Shock Absorbers

Shock Absorbers

Shock Absorbers can be used to decelerate loads or to absorb excess Kinetic Energy.

Calculating Kinetic Energy

When a load is being moved by the High Load Ultran, kinetic energy is generated. This energy must be absorbed either by the High Load Ultran or by some external device. If the energy is to be absorbed by the High Load Ultran, then the energy must not exceed 3.5 foot-pounds (42 inch-pounds).

Kinetic energy is defined by the formula $1/2mV^2$, where m is the mass of the load being moved and V is the speed at which the load is moving upon impact.

m is defined as W/g, where W is the known weight of the load including the weight of the carriage, and g is acceleration due to gravity. V is defined in feet per second.

Considering Total Energy

In addition to the energy generated by the moving load, other external (propelling) forces must be considered to ensure the proper use of the shock absorber. See page 577 for maximum force information. Propelling forces are those forces generated by cylinder air pressure, springs, gravity, etc. Once the energy generated by these forces is determined, it must be added to the kinetic energy generated by the moving load to determine total energy (ET) to be absorbed by the shock (see example below).

Selecting Shock Absorber Setting

The shock absorber offered for the High Load Ultran Slide is adjustable. This means that the shock absorber is capable of decelerating loads over a range of velocities. Use Graph 5 to determine the appropriate setting for your application. Some adjustment to this setting may be required to achieve the desired deceleration rate. Page 577 shows the shock absorber ratings.

Example (Total Energy):

Operating a UHL-17 at 60 psi in a horizontal application, carrying a 100-pound load at 10 inches per second end-of-stroke velocity, the total energy, ET, is determined as follows.

1. Determine kinetic energy generated by the moving load using the formula, KE = 1/2 mV2.
   m = (W + weight of carriage)/g = (7.5 + 100)/32.179 = 3.34 lbm
   V = 10 in/sec = 0.833 feet per second
   KE = 1/2 * 3.34 * 0.8332 = 1.16 foot-pounds or 13.92 inch-pounds (1.16 x 12 inches)
2. Determine the propelling forces and their respective energy.
   Force (F) = piston area * air pressure = 1.76 * 60 = 106 pounds
   Energy (E) = F * stroke of shock = 106 * 0.5 = 53 inch-pounds
3. Total Energy (ET) = 53 + 13.92 = 66.92 inch-pounds

NOTE: If the total energy (ET) of your application exceeds the allowable maximum of 100 inch-pounds for the adjustable shock absorber, the standard HS-17 shock absorber may be used. Refer to page 578 for specifications.

Bore	Carriage Weight
1-1/4" (12)	3.9 lbs.
1-1/2" (17)	7.5 lbs.

Table 2

Shock Absorber (Ultran Slide and Ultran Rodless Cylinders)

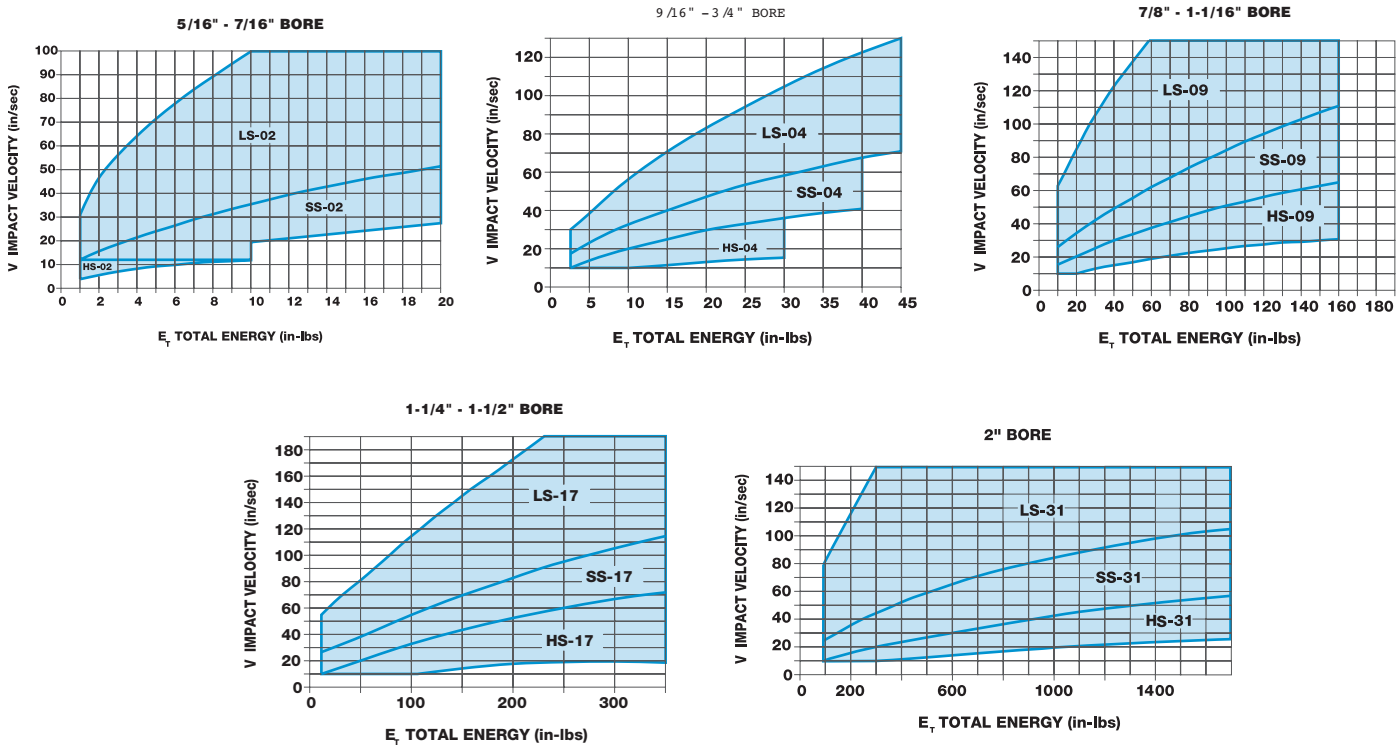
Ultran Slide

Bore	007	01	02	04	06	09	12	17	31
SF	0.250	0.250	0.410	0.410	0.630	0.630	0.880	0.880	1.560
UF1	0.077	0.150	0.249	0.442	0.601	0.887	1.227	1.767	3.142
UF2	0.285	0.385	0.805	1.565	2.195	3.140	4.750	7.530	24.380
ET	20	20	45	45	190	190	400	400	1,700
ET-C	36,000	36,000	125,000	125,000	300,000	300,000	475,000	475,000	670,000

Ultran Standard

Bore	007	01	02	04	06	09	12	17	31
SF	N/A	N/A	0.250	0.410	0.630	0.630	0.880	0.880	1.560
UF1	N/A	N/A	0.249	0.442	0.601	0.887	1.227	1.767	3.142
UF2	N/A	N/A	0.485	1.060	1.585	2.285	3.500	5.845	16.965
E_T	N/A	N/A	20	45	190	190	400	400	1,700
E_T-C	N/A	N/A	36,000	125,000	300,000	300,000	475,000	475,000	670,000

Velocity vs. Load for Shock Absorbers



*Ultran Maximum Velocity: 20 inches per second or cycle rate not to exceed 15 per minute

Shock Absorber (Ultran Slide and Ultran Rodless Cylinders)

For each model, dimensions and engineering specifications are the same for Light, Standard, and Heavy Duty Shock Absorbers. (LS, SS and HS model numbers).

Shock Absorber Selection Guide

Bore	Ultran	Ultran Slide
5/16" (007)	N/A	☐ S-02
7/16" (01)		
9/16" (02)	☐ S-02	☐ S-04
3/4" (04)	☐ S-04	
7/8" (06)	☐ S-09	☐ S-09
1-1/16" (09)		
1-1/4" (12)	☐ S-17	☐ S-17
1-1/2" (17)		
2" (31)	☐ S-31	☐ S-31

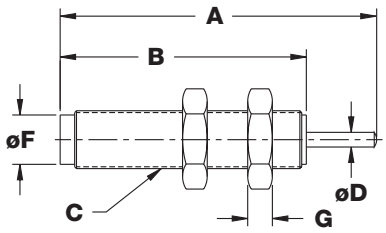
NOTE: Do not let shock absorbers bottom out. The shock should not be used as a stroke adjuster. A stop collar is needed for the shock if stroke adjustment is required.

Dimensions (in)

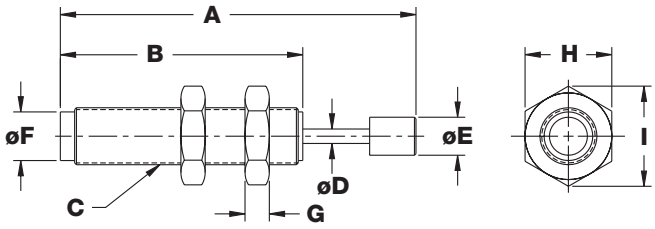
Model	A	B	C	D	E	F	G	H	I
☐ S-02	1.39	1.13	3/8-32 UNEF	0.12	N/A	0.32	0.09	0.50	0.58
☐ S-04	2.74	1.96	7/16-28 UNEF	0.12	0.40	0.39	0.16	0.56	0.65
☐ S-09	4.25	3.20	1/2-20 UNF	0.16	0.44	0.43	0.12	0.63	0.72
☐ S-17	5.13	3.76	3/4-16 UNF	0.19	0.50	0.64	0.18	0.94	1.08
☐ S-31	7.93	5.21	1-12 UNF	0.31	0.88	N/A	0.18	1.13	1.30

Model (LS, SS, HS)

☐ S-02



☐ S-04, ☐ S-09, ☐ S-17, ☐ S-31



Engineering Specifications

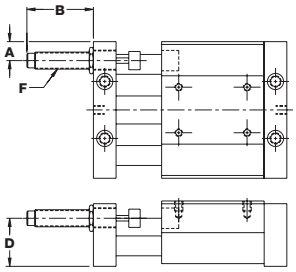
Model	Shock Absorber Bore	(S) Stroke (in)	Thread Type	(E_T) Max. in-lbs Per Cycle	(E_T-C) Max. in-lbs Per Hour	(F_P) Max. Shock Force (lbs)	Nominal Coil Spring Force		(F_D) Max. Propelling Force (lbs)	Model Weight (oz)
							Extension (lbs)	Compression (lbs)		
☐ S-02	0.28	0.25	3/8-32 UNEF	20	36,000	160	0.65	1.13	20	0.4
☐ S-04	0.25	0.41	7/16-28 UNEF	45	125,000	225	0.7	1.6	50	2
☐ S-09	0.28	0.63	1/2-20 UNF	190	300,000	500	1	3.6	120	3
☐ S-17	0.44	0.88	3/4-16 UNF	400	475,000	700	2	6.8	200	7
☐ S-31	0.56	1.56	1-12 UNF	1,700	670,000	1,700	4	11	500	16

Shock Absorber (Ultran Slide and Ultran Rodless Cylinders)

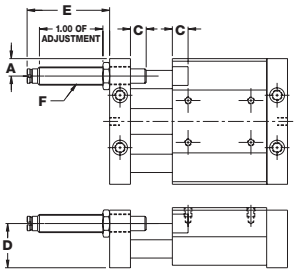
Shock Absorber/Stroke Adjustment (in)

Bore	A	B	C	D	E	F
5/16" (007)	0.215	0.750	0.000	0.785	1.093	3/8-32 UNEF
7/16" (01)	0.218	0.750	0.000	0.780	1.093	3/8-32 UNEF
9/16" (02)	0.406	1.460	0.375	1.094	1.594	7/16-28 UNEF
3/4" (04)	0.406	1.335	0.375	1.438	1.469	7/16-28 UNEF
7/8" (06)	0.500	2.490	0.375	1.562	1.438	1/2-20 UNF
1-1/16" (09)	0.594	2.490	0.375	1.875	1.438	1/2-20 UNF
1-1/4" (12)	0.656	2.890	0.500	2.062	1.500	3/4-16 UNF
1-1/2" (17)	1.000	2.890	0.562	2.219	1.438	3/4-16 UNF
2" (31)	1.125	3.500	0.562	3.312	1.563	1-12 UNF

Shock Absorber



Stroke Adjustment



NOTE: Do not let the shock absorbers bottom out. The shock should not be used as a stroke adjuster. A stop collar is needed for the shock if stroke adjustment is required.

How to Size a Shock Absorber

Selecting the proper shock absorber model is accomplished using the shock absorber graph given for each Ultran bore.

The intersection of the total energy per stroke "E_T", and velocity at shock absorber contact "V", indicates the proper shock absorber model. E_T is calculated by the equation given below using values determined for:

P	=	Air pressure (PSI)
V	=	Velocity at impact (in/sec)
W_U	=	Load attached to the Ultran mounting plate (lbs.)
C	=	Cycles per hour
SF	=	Shock factor
UF1	=	Ultran factor #1
UF2	=	Ultran factor #2

E_T (Total energy) equals the sum of E_K (Kinetic energy) and E_W (Work energy)

NOTE: the Work energy calculation varies with mounting position, E_{WH} Horizontal, or E_{WV} Vertical.

$E_K = ((W_U + UF2) / 772) \times V^2$ (Kinetic energy, in-lbs)

$E_{WH} = UF1 \times SF \times P$ (Work energy, in-lbs) **HORIZONTAL**

$E_{WV} = ((UF1 \times P) + W_U + UF2) \times SF$ (Work energy, in-lbs) **VERTICAL**

Example: determine the proper shock absorber for a model Ultran Slide mounted vertically with an attached load of 15 lbs, operating air pressure of 80 PSI, and a velocity of 20 in/sec, at a cycle rate of 3,600 per hour.

P	=	80 PSI
V	=	20 in/sec
S	=	6 in
W_U	=	15 lbs
C	=	3,600 cycles/hr

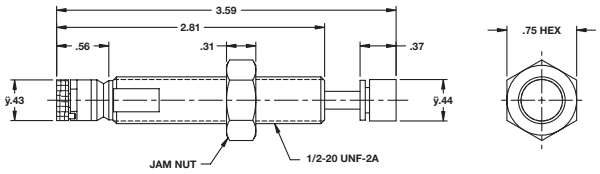
From the charts for a 3/4" bore Ultran Slide

SF	=	0.410	
UF1	=	0.442	
UF2	=	1.565	
E_K	=	(15 lbs + 1.565) / 772) x $(20 \text{ in/sec})^2$	E_K = 8.56 in-lbs
E_{WV}	=	((0.442 x 80 PSI) + 15 lbs + 1.565 x 0.410	E_{WV} = 21.29 in-lbs
E_T	=	$E_K + E_{WV}$ = 29.85 in-lbs	$E_TC = E_T \times C$ = 107,457 in-lbs/hr

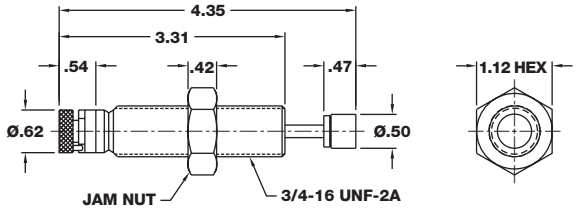
Checking specifications chart, both E_T and E_TC are less than maximum. Per the sizing graph for a model UGS-04 with 21.29 in-lbs total energy at 20 in/sec velocity, use a heavy duty model HS-04 shock absorbers.

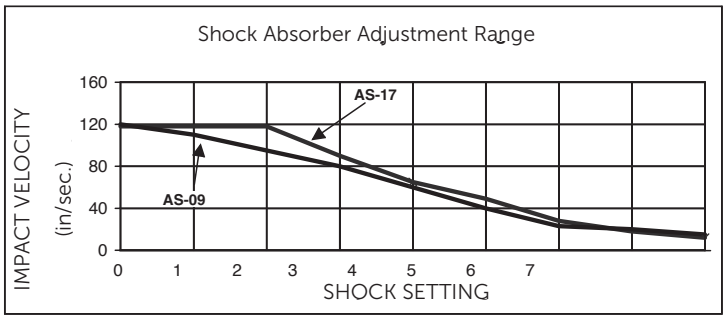
Shock Absorber (High Load Ultran)

Dimensions (in)
1-1/16" bore



Dimensions (in)
1-1/2" bore





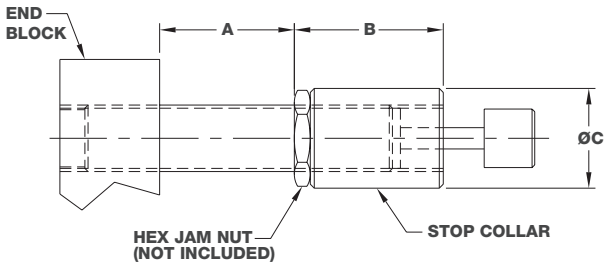
GRAPH 5

Table 3. Shock Absorber Ratings

Model	Shock Absorber Bore	(S) Stroke	Thread Type	(E_T) Max. In-Lb Per Cycle	(E_T-C) Max. In-Lb Per Cycle	(F_P) Max. Shock Force	Normal Coil Spring Force		(F_D) Max. Propelling Force	Weight
							Extension	Compression		
AS-09	.25	.38	1/2"-20 UNF	50	178,000	200	.8	1.7	8	2
AS-17	.28	.5	3/4"-16 UNF	100	284,000	300	1.5	2.0	150	5

Stop Collar (Ultran Models)

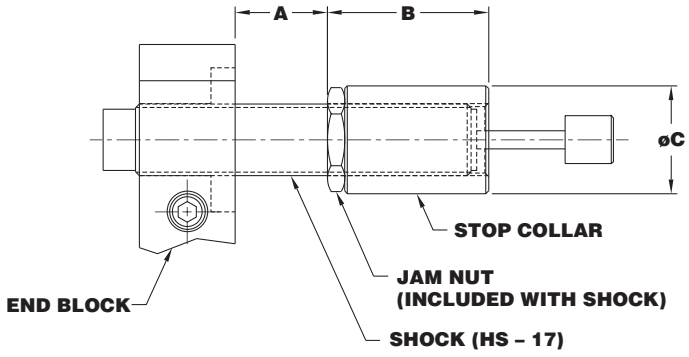
Ultran Slide & Ultran Rodless Cylinders



Model	A	B	øC
USC-04	1.0	.91	.63
USC-09	1.5	1.12	.69
USC-17	2.0	1.68	1.12
USC-31	3.0	1.93	1.50

NOTE: The Ultran Stroke Length needs increased by the B dimension in order to maintain intended stroke length. The overall length increases by the same amount. The A dimension indicates maximum amount of stroke adjustment attainable. The Hex Jam Nut is included with the shock absorber.

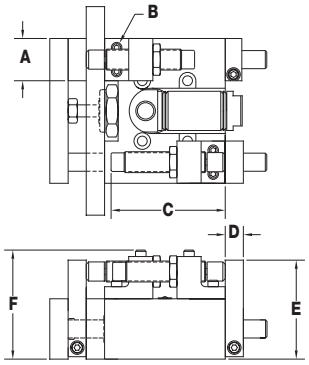
High Load Ultran



Model	A	B	øC
USC-09	.96	1.12	ø1.69
USC-17	.96	1.68	ø1.12

NOTE: The High Load Ultran Slide needs increased by the B dimension in order to maintain intended stroke length. The overall length increases by the same amount. The A dimension indicates maximum amount of stroke adjustment attainable.

Shock Absorber (Linear Thruster Cylinders)



Dimensions

Bore	A	B	C	D	E	F
9/16" (02)	0.75	#6-32	1.14	0.25	1.65	1.88
3/4" (04)	0.88	#6-32	2.37	0.38	2.05	2.13
1-1/16" (09)	1	#8-32	3.68	0.38	2.87	3
1-1/2" (17)	1.25	#10-32	4.47	0.5	3.75	4
2" (31)	1.5	1/4-20	4.75	0.75	4.50 (TE) 5.50 (T)	4.75 (TE) 5.75 (T)

How to Size a Shock Absorber

Selecting the proper shock absorber model is accomplished using the shock absorber graph given for each Thruster bore.

The intersection of the total energy per stroke "E_T", and velocity at shock absorber contact "V", indicates the proper shock absorber model. E_T is calculated by the equation given below using values determined for:

E_T (Total energy) equals the sum of E_K (Kinetic energy) and E_W (Work energy).

NOTE: the Work energy calculation varies with mounting position, E_{WH} Horizontal, or E_{WV} Vertical.

$E_K = ((W_U + (TF2 + (TF3 \times S))) / 772) \times V^2$ (Kinetic energy, in-lbs)

$E_{WH} = TF1 \times SF \times P$ (Work energy, in-lbs)

HORIZONTAL

$E_{WV} = ((TF1 \times P) + W_U + (TF2 + (TF3 \times S))) \times SF$ (Work energy, in-lbs)

VERTICAL

$E_T = E_K + E_W$ (Total energy per stroke, in-lbs)

$E_TC = E_T \times C$ (Total energy per hour, in-lbs/hr)

P	=	Air pressure (PSI)
V	=	Velocity at impact (in/sec)
S	=	Stroke of the Thruster (in)
W_U	=	Load attached to the Thruster mounting plate (lbs)
C	=	Cycles per hour
SF	=	Shock factor
TF1	=	Thruster factor #1
TF2	=	Thruster factor #2
TF3	=	Thruster factor #3

E_T and E_TC must not exceed maximum listed in specifications.

Example: determine the proper shock absorber for a model T-046 Thruster mounted vertically with an attached load of 15 lbs, operating air pressure of 80 PSI, and a velocity of 20 in/sec, at a cycle rate of 3,600 per hour.

P	=	80 PSI
V	=	20 in/sec
S	=	6 in
W_U	=	15 lbs
C	=	3,600 cycles/hr

From the charts for a 3/4" bore "T" series Thruster:

SF	=	0.410
TF1	=	0.442
TF2	=	0.632
TF3	=	0.063
E_K	=	$((15 \text{ lbs} + (0.632 + (0.063 \times 6 \text{ in}))) / 772) \times (20 \text{ in/sec})^2$ $\quad E_K = 8.30$ in-lbs
E_{WV}	=	$((0.442 \times 80 \text{ PSI}) + 15 \text{ lbs} + (0.632 + (0.063 \times 6 \text{ in}))) \times 0.410 \quad E_{WV} = 21.06$ in-lbs
E_T	=	$E_K + E_{WV} = 29.36$ in-lbs $\quad E_TC = E_T \times C = 105{,}685$ in-lbs/hr

Checking specifications chart, both E_T and E_TC are less than maximum. Per sizing graph for a model T-04 with 29.36 in-lbs total energy at 20 in/sec velocity, use a heavy duty model HS-04 shock absorbers.

Shock Absorber (Linear Thruster Cylinders)

T Series Thruster Calculation

Model T					
Factor	**9/16"**	**3/4"**	**1-1/16"**	**1-1/2"**	**2"**
SF	0.250	0.410	0.630	0.880	1.000
TF1	0.249	0.442	0.887	1.767	3.142
TF2	0.310	0.632	1.675	3.874	7.444
TF3	0.028	0.063	0.111	0.174	0.250
(ET) max. in-lbs per cycle	20	45	190	400	650
(ET-C) max. in-lbs per hour	36,000	125,000	300,000	475,000	622,000

TE Series Thruster Calculation

Model TE					
Factor	**9/16"**	**3/4"**	**1-1/16"**	**1-1/2"**	**2"**
SF	0.250	0.410	0.630	0.880	1.000
TF1	0.249	0.442	0.887	1.767	3.142
TF2	0.434	0.905	2.075	4.033	6.754
TF3	0.063	0.111	0.174	0.250	0.340
(ET) max. in-lbs per cycle	20	45	190	400	650
(ET-C) max. in-lbs per hour	36,000	125,000	300,000	475,000	622,000

Velocity vs. Load for Shock Absorbers