NCK/SCK/FCK

Shock absorber

Related products

CONTENTS

●: Standard, ◎: Option, ○: Custom order, ▨: Not available

Method	Model no.		Max. colliding speed working range m/s	Max. energy absorption (J) 5 10 50 100 500 1000	Mounting style		Option			Page
					Basic type 00	Flange FA	With stop nut N1	Capped C	Deflection angle adaptor	
Fixed type	NCK		to 3.0	1 ├──┤ 200	●	◎	◎	◎	▨	507
Adjustable type	SCK		to 4.0	0.049 ├──┤ 588	●	◎	◎	▨	▨	519
	FCK	Low speed type	to 1	1.5 ├──┤ 720	●	▨	◎	◎	◎	527
		Medium speed type	to 2		●	▨	◎	◎	◎	
		High speed type	to 3		●	▨	◎	◎	◎	

Pneumatic components

Safety precautions

Always read this section before starting use.
Refer to Intro 69 for general details on the cylinders, and to Ending 78 for cylinder switches.

Shock absorber NCK/SCK/FCK series

Design & Selection

1. COMMON

⚠ WARNING

■ Use within the product specification range.

If maximum energy absorption in specifications is exceeded, damage or operation faults may occur. Performance in specifications may not be attained if not used at the full stroke length.

⚠ CAUTION

■ Check that the product withstands the working environment before use.

- ● Use in conditions exceeding the ambient temperature range will cause durability to drop.
- ● Do not use in an environment (vacuum, high pressure) other than atmospheric pressure.

■ Check for scatter caused by cap damage.

- ● If used with exceeding specifications, the cap may be damaged and cause injuries by scatter.
- ● Provide a scatter-prevention cover, or move to a safe position while the main machine is operating.
- ● Do not use this product in cleanrooms.
  Otherwise, cleanrooms may be contaminated.

■ Check collision conditions.

- ● Before starting use, obtain collision speed, collision object weight, thrust applied to the shock absorber and the number of collisions per minute.

(1) This is also necessary for calculating selection. If collision speed is less than the specification range, resistance is not generated and only a small amount of energy is absorbed, preventing the shock absorber from having any effect.

(2) This product may not be used if the number of collisions per minute exceeds the maximum repetition cycle.

■ Check that the surface of the collision object contacted by the piston rod is hard enough.

- ● When the cap is not used, a high surface compression load is applied to the surface of the collision object contacted by the piston rod. The contact surface must be HRC35 and over.

■ Check for the collision object's return force.

- ● When using this product for conveyor drives, etc., it may be pressed back by internal spring force after energy is absorbed.
  Refer to the return spring force section in specifications for details.

■ Do not use more than one shock absorber in parallel due to difficulty in balancing them. Use one shock absorber having a large absorption energy.

■ Use an external stopper or the optional stopper nut at the final stop position of the collision object so impact is not applied to the main device. If impact is applied to the main device, durability may drop and return failures occur. Check that the product withstands the working environment before use.

■ The maximum repetition cycle differs with ambient temperature.

■ Values given in specification descriptions are for room temperature (20℃). Note that these values may change with the working temperature.

Installation & Adjustment

1. Common

DANGER

■ Do not use this product near fire or in devices or machines having an ambient temperature exceeding specifications.

Flammable oil in the product poses the risk of fire.

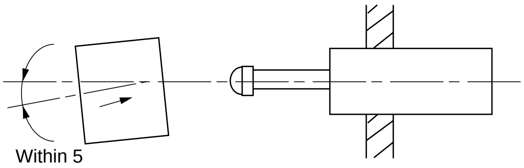
■ Do not place in fire.

Since oil is sealed, this product may explode or ignite if placed in fire.

WARNING

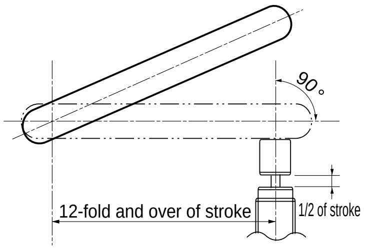
■ Do not apply an eccentric load exceeding ± A° from the piston rod centerline.

- If load collides at a deflection angle exceeding ± A°, the piston rod may bend and cause a return failure or a drop in performance caused by offset wear of the sliding section. When using at a deflection angle exceeding ± A°, use the optional deflection angle adapter. This may be used up to ± 10°. (FCK Series)



	FCK	NCK/SCK
A	2.5°	5°

- When using rotary motion collision, set the distance from the center of the collision object's rotation to the shock absorber installation position at 12-fold and over of the shock absorber stroke (3-fold and over when using a deflection angle adapter). Install so contact is at a right angle at a position half of the stroke.

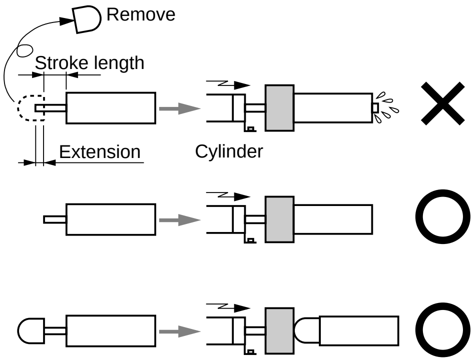


■ Do not use with insufficient installation section strength.

- The main machine may be damaged and injuries result if installation section strength is insufficient.
- Secure the maximum load × safety factor for installation section strength. (Refer to the max. load, or consult with CKD.)

■ Do not remove the cap from the shock absorber.

- The piston rod is extended so the cap may be installed. Use without the cap may damage the base.



■ A guide is required if the collision object vibrates.

Install a secure guide on the collision object if the collision object vibrates or if force is applied to the piston rod at an axial right angle direction.

■ Risk of static electricity buildup in explosion-proof environment.

Use a grounding device for discharge, and do not use cushioning materials that generate sparks.

■ Do not place in fire.

- Oil is sealed, so the product may explode or ignite if placed in fire.
- Follow specified waste oil treatment to dispose of this product.

■ Do not apply another external load by stroke end colliding object stops. Applying a separate external load to a collision object stopped at the stroke end may result in damage.

■ Turn device power off and confirm the machine is stopped before installing, removing, or adjusting the stroke.

⚠ CAUTION

■ Observe the following table for mounting nut tightening torque.

● The shock absorber may be damaged if nut tightening torque exceeds the upper limit below.
If the nut is to be securely tightened, use adhesives, etc., to ensure nut tightness.

(NCK Series)

Thread (mm)	M8×0.75	M10×1	M12×1	M14×1.5	M20×1.5
Nut tightening torque (N·m)	1.2 to 2.0	3 to 4	5 to 6	7.5 to 10	22 to 30

Thread (mm)	M25×1.5	M27×1.5
Nut tightening torque (N·m)	55 to 70	100 to 130

(SCK Series)

Thread (mm)	M10×1	M12×1	M16×1	M20×1	M25×1.5
Nut tightening torque (N·m)	3.4	5.4	14.2	70.8	421.7 to 588.4

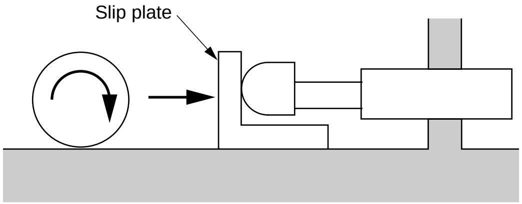
Thread (mm)	M30×1.5	M40×1.5	M45×1.5
Nut tightening torque (N·m)	149.1 to 196.1	274.6 to 353.0	421.7 to 588.4

(FCK Series)

Thread (mm)	M10×1	M12×1	M14×1.5	M16×1.5	M20×1.5
Nut tightening torque (N·m)	5.9 to 7.8	5.9 to 7.8	8.3 to 9.8	11.8 to 14.7	29.4 to 35.3

Thread (mm)	M25×1.5 M25×2	M27×1.5 M27×3	M30×1.5	M36×1.5	M42×1.5
Nut tightening torque (N·m)	49.0 to 61.0	58.9 to 73.5	78.4 to 98.0	98.0 to 122.5	392.0 to 490.0

■ If the rotating objects or if deformation or wear is generated between the shock absorber and the collision object, place protective material before the collision surface to prevent deformation and wear.



