Select HI Series model from Engineering Data Chart	Select mounting method • FF (Flange Front) • FR (Flange Rear)	Additional Options • B Protective Bellows • C Safety cable	Required for all models: • Vertical/Horizontal Motion • Weight • Impact Velocity • Propelling Force (if any) • Cycles/Hour • Temperature/Environment • Applicable Standards

HI 50 x 50 → HI 120 x 1000 Series

Technical Data



Catalog No./ Model	S Stroke in. (mm)	Max. Energy/cycle in.-lbs. (Nm)	Max. Shock Force lbs. (kN)	Return Force: Extension lbs. (kN)	Return Force: Compression lbs. (kN)	Weight lbs. (Kg)	A_1 in. (mm)	A_2 in. (mm)	Z in. (mm)	H in. (mm)	ØB in. (mm)	SA in. (mm)	SB in. (mm)	ØFC in. (mm)	BOLT SIZE in. (mm)	ØE in. (mm)
HI 50 x 50	2 (50)	26,500 (3 000)	15,700 (70)	120 (0,5)	710 (3,2)	11 (5)	10.3 (262)	– –	– –	0.6 (15)	2.56 (65)	3.94 (100)	2.76 (70)	0.57 (14,5)	½ (M14)	2.28 (58)
HI 50 x 100	3.9 (100)	55,500 (6 200)	15,700 (70)	70 (0,3)	140 (0,6)	20 (9)	15.4 (392)	– –	– –	0.6 (15)	2.56 (65)	3.94 (100)	2.76 (70)	0.57 (14.5)	½ (M14)	2.28 (58)
HI 85 x 50	2 (50)	60,200 (6 800)	36,000 (160)	225 (1,0)	430 (1,9)	36 (16)	12.8 (324)	– –	– –	0.6 (15)	3.35 (85)	5.04 (128)	3.50 (89)	0.79 (20)	¾ (M18)	3.11 (79)
HI 85 x 100	3.9 (100)	120,500 (13 600)	36,000 (160)	225 (1,0)	1,800 (8,0)	49 (22)	16.7 (424)	– –	– –	0.6 (15)	3.35 (85)	5.04 (128)	3.50 (89)	0.79 (20)	¾ (M18)	3.11 (79)
HI 100 x 50	2 (50)	88,500 (10 000)	52,800 (235)	370 (1,65)	4,050 (18,0)	36 (16)	11.9 (302)	11.9 (301)	6.9 (175)	0.8 (20)	3.94 (100)	5.91 (150)	4.72 (120)	0.73 (18,5)	⅝ (M16)	3.90 (99)
HI 100 x 100	3.9 (100)	177,000 (20 000)	52,800 (235)	370 (1,65)	4,050 (18,0)	49 (22)	18.9 (479)	18.6 (473)	9.7 (245)	0.8 (20)	3.94 (100)	5.91 (150)	4.72 (120)	0.73 (18,5)	⅝ (M16)	3.90 (99)
HI 100 x 150	5.9 (150)	265,500 (30 000)	52,800 (235)	370 (1,65)	4,050 (18,0)	62 (28)	24.3 (618)	24.1 (612)	11.8 (300)	0.8 (20)	3.94 (100)	5.91 (150)	4.72 (120)	0.73 (18,5)	⅝ (M16)	3.90 (99)
HI 100 x 200	7.9 (200)	354,000 (40 000)	52,800 (235)	370 (1,65)	4,050 (18,0)	71 (32)	29.8 (756)	29.5 (750)	15.4 (390)	0.8 (20)	3.94 (100)	5.91 (150)	4.72 (120)	0.73 (18,5)	⅝ (M16)	3.90 (99)
HI 100 x 400	15.7 (400)	708,060 (80 000)	52,830 (235)	370 (1,65)	4,050 (18,0)	101 (46)	53.1 (1 349)	53.0 (1 345)	25.4 (645)	0.8 (20)	3.94 (100)	5.91 (150)	4.72 (120)	0.73 (18,5)	⅝ (M16)	3.90 (99)
HI 100 x 500	19.7 (500)	831,900 (94 000)	52,800 (235)	370 (1,65)	4,050 (18,0)	115 (52)	– –	63.6 (1 616)	35.0 (890)	0.8 (20)	3.94 (100)	5.91 (150)	4.72 (120)	0.73 (18,5)	⅝ (M16)	3.90 (99)
HI 100 x 600	23.6 (600)	991,200 (112 000)	50,000 (220)	370 (1,65)	4,050 (18,0)	128 (58)	– –	74.3 (1 888)	40.9 (1 040)	0.8 (20)	3.94 (100)	5.91 (150)	4.72 (120)	0.73 (18,5)	⅝ (M16)	3.90 (99)
HI 100 x 800	31.5 (800)	1,200,000 (136 000)	45,000 (200)	370 (1,65)	4,050 (18,0)	152 (69)	– –	95.5 (2 426)	53.0 (1 345)	0.8 (20)	3.94 (100)	5.91 (150)	4.72 (120)	0.73 (18,5)	⅝ (M16)	3.90 (99)
HI 120 x 100	3.9 (100)	283,200 (32 000)	84,300 (375)	630 (2,8)	11,250 (50,0)	75 (34)	18.5 (471)	18.4 (467)	10.6 (270)	0.8 (20)	4.72 (120)	8.66 (220)	6.69 (170)	1.03 (26,5)	1 (M24)	5.0 (127)
HI 120 x 150	5.9 (150)	424,800 (48 000)	84,300 (375)	630 (2,8)	11,250 (50,0)	86 (39)	23.5 (597)	23.3 (593)	13.0 (330)	0.8 (20)	4.72 (120)	8.66 (220)	6.69 (170)	1.03 (26,5)	1 (M24)	5.0 (127)
HI 120 x 200	7.9 (200)	566,400 (64 000)	84,300 (375)	630 (2,8)	11,250 (50,0)	95 (43)	28.5 (724)	28.3 (720)	15.4 (390)	0.8 (20)	4.72 (120)	8.66 (220)	6.69 (170)	1.03 (26,5)	1 (M24)	5.0 (127)
HI 120 x 300	11.8 (300)	831,900 (94 000)	84,300 (375)	630 (2,8)	11,250 (50,0)	117 (53)	38.3 (973)	38.1 (969)	20.5 (520)	0.8 (20)	4.72 (120)	8.66 (220)	6.69) (170	1.03 (26,5)	1 (M24)	5.0 (127)
HI 120 x 400	15.7 (400)	1,106,300 (125 000)	84,300 (375)	630 (2,8)	11,250 (50,0)	155 (70)	48.2 (1 225)	48.1 (1 221)	26.8 (680)	1.0 (25)	4.72 (120)	8.66 (220)	6.69 (170)	1.03 (26,5)	1 (M24)	5.0 (127)
HI 120 x 600	23.6 (600)	1,663,900 (188 000)	84,300 (375)	630 (2,8)	11,250 (50,0)	232 (105)	– –	67.9 (1 725)	36.0 (915)	1.0 (25)	4.72 (120)	8.66 (220)	6.69 (170)	1.03 (26,5)	1 (M24)	5.0 (127)
HI 120 x 800	31.5 (800)	1,991,250 (225 000)	74,200 (330)	630 (2,8)	11,250 (50,0)	243 (110)	– –	91.8 (2 332)	50.8 (1 290)	1.0 (25)	4.72 (120)	8.66 (220)	6.69 (170)	1.03 (26,5)	1 (M24)	5.0 (127)
HI 120 x 1000	39.4 (1000)	2,301,000 (260 000)	67,400 (300)	630 (2,8)	11,250 (50,0)	256 (116)	– –	111.7 (2 836)	53.5 (1 360)	1.0 (25)	4.72 (120)	8.66 (220)	6.69 (170)	1.03 (26,5)	1 (M24)	5.0 (127)

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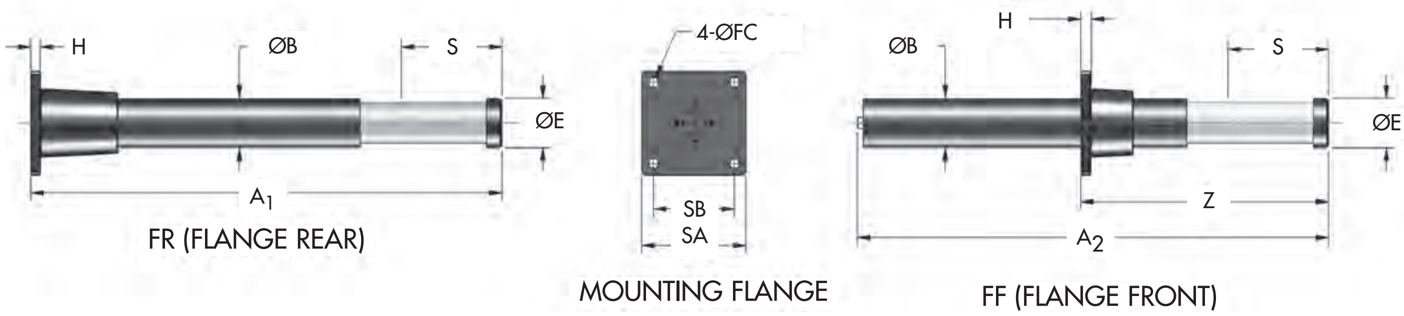
Heavy Industry Shock Absorbers
HI Series

HI 130 x 250 ➞ HI 150 x 1000 Series

Technical Data



Catalog No./ Model	S Stroke in. (mm)	Max. Energy/cycle in.-lbs. (Nm)	Max. Shock Force lbs. (kN)	Return Force Extension lbs. (kN)	Return Force Compression lbs. (kN)	Weight lbs. (Kg)	A_1 in. (mm)	A_2 in. (mm)	Z in. (mm)	H in. (mm)	ØB in. (mm)	SA in. (mm)	SB in. (mm)	ØFC in. (mm)	BOLT SIZE in. (mm)	ØE in. (mm)
HI 130 x 250	9.8 (250)	885,000 (100 000)	106,800 (475)	725 (3,2)	1,300 (50,0)	159 (72)	35.3 (897)	35.2 (894)	21.5 (545)	1.0 (25)	5.12 (130)	10.63 (270)	8.27 (210)	1.03 (26,5)	1 (M24)	5.08 (129)
HI 130 x 300	11.8 (300)	1,062,000 (120 000)	106,800 (475)	720 (3,2)	1,300 (50,0)	175 (79)	40.5 (1 029)	40.4 (1 025)	23.8 (605)	1.0 (25)	5.12 (130)	10.63 (270)	8.27 (210)	1.03 (26,5)	1 (M24)	5.08 (129)
HI 130 x 400	15.7 (400)	1,416,100 (160 000)	106,800 (475)	720 (3,2)	1,300 (50,0)	199 (90)	50.9 (1 293)	50.8 (1 289)	28.9 (735)	1.0 (25)	5.12 (130)	10.63 (270)	8.27 (210)	1.03 (26,5)	1 (M24)	5.08 (129)
HI 130 x 600	23.6 (600)	1,858,500 (210 000)	89,900 (400)	720 (3,2)	10,000 (45,0)	263 (119)	– –	75.5 (1 917)	41.5 (1 055)	1.0 (25)	5.12 (130)	10.63 (270)	8.27 (210)	1.03 (26,5)	1 (M24)	5.08 (129)
HI 130 x 800	31.5 (800)	2,388,500 (270 000)	89,900 (400)	720 (3,2)	10,000 (45,0)	309 (140)	– –	96.3 (2 445)	53.0 (1 345)	1.0 (25)	5.12 (130)	10.63 (270)	8.27 (210)	1.03 (26,5)	1 (M24)	5.08 (129)
HI 150 x 115	4.5 (115)	548,700 (62 000)	145,000 (645)	1,125 (5,0)	14,750 (65,7)	124 (56)	20.3 (516)	20.2 (513)	12.6 (320)	1.0 (25)	5.91 (150)	10.63 (270)	8.27 (210)	1.03 (26,5)	1 (M24)	5.87 (149)
HI 150 x 150	5.9 (150)	725,700 (82 000)	145,000 (645)	1,125 (5,0)	14,750 (65,7)	130 (59)	23.9 (606)	23.7 (602)	14.0 (355)	1.0 (25)	5.91 (150)	10.63 (270)	8.27 (210)	1.03 (26,5)	1 (M24)	5.87 (149)
HI 150 x 400	15.7 (400)	1,947,000 (220 000)	145,000 (645)	1,125 (5,0)	14,000 (62,4)	216 (98)	49.5 (1 257)	49.0 (1 245)	28.0 (710)	1.0 (25)	5.91 (150)	10.63 (270)	8.27 (210)	1.03 (26,5)	1 (M24)	5.87 (149)
HI 150 x 500	19.7 (500)	2,433,900 (275 000)	145,000 (645)	1,125 (5,0)	17,000 (75,5)	243 (110)	– –	59.0 (1 498)	30.3 (770)	1.0 (25)	5.91 (150)	10.63 (270)	8.27 (210)	1.03 (26,5)	1 (M24)	5.87 (149)
HI 150 x 600	23.6 (600)	2,920,500 (330 000)	145,000 (645)	1,125 (5,0)	17,000 (75,5)	265 (120)	– –	69.0 (1 752)	34.4 (875)	1.0 (25)	5.91 (150)	10.63 (270)	8.27 (210)	1.03 (26,5)	1 (M24)	5.87 (149)
HI 150 x 800	31.5 (800)	3,965,100 (448 000)	144,000 (640)	1,125 (5,0)	15,250 (68,0)	364 (165)	– –	93.0 (2 363)	48.8 (1 240)	1.0 (25)	5.91 (150)	10.63 (270)	8.27 (210)	1.03 (26,5)	1 (M24)	5.87 (149)
HI 150 x 1000	39.4 (1000)	4,513,500 (510 000)	134,900 (600)	1,125 (5,0)	13,750 (61,0)	397 (180)	– –	113.4 (2 880)	62.8 (1 595)	1.0 (25)	5.91 (150)	10.63 (270)	8.27 (210)	1.03 (26,5)	1 (M24)	5.87 (149)

Application Worksheet

FAX NO.: ____________________

DATE: ____________________

ATTN: ____________________

COMPANY: ____________________

The ITT Enidine Application Worksheet makes shock absorber sizing and selection easier.

Fax, phone, or mail worksheet data to Enidine headquarters or your nearest ITT Enidine subsidiary/affiliate or distributor. (See catalog back cover for ITT Enidine locations, or visit www.enidine.com for a list of ITT Enidine distributors.)

Upon ITT Enidine's receipt of this worksheet, you will receive a detailed analysis of your application and product recommendations. (For custom design projects, Enidine representatives will consult with you for specification requirements.)

GENERAL INFORMATION

CONTACT: ____________________

DEPT/TITLE: ____________________

COMPANY: ____________________

ADDRESS: ____________________

TEL: __________ FAX: __________

EMAIL: ____________________

PRODUCTS MANUFACTURED: ____________________

APPLICATION DESCRIPTION

Motion Direction (Check One):

☐ Horizontal ☐ Vertical ☐ Up ☐ Down ☐ Incline Angle ______ Height ______

☐ Rotary Horizontal ☐ Rotary Vertical ☐ Up ☐ Down

Weight (Min./Max.): ____________________ (lbs.)(Kg)

Cycle Rate ____________________ (cycles/hour)

Additional Propelling Force (If Known) ____________ (lbs.)(N)

☐ Air Cyl: Bore ____ (in.)(mm) Max. Pressure ____ (psi)(bar) Rod Dia. ____ (in.)(mm)

☐ Hydraulic Cyl: Bore ____ (in.)(mm) Max. Pressure ____ (psi)(bar) Rod Dia. ____ (in.)(mm)

☐ Motor ________ (hp)(kW) Torque ________ (in-lbs.)(Nm)

Ambient Temp. ____________________ °F (°C)

Environmental Considerations: ____________________

SHOCK ABSORBER APPLICATION

(All Data Taken at Shock Absorbe

Number of Shock Absorbers to Stop Load

Impact Velocity (min./max.) ____________ (in./sec.)(m/sec.)

Shock Absorber Stroke Requirements: ____________ (in.)(mm)

G Load Requirements __________ (G)(m/sec^2)

APPLICATION SKETCHES / NOTES

Enidine is a diversified leading manufacturer of highly engineered critical components and customized technology solutions for growing industrial end-markets in energy infrastructure, electronics, aerospace and transportation.

As part of our strategy to make the customer central to everything we do, our core technologies, engineering strength and global scale offers greater value for customers in terms of quality, cost and delivery.

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Common Applications:

- Automotive
- Auto, Storage and Retrieval
- Bridges and Structures
- Conveyor Systems
- Steel Mills
- Plastic Bottle Manufacturing
- Packaging Machinery
- Overhead Cranes
- Robotics
- Electronics Cabinets
- Sub-Sea Equipment
- Medical Equipment

Enidine provides energy absorption and vibration isolation solutions to meet the challenging demands of global industrial markets.

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