■ Do not damage the piston rod sliding section or the damper case thread O.D. section.
Do not contact or sandwich objects between the piston rod sliding section or outer tube thread O. D. section, or fit setscrews, etc., into these causing damage or dents. Damage or dents on the position rod's sliding section may damage packing or cause oil leakage or operation faults. Damage or dents on the outer tube thread O. D. section may prevent proper installation on the platform, causing operation faults due to deformation of internal components.

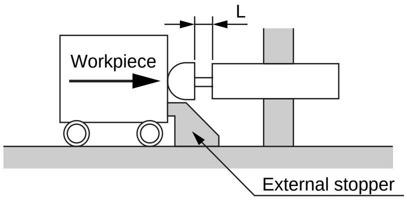
■ Do not use in conditions where oil mist or water drops may contact the rod surface, or in areas with high levels of wear powder. Energy is not absorbed properly and faults may occur.

■ Do not use without the external stopper.

● Operation without the external stopper may damage the main body from bottom end.

● Install the external stopper at the specified position.

	L
NCK	0.5mm
SCK	2 to 3mm
FCK	1mm



■ Do not use with outside specified tightening torque range.

● Installation with outside specified tightening torque range may damage the main body.

● Do not fix with screws that do not fit mounting holes. The product may drop off or be damaged.

■ Check for snap ring looseness or loss.

● If using outside specifications, the internal pressure of the inner tube in the shock absorber may rise abnormally causing the snap ring to come off. This may cause inner parts to pop out and cause injury.

● Do not approach the shock absorber during operation.

■ If the device is stored with the rod pressed in, the performance of the air chamber may drop. Do not store pressed in.

■ Adjust the adjustable type, and use at the optimum position.

■ Do not damage a piston or tube outer diameter thread.

● Damaged sealing section may cause durability drop and return failure.

2. Adjustment method of FCK series

⚠ CAUTION

■ To adjust the shock absorber, first set the adjusting dial to "2", collide, then while observing the state, rotate in the direction of "1" or "3" to the optimum position.

● After setting the scale to the optimum position, tighten the lock screw before starting use. If the lock screw is not tightened, the adjusted position may deviate and optimum absorption may not be attained.
Note that the FCK-L-0.15, FCK-$^{H}_{M}$-0.18, FCK-L-0.3 and FCK-$^{H}_{M}$-0.5 are without lock screws.

● Protect the shock absorber with an external stopper or stopper nut during adjustment.

*1 → 2 → 3 on the adjusting dial refers to the absorbed energy, weak → medium → strong.

● There may be a slight variation in products. Adjust individual products to the optimum position.

3. Adjustment method of SCK series

CAUTION

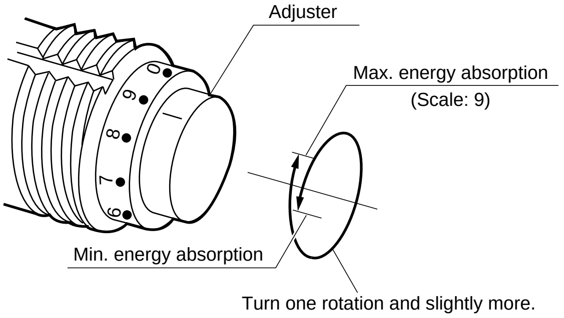
The SCK-**-0.3 and larger products are provided with an adjuster. Adjust as follows:

If collision force cannot be absorbed, turn the adjuster toward large values.

The adjuster is non-rotating and locks the position with a detent. Check that collision force is applied when the detent is activated.

Note 1: Maximum energy absorption is attained when the adjuster is turned clockwise to 9, and minimum energy absorption is attained when the adjuster is turned counterclockwise by one rotation and slightly more. Minimum energy may vary per product. Turning the adjuster forcibly may lock or damage it.

Note 2: Operation time may increase or operation may stop midway if the adjuster is not set appropriately.



During Use & Maintenance

1. Common

WARNING

■ Do not disassemble.

- Attempts to disassemble the product may pose the risk of danger.

CAUTION

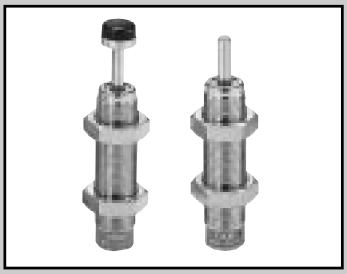
■ Improper disposal of oil is prohibited.

- Improper disposal of oil sealed in the shock absorber causes environmental contamination.
- Follow specified waste oil treatment to dispose of this product.

■ Check for to abnormal vibration sounds and vibration.

- If collision or vibration increases abnormally, product life may be expired. Replace the product. Continuing using is may damage equipment.

RRC
GRC
RV3*
NHS
HR
LN
FH100
HAP
BSA2
BHA/BHG
LHA
LHAG
HKP
HLA/HLB
HLAG/HLBG
HEP
HCP
HMF
HMFB
HFP
HLC
HGP
FH500
HBL
HDL
HMD
HJL
BHE
CKG
CK
CKA
CKS
CKF
CKJ
CKL2
CKL2-*-HC
CKH2
CKLB2
NCK/SCK/FCK
FJ
FK
Ending
Shock absorber
Related products



Shock absorber

NCK Series

- Maximum energy absorption: 1 to 200J

Specifications

Descriptions			NCK							
Series			0.1	0.3	0.7	1.2	2.6	7	12	20
Type/classification			Without adjuster Spring return type							
Max. energy absorption		J	1	3	7	12	26	70	120	200
Stroke length		mm	4.5	6	8	10	15	20	25	30
Max. energy absorption per hour		kJ/hour	4.8	6.3	12.6	21.6	39.0	84.0	86.4	108.0
Max. colliding speed		m/s	1.0	1.5		2.0		2.5	3.0	
Max. repeating cycle		Cycle/min.	80	35	30		25	20	12	9
Ambient temperature		℃	-10 to 80							
Max. load (resistance)		N	1450	3540	6150	8400	12100	24400	33500	47000
Return time		S	0.3 or less					0.4 or less		0.5 or less
Product weight		kg	0.009	0.012	0.02	0.04	0.07	0.2	0.3	0.45
Recoiling force	Extended	N	3.0		2.0	2.9	5.9	9.8	16.3	
	Compressed	N	4.6		4.3	5.9	11.8	21.6	33.3	33.9

How to order

NCK - **00** - **0.7** - **N1**

Ⓐ Mounting style

Ⓑ Series

Ⓒ Option
Note 1

Symbol	Descriptions
Ⓐ Mounting style	
00	Basic type
FA	Flange type
Ⓑ Series (MAX. energy value)	
0.1	1J
0.3	3J
0.7	7J
1.2	12J
2.6	26J
7	70J
12	120J
20	200J
Ⓒ Option	
Blank	Standard
N1	With stop nut
C	Capped

⚠ Note on model no. selection

Note 1: 3 hexagon nuts are provided for N1 specifications products.

<Example of model number>

NCK-00-0.7-N1

Model: Shock absorber
Ⓐ Mounting style: Basic type
Ⓑ Series: MAX energy-7J
Ⓒ Option: With stop nut

How to order accessories

- Flange bracket (1 pc.)

NCK - **0.7** - **FA**

- Stop nut + hexagon nut (each 1 pc.)

NCK - **0.7** - **N1**

- Hexagon nut (1 pc.)

NCK - **0.7** - **NT**

Symbol	Series (MAX energy value)
0.1	1J
0.3	3J
0.7	7J
1.2	12J
2.6	26J
7	70J
12	120J
20	200J

RRC
GRC
RV3*
NHS
HR
LN
FH100
HAP
BSA2
BHA/BHG
LHA
LHAG
HKP
HLA/HLB
HLAG/HLBG
HEP
HCP
HMF
HMFB
HFP
HLC
HGP
FH500
HBL
HDL
HMD
HJL
BHE
CKG
CK
CKA
CKS
CKF
CKJ
CKL2
CKL2-*-HC
CKH2
CKLB2
NCK/SCK/FCK
FJ
FK
Ending
Shock absorber
Related products

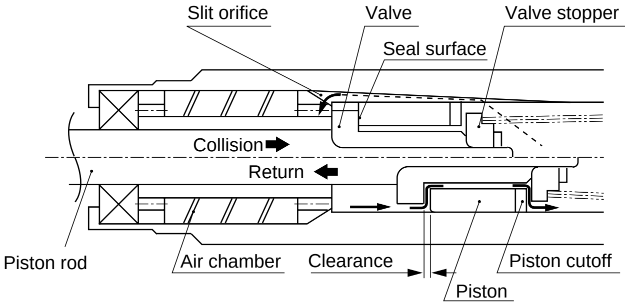
Operational explanation

(1) Collision

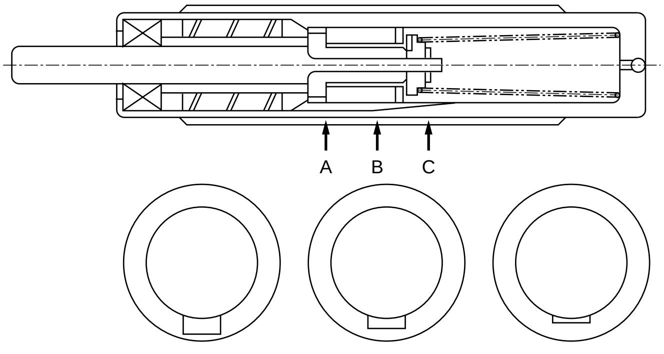
If the workpiece collides with the piston rod, oil in the tube pressed by the piston is pressurized, passes through grooves on CKD's original slit orifice, and flows toward the oil room with the air chamber. The piston is further pressed in by cylinder thrust or workpiece weight, etc., but the area of the slit orifice gradually decreases, so even higher resistance is generated. This series of operation is done continuously to stop the workpiece smoothly.

(2) Return

When released from the workpiece, the piston returned with the integrated spring, moving from the seal to the valve stopper, so the oil return flow path is opened by the cutoff section on the piston. Oil passes through this flow path and the slit orifice and returns to the state before the workpiece collided. The system waits for the next workpiece collision in this state.

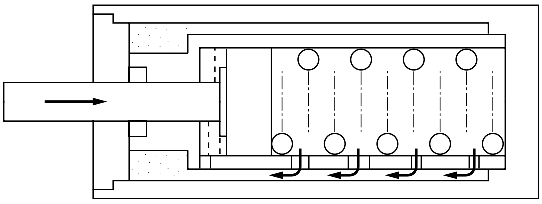


Structural explanation



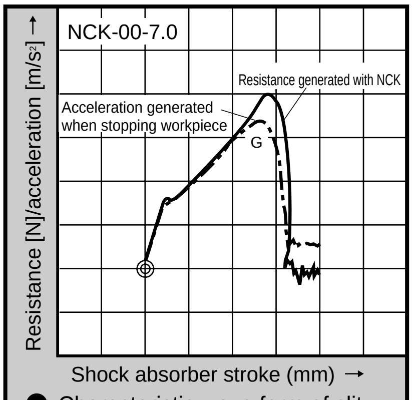
Section A　Section B　Section C

1. The silt orifice smoothly changes (decreases) as the piston moves as shown above.
This structure enables an ideal "stop" when used with a hydraulic damper, but as manufacturing is difficult, it has not been integrated in other brands. CKD has implemented linear stopping performance as shown in Fig. 1.



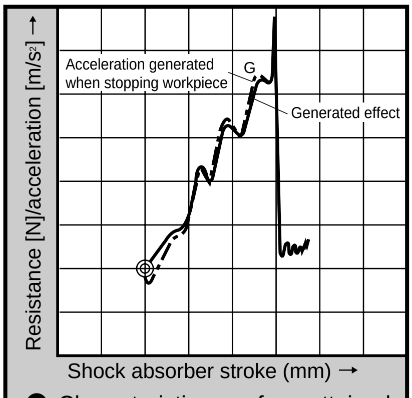
2. Generally, the dual tube shown above is used for the orifice area changes with piston movement. Multiple small orifice holes in the inner pipe are closed as the piston moves, greatly affecting performance via hole positioning precision, and resistance changes with each orifice as shown in Fig. 2, preventing smooth operation.

Fig. 1



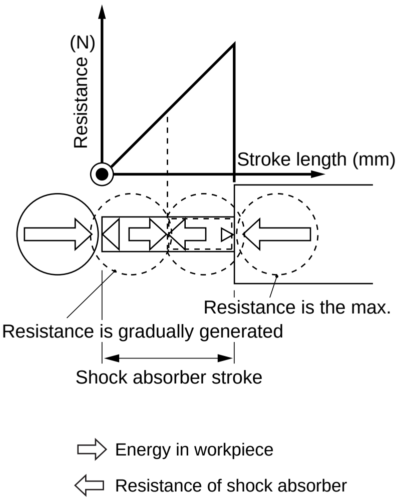
● Characteristic wave form of slit orifice integrated with NCK Series

Fig. 2



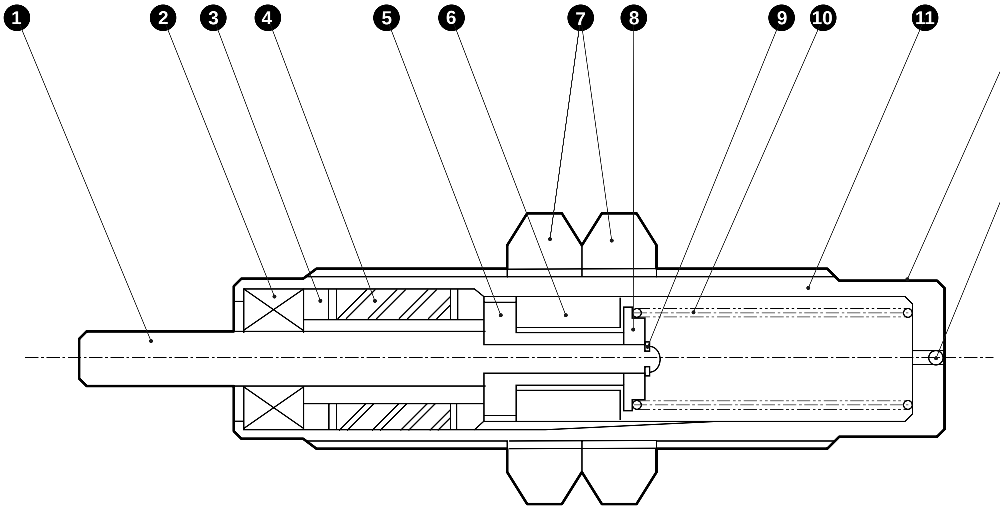
● Characteristic waveform attained with conventional multiple orifice

◉ : Indicates point where workpiece contacts end of shock absorber.

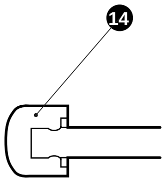


Internal structure and parts list

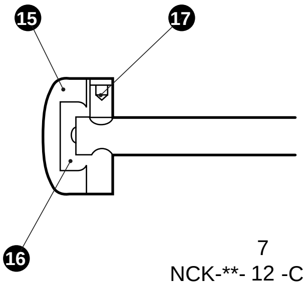
● Basic type (without cap)



● Capped



0.1
0.3
NCK-**-0.7-C
1.2
2.6



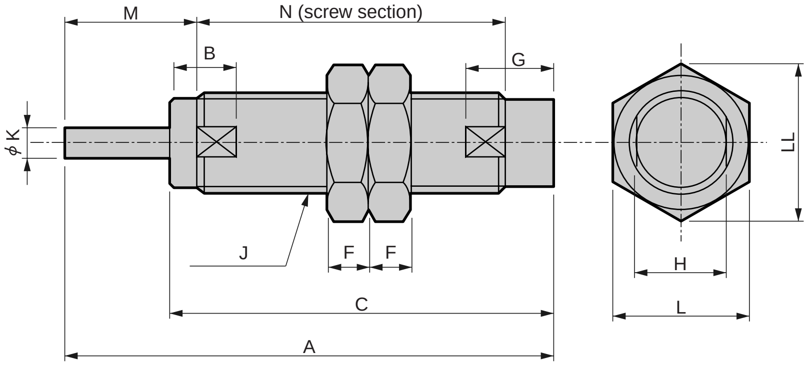
7
NCK-**- 12 -C
20

Parts list

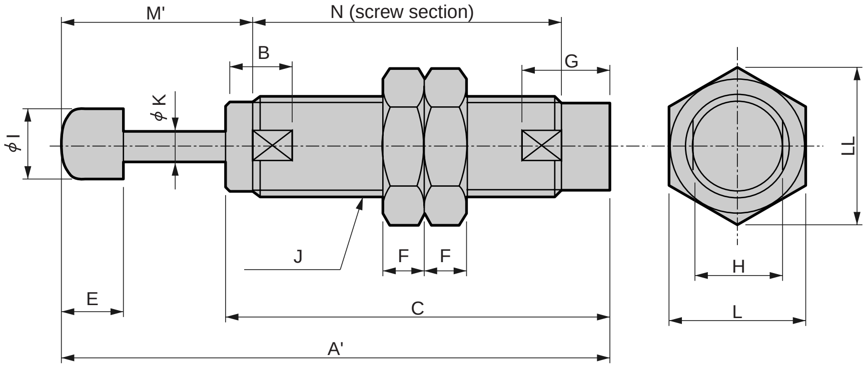
No.	Parts name	Material	Remarks
1	Rod	Steel	Industrial chrome plated
2	Oil seal	Special nitrile rubber	
3	Rod guide	Copper alloy	
4	Air chamber	Nitrile rubber	
5	Valve	Steel	
6	Piston	Cast iron	
7	Hexagon nut	Steel	Galvanizing
8	Valve stopper	Steel	
9	E type snap ring	Steel for spring	Galvanizing
10	Spring	Piano wire	
11	Damper case	Steel	Chrome plating
12	Label	Polyester film	
13	Ball	Alloy steel	
14	Damper cushion	Polyamide resin	Black
15	Damper cushion	Polyester resin	Black
16	Cushion stopper	Steel	Galvanizing
17	Hexagon socket head set screw	Steel	

Dimensions

- Standard (NCK-**-**)



- Capped (NCK-**-**-C)

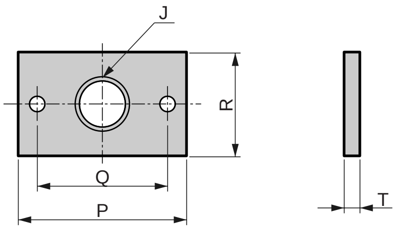


Symbol	Basic type (00)															
Model no.	A	A'	B	C	E	F	G	H	I	J	K	L	LL	M	M'	N
NCK-00-0.1	34.5	40.5	4	29.5	6	4	7.5	7	6	M8×0.75	2.8	12	13.9	6	12	23
NCK-00-0.3	45.5	51.5	7.5	39	6	4	8	7	6	M8×0.75	2.8	12	13.9	11	16.5	29.0
NCK-00-0.7	50	57	7.5	41.5	7	4	9	9	8	M10×1.0	3	14	16.2	13	20	31
NCK-00-1.2	57.5	65	8.5	47	7.5	5	11	11	10	M12×1.0	3.5	17	19.6	15	22.5	35.5
NCK-00-2.6	86	96	10.5	70.5	10	5.5	14	13	12	M14×1.5	5	19	21.9	20	30	58
NCK-00-7	98.5	109.5	12.5	78	11	8	18	19	16	M20×1.5	6	27	31.2	25	36	63.5
NCK-00-12	129	142	15.5	103.5	13	10	23	24	22	M25×1.5	8	32	37	30	43	87
NCK-00-20	141	154	15.5	110.5	13	10	25	24	22	M27×1.5	8	32	37	35	48	92

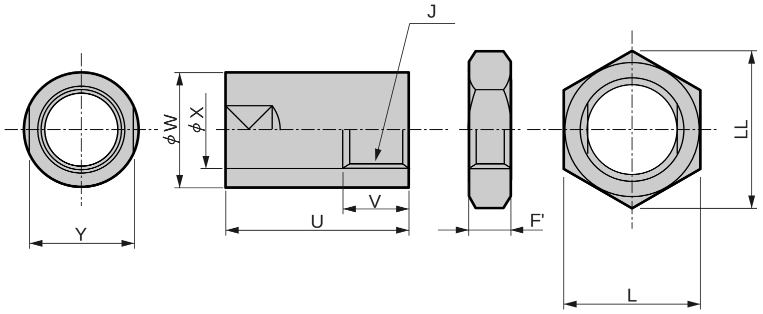
Dimensions: Option (flange (mounting bracket))

- NCK-**-
  0.1
  0.3
  0.7
  1.2

Flange (FA)

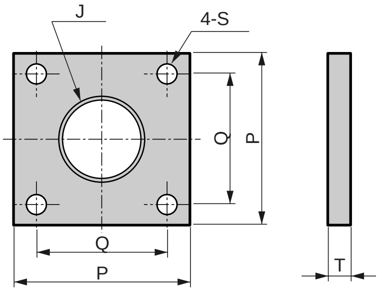


Stop nut (N1)

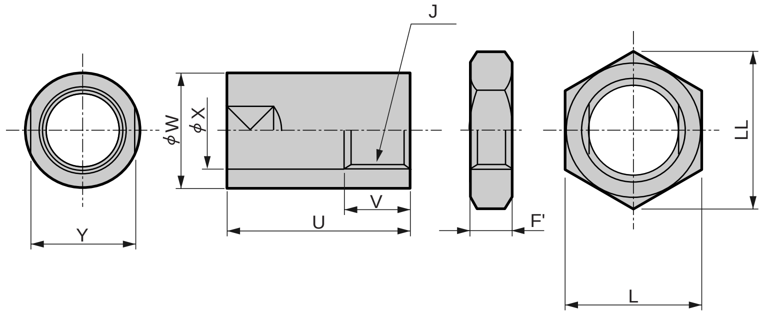


- NCK-**-
  2.6
  7
  12
  20

Flange (FA)



Stop nut (N1)



Symbol	Flange (FA)						Stop nut (N1)						
Model no.	J	P	Q	R	S	T	F'	J	U	V	W	X	Y
NCK-00-0.1	M8×0.75	42	30	20	5.5	2.3	4	M8×0.75	15	8	14	9	12
NCK-00-0.3	M8×0.75	42	30	20	5.5	2.3	4	M8×0.75	15	8	14	9	12
NCK-00-0.7	M10×1.0	42	30	20	5.5	2.3	4	M10×1.0	17	10	15	11	13
NCK-00-1.2	M12×1.0	46	34	20	5.5	3.6	5	M12×1.0	23	10	19	13	17
NCK-00-2.6	M14×1.5	52	38	-	6.5	6	5.5	M14×1.5	26.5	10	20	15	17
NCK-00-7	M20×1.5	52	38	-	6.5	6	8	M20×1.5	36.5	15	26	21	24
NCK-00-12	M25×1.5	52	38	-	6.5	6	10	M25×1.5	35	15	32	26	30
NCK-00-20	M27×1.5	52	38	-	6.5	6	10	M27×1.5	45.5	15	35	28	32

Shock absorber selection guide (1)

RRC
GRC
RV3*
NHS
HR
LN
FH100
HAP
BSA2
BHA/BHG
LHA
LHAG
HKP
HLA/HLB
HLAG/HLBG
HEP
HCP
HMF
HMFB
HFP
HLC
HGP
FH500
HBL
HDL
HMD
HJL
BHE
CKG
CK
CKA
CKS
CKF
CKJ
CKL2
CKL2-*-HC
CKH2
CKLB2
NCK/SCK/FCK
FJ
FK
Ending

1 Make collision pattern of device clear

Horizontal motion
- a. Simple horizontal colliding
- b. Colliding with thrust of cylinder
- c. Colliding with drive force of motor

Vertical motion
- d. Colliding caused by free drop
- e. Colliding with thrust of cylinder (down)
- f. Colliding with thrust of cylinder (up)

Slope motion
- g. Colliding caused by free slide
- h. Colliding with thrust of cylinder (down)
- i. Colliding with thrust of cylinder (up)

Oscillation motion Rotation
- j. Colliding caused by free oscillating drop
- k. Colliding with torque of motor, etc. (oscillation)
- l. Colliding with torque of motor, etc. (rotation)

Note: Refer to "Example of colliding pattern".

2 Make required conditions / descriptions clear to calculate energy

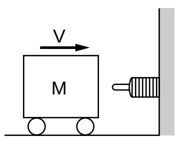
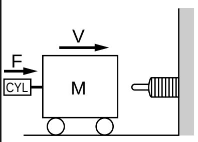
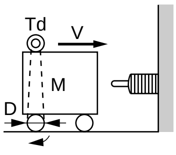
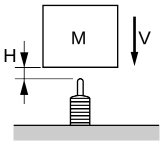
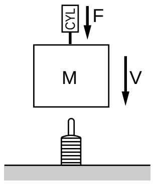
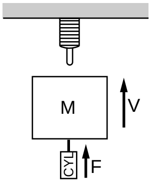
E = all absorbed energy (J)
E_1 = kinetic energy (J)
E_2 = thrust/self-weight energy (J)

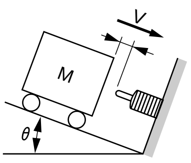
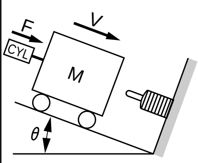
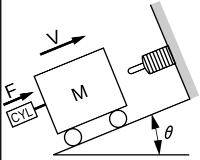
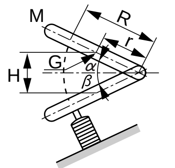
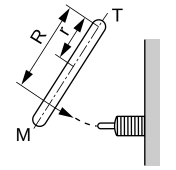
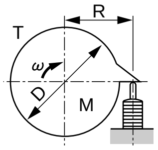
L = colliding object moving distance (m)
(Slope free drop)
R = distance from center of rotation to colliding point (m)
r = distance from center of rotation to center of gravity (m)
G = position of center of gravity

M = colliding weight (kg)
V = colliding speed (m/s)
S = NCK stroke length (m)
F = pressure (N)
g = acceleration of gravity 9.8m/s^2
ω = angular speed (rad/s)
J = moment of inertia (kg/m^2)
D = diameter (m)
N = number of rotation (rpm)
Me = colliding object equivalent weight (kg)

H = drop height (m)
T = torque (N·m)
Td = motor start torque (N·m)
K = reduction ratio
θ, α, β = angle (deg)

Example of colliding pattern

	Horizontal colliding			Vertical colliding		
	a. Simple horizontal colliding	b. Pressure of cylinder applies	c. Pressure of motor applies	d. Free drop	e. Cylinder lower limit stopper	f. Cylinder upper limit stopper
Applications						
Kinetic energy E_1 (J)	$\frac{1}{2}\cdot M\cdot V^2$	$\frac{1}{2}\cdot M\cdot V^2$	$\frac{1}{2}\cdot M\cdot V^2$	$\frac{1}{2}\cdot M\cdot V^2$	$\frac{1}{2}\cdot M\cdot V^2$	$\frac{1}{2}\cdot M\cdot V^2$
Thrust/self-weight energy E_2 (J)	——	$F\cdot S$	$2\cdot\frac{K}{D}\cdot Td\cdot S$	$M\cdot g\cdot S$	$(M\cdot g + F)\cdot S$	$(F - M\cdot g)\cdot S$
All absorbed energy E (J)	$E = E_1$	$E = E_1 + E_2$	$E = E_1 + E_2$	$E = E_1 + E_2$	$E = E_1 + E_2$	$E = E_1 + E_2$
Colliding object equivalent weight Me (kg)	$Me = M$	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}$ $(V = \sqrt{2\cdot g\cdot H})$	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}$

	Slope colliding			Oscillation colliding		Rotation colliding
	g. Free drop	h. Pressure of cylinder applies	i. Pressure of cylinder applies	j. Free drop	k. Torque of motor, etc. applies	L. Torque of motor, etc. applies
Applications						
Kinetic energy E_1 (J)	$\frac{1}{2}\cdot M\cdot V2$	$\frac{1}{2}\cdot M\cdot V2$	$\frac{1}{2}\cdot M\cdot V2$	$M\cdot g\cdot H$	$\frac{J\cdot\omega^2}{2}$ or $\frac{1}{2}\cdot M\cdot V^2$	$\frac{J\cdot\omega^2}{2} = \frac{M\cdot D^2\cdot\omega^2}{16}$
Thrust/self-weight energy E_2 (J)	$M\cdot g\cdot S\cdot\sin\theta$	$(M\cdot g\cdot\sin\theta + F)\cdot S$	$(M\cdot g\cdot\sin\theta + F)\cdot S$	$\frac{r}{R}\cdot M\cdot g\cdot S$	$\frac{T}{R}\cdot S$	$\frac{T}{R}\cdot S$
All absorbed energy E (J)	$E = E_1 + E_2$	$E = E_1 + E_2$	$E = E_1 + E_2$	$E = E_1 + E_2$	$E = E_1 + E_2$	$E = E_1 + E_2$
Colliding object equivalent weight Me (kg)	$Me = \frac{2\cdot E}{V^2}(V = \sqrt{2\cdot g\cdot L\cdot\sin\theta})$	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}(V = \frac{R}{r}\sqrt{\frac{3\cdot g\cdot H}{2}})$	$(M\cdot g\cdot\sin\theta + F)\cdot S$	$Me = \frac{2\cdot E}{V^2}(V = \omega\cdot R,\ \omega = \frac{2\pi\cdot N}{60})$

3 Check shock absorber specifications range

a. Max. repeating cycle (cycle/min.)
b. Max. colliding speed (m/s)
c. Ambient temperature (℃)
d. Return time (s)

Note: Value of allowable energy absorption may vary depending on colliding speed. Refer to page 517 and graph 5.

4 Calculate actual energy per "Example of colliding pattern".

●Explanation of symbol

E = all absorbed energy J

E_1 = kinetic energy J

E_2 = thrust/self-weight energy J

a. Kinetic energy : Calculate the E_1 value according to "Example of colliding pattern".

b. Thrust, self-weight energy : Calculate value of E_2 according to "Example of colliding pattern". For S (stroke length of NCK) in expression, select model whose maximum energy absorption exceeds E_1, and use S per model No.

c. All absorbed energy : If result of calculation exceeds Emax (maximum energy absorption) after that, select one size larger NCK according to selected model No. before, and recalculate. If calculated E is lower than Emax selected model No., the selection is acceptable.

5 Confirmation on colliding object equivalent weight

Me = colliding object equivalent weight (kg)

Note: Colliding object equivalent weight corresponds to weight of workpiece, even for body moving with thrust etc., if it is assumed that all of them are kinetic energy only. If only expression of energy is used, load is restricted by colliding object equivalent weight, because the weight of workpiece will extremely increase in low speed operations.

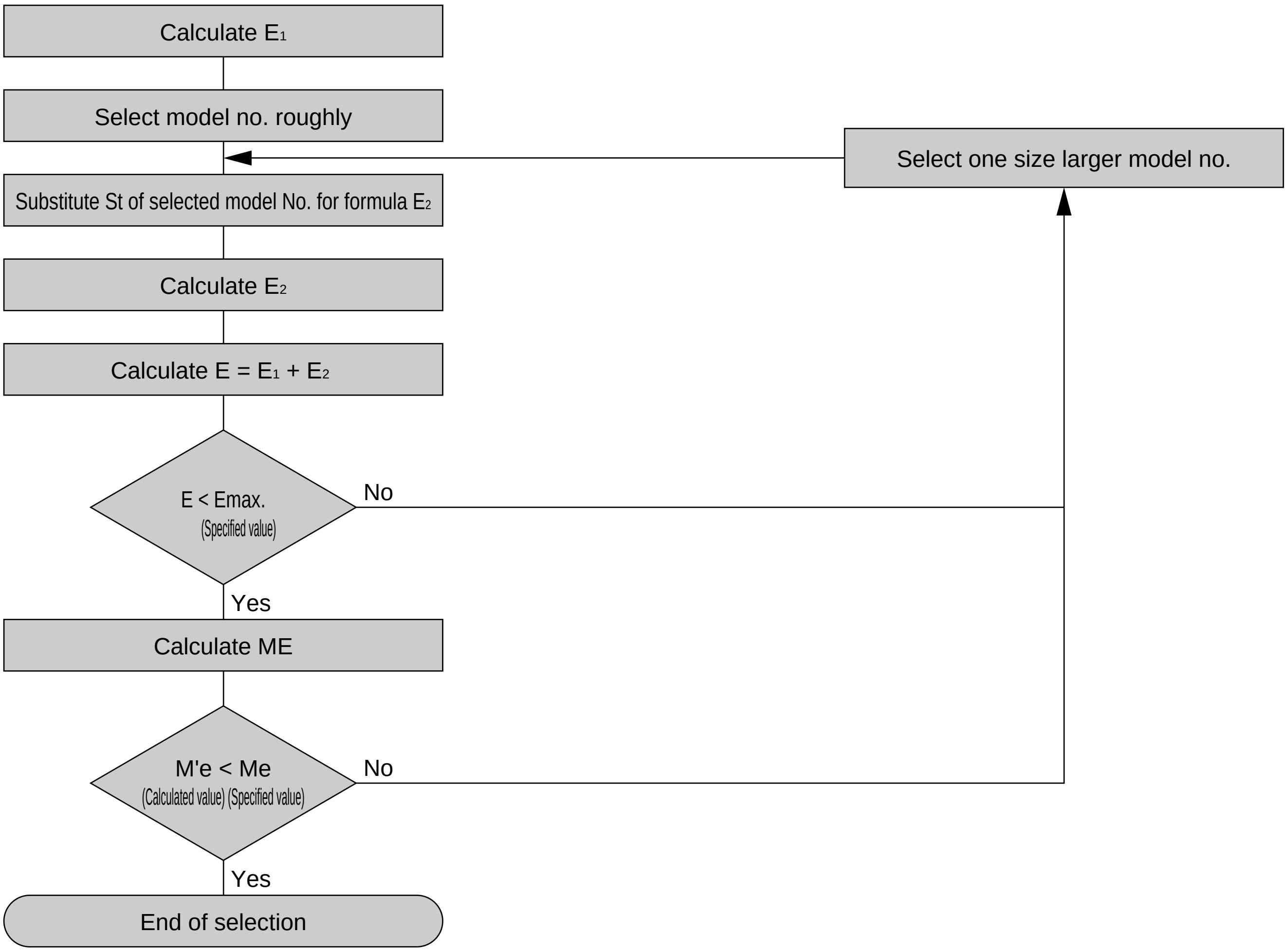
a. Calculate value of Me according to "Example of colliding pattern".

b. Permissible if Me is within Me range of selected model (calculated value of Me < specified value of Me) according to calculation of Me (catalog value) and "a" for model No. selected at (4).

c. When exceeding the range of selected Me model at "b", select one size larger NCK, and check conditions in same manner.

Note) Colliding object equivalent weight (Me) is listed on page 517 (graph 4).

6 Calculation flow chart of step 4 and 5



Shock absorber selection guide (2)

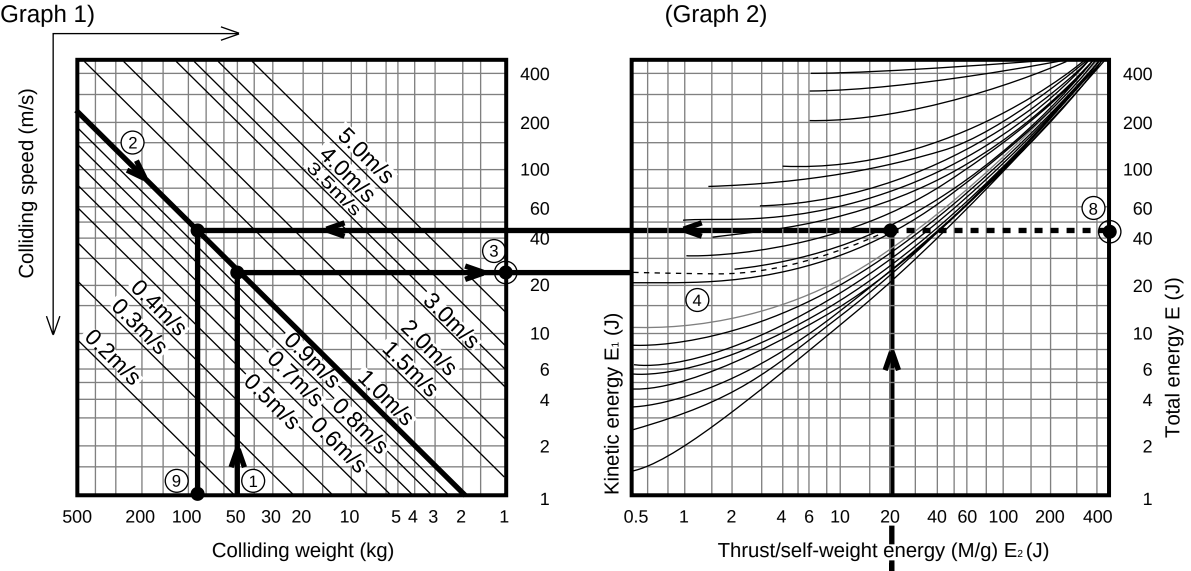
Shock absorber can be selected by calculation as (1) or reading graph. If not required to grasp energy values etc. during calculation, if this graph is used, proper model can be selected efficiently.

Condition of this figure: Horizontal colliding wit thrust
m = 50kg, V = 1.0m/s
Cylinder bore size ϕ50 Supply pressure = 0.5MPa

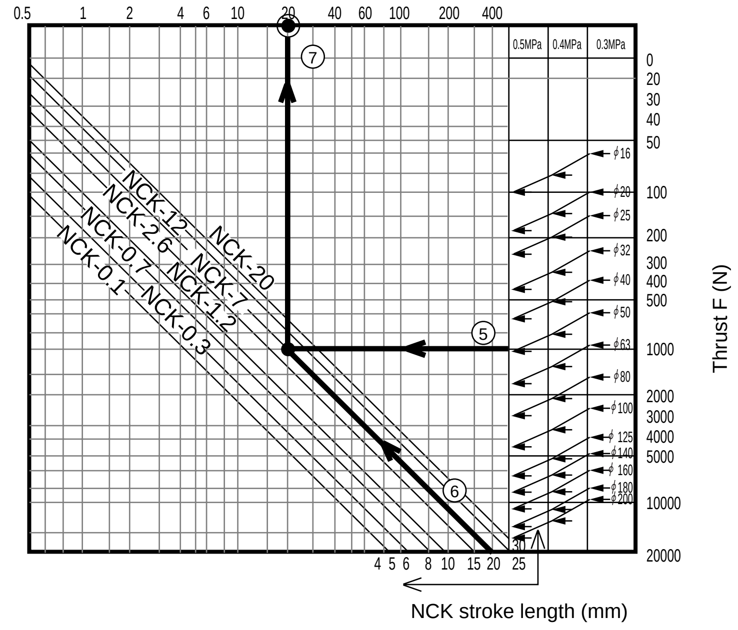
Energy calculation graph

● Thrust applies at horizontal collision

(Graph 1) (Graph 2)



(Graph 3)

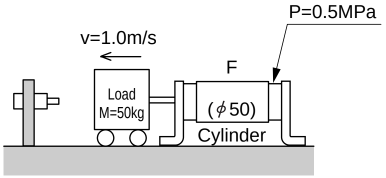


a) Decide colliding weight M(kg): (1)
b) Colliding speed V (m/s): (2)
c) Point of intersection between M and V (3) is kinetic energy E_1 (J). : (3)
d) Extend (3) to <Graph 2>, and refer to curve in figure to draw same curve. (dotted line): (4)
e) Next, if thrust applies, decide thrust F (N) (from inner diameter and pressure of cylinder) by right end chart of <Graph 3>: (5)
f) Determine model no. of NCK according to stroke length and max. energy absorption. : (6)
(Select model no. whose max. energy absorption exceeds E_1 found at (3).)
g) Point of intersection between F and NCK model no. (7) shows thrust/ self-weight energy E_2 (J). : (7)
h) Extend point (B) to <Graph 2>, and point of intersection (8) with curve (4) shows total energy E (= $E_1 + E_2$) (J).
Here, if value E exceeds selected NCK Emax (max. energy absorption) at (f), select one size larger model no. of NCK again, the find E with same procedure.
i) Here, if (C) and (8) are extended to <Graph 1>, point of intersection (9) with V (m/s) shows colliding object equivalent weight Me. : (9)
Check that colliding object equivalent weight is to be within specified value range <Graph 4>.
(When Me is exceeding specifications values, return to (f) , and repeats same procedures.)

Example of selection

Select shock absorber according to example.

Example Select shock absorber which stops load M smoothly under left figure conditions.



Frequency: 10 cycle/min. (Refer to equipment indoors.)

1 Colliding pattern of device equals to "b".

2 Summarize required conditions to calculate.

a. Colliding object weight M = 50kg
b. Colliding speed V = 1.0m/s
c. Cylinder thrust F = $\pi/4 \times 50^2$mm$\times$0.5MPa = 981.7N

3 Check specifications.

a. Frequency 10 cycle/min. : NG, since max. repeating cycle of NCK-20 is 9 cycle/min. (must be limited to model below NCK-12.)
b. Colliding speed 1.0m/s : All models are available
c. Ambient temperature: Indoor equipment: All models are available
d. Return time: Not specified All models are available

4 Calculate actual energy.

● From pattern figure example "b"

a. Kinetic energy: $E_1 = \frac{1}{2}\cdot m\cdot V^2 = \frac{1}{2} \times 50$ (kg) $\times 1.0^2$ (m/s) = 25 (J) Select NCK-2.6 (Emax = 26J) (St = 15mm) temporarily, since only E_1 achieved 25J here.

b. Thrust: $E_2 = F \times S$ = 981.7 (N) $\times$ 0.015 (m) = 14.7 (J)

c. All absorbed energy: $E = E_1 + E_2$ = 25 (J) + 14.7(J) = 39.7(J) Recalculate with one size larger NCK-7, since this E = 39.7 (J) cannot be absorbed by temporarily selected NCK-2.6.

b'. $E_2 = F \times S$ = 981.7 (N) $\times$ 0.02 (m) = 19.6 (J)

c'. $E = E_1 + E_2$ = 25 (J) + 19.6 (J) = 44.6 (J) Go to confirmation of colliding object equivalent weight, since this E = 44.6 (J) can be absorbed by NCK-7.

5 Check colliding object equivalent weight.

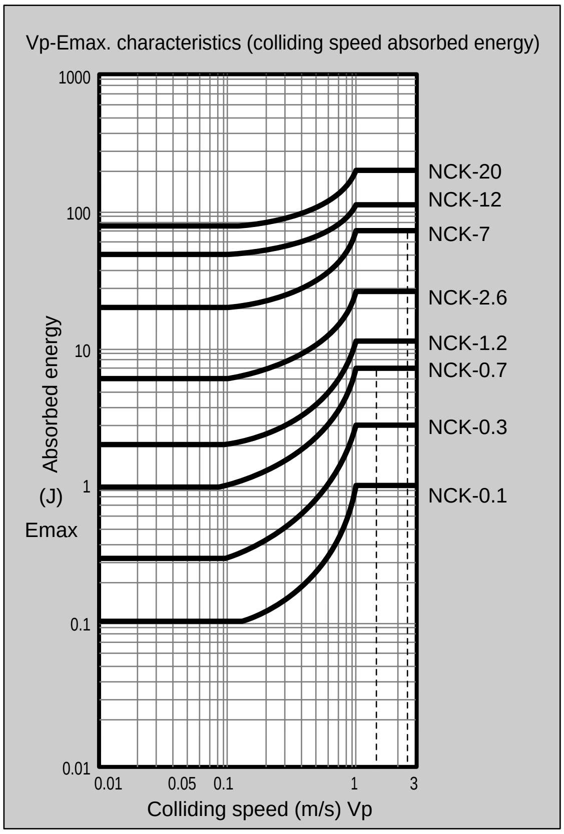
● From pattern figure example "b" as same as 4

a. Colliding object equivalent weight Me = $\frac{2\cdot E}{V^2} = \frac{2\times 44.6\ (J)}{1.0^2\ (m/s)}$ = 89.2kg

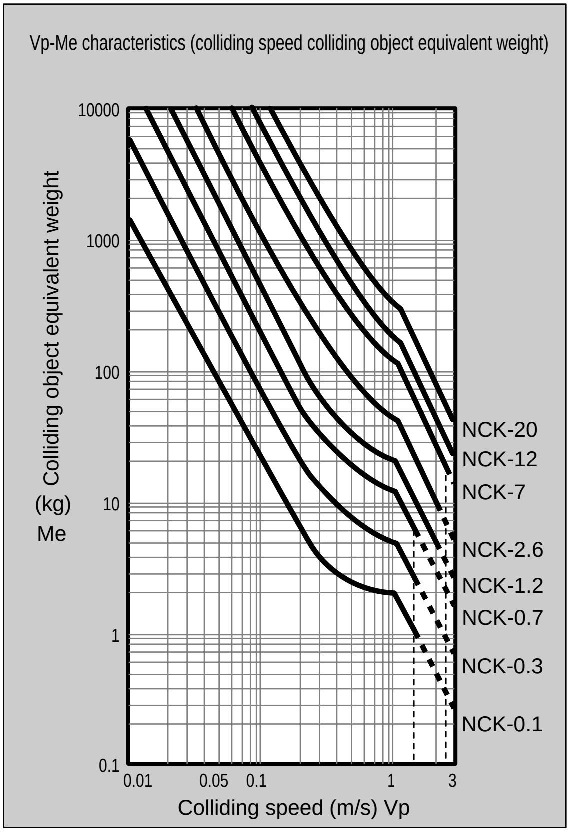
b. NCK-7 Me is 150 (kg), so this is larger than calculated colliding object equivalent weight. Therefore, use NCK-7 under these conditions.

Rush speed characteristics graph of colliding object equivalent weight/absorbed energy

<Graph 5>



<Graph 4>



Shock absorber

SCK Series

● Maximum energy absorption: 0.049 to 588J

RoHS CAD

Specifications

Descriptions	SCK																
Series	0.005	0.01	0.03	0.3	0.6	1.2	2.6	6.5	8	12	20	30	40	60	0.25M	0.5M	1.0M
Type/classification	Without adjuster Spring return type			With adjuster Spring return type											With adjuster Spring return type (Screw pitch large)		
Max. energy absorption J	0.049	0.098	0.294	2.94	5.88	11.8	25.5	63.7	78.4	118	196	294	392	588	3.43	11.8	74.5
Stroke length mm	7	10				15		25			40	60	70		10	15	30
Max. energy absorption per hour kJ/hour	0.135	0.27	0.98	8.1	10.8	21.6	39	78	86.4		108	126	120	144	9.2	21.2	80.5
Max. colliding speed m/s	1.0				1.5	2.0		2.5		3.0				4.0	1.0	2.0	2.5
Max. frequency Cycle/min.	45				30		25	20	18	12	9	7	5	4	45	30	18
Ambient temperature ℃	-10 to 80																
Max. load N	13	18	54	540	1000	1400	3100	4600	5700	8600	9000		10000	15000	630	1440	4560
Return time S	0.3 or less			0.4 or less				0.5 or less			0.6 or less				0.4 or less		0.5 or less
Product weight kg	0.02	0.04	0.07	0.2		0.32		0.63		1.17	1.25	1.39	1.45	2.05	0.05	0.13	0.39
Recoiling force Extended N	1.2	2.0	5.9	5.9		6.9		12.0		20.0				29.0	3.9	5.5	7.6
Compressed N	2.6	5.0	10.5	11.3		17.2		30.0		39.0	51.0	68.0	75.0	84.0	8.4	11.5	21.0
Copper and PTFE free	-			Standard													

Note: Minimum energy absorption to be 1/5 of maximum energy absorption.

How to order

SCK - 00 - 0.3 - N1

Ⓐ Mounting style

Ⓑ Series

Ⓒ Option

Symbol	Descriptions
Ⓐ Mounting style	
00	Basic type
FA	Flange type
Ⓑ Series (MAX. energy value)	
0.005	0.049J
0.01	0.098J
0.03	0.294J
0.3	2.94J
0.6	5.88J
1.2	11.8J
2.6	25.5J
6.5	63.7J
8	78.4J
12	118J
20	196J
30	294J
40	392J
60	588J
0.25M	3.43J
0.5M	11.8J
1.0M	74.5J
Ⓒ Option	
Blank	Standard
N1	With stop nut

⚠ Note on model no. selection

Note 1: 3 hexagon nuts are provided for N1 specifications products.

<Example of model number>

SCK-00-0.3-N1

Model: Shock absorber
Ⓐ Mounting style: Basic type
Ⓑ Series: MAX energy 2.94J
Ⓒ Option: With stop nut

How to order accessories

● Flange bracket (1 pc.)

SCK - 0.01 - FA

Ⓑ Series

● Stop nut + hexagon nut (each 1 pc.)

SCK - 0.01 - N1

Ⓑ Series

● Hexagon nut (1 pc.)

SCK - 0.01 - NT

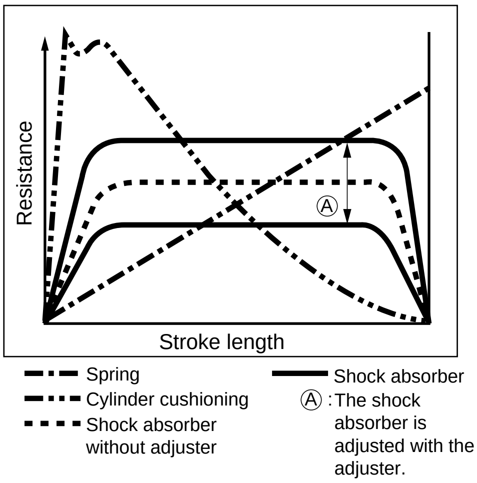
Ⓑ Series

RRC
GRC
RV3*
NHS
HR
LN
FH100
HAP
BSA2
BHA/ BHG
LHA
LHAG
HKP
HLA/ HLB
HLAG/ HLBG
HEP
HCP
HMF
HMFB
HFP
HLC
HGP
FH500
HBL
HDL
HMD
HJL
BHE
CKG
CK
CKA
CKS
CKF
CKJ
CKL2
CKL2 -*-HC
CKH2
CKLB2
NCK/ SCK/FCK
FJ
FK
Ending
Shock absorber Related products

Shock absorber and other buffer devices

As shown at right:

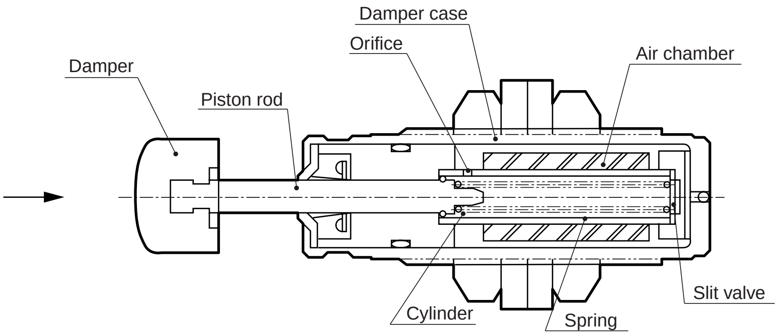
- The spring accumulates energy and functions as spring return force at the stroke end.
- Cylinder cushioning (a simple orifice provided to the hydraulic cylinder) has a sudden increase in resistance at collision and does not decelerate smoothly.
- A shock absorber without an adjuster has a constant absorbed energy so working conditions are limited (SCK-00-0.03 or less).
- A shock absorber with an adjuster has roughly constant resistance throughout the stroke, uniformly decelerating the object's speed. The curve moves in parallel vertically when adjusted, and collision energy is absorbed appropriately.



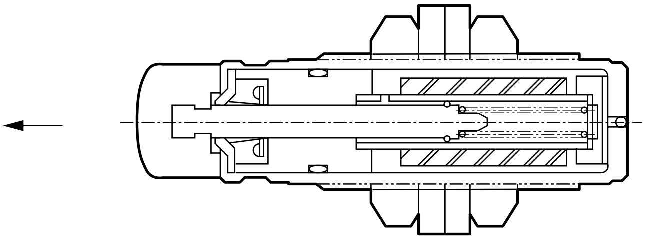
Internal structure and operational explanation

● SCK-00-0.005
00-0.01
00-0.03

Collision

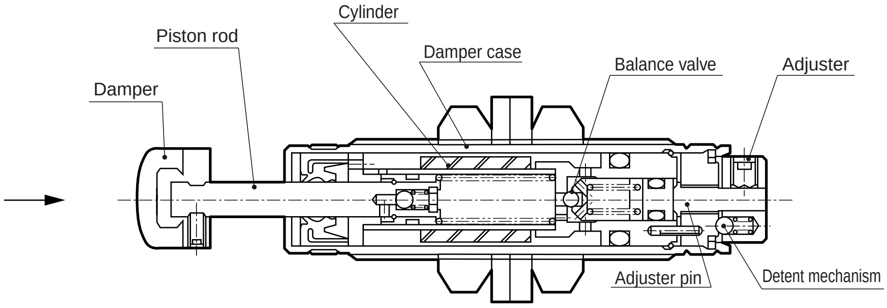


Return

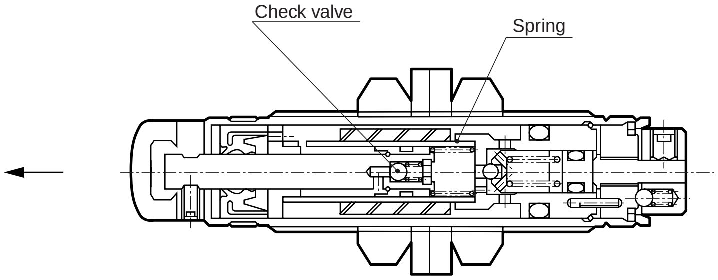


● SCK-00-0.3 to 60

Collision



Return



Collision

Collision force applied to the damper presses the piston rod and pressurizes oil in the cylinder. When generated hydraulics pass through the orifice and flow into the damper case, shock is absorbed.
Oil flowing into the damper case pressurizes the air chamber and decreases air chamber volume.
Note) With this product mechanism, internal pressure increases with workpiece speed during collision, generating resistance and absorbing energy. Resistance may thus appear low when pressed with a finger, but this poses no problem.

Return

When the colliding workpiece is removed, the piston rod is pushed out by the internal spring. At the same time, the slit valve (check valve) is opened by pressure in the air chamber. Oil flows to the inner pipe and at completion, the slit valve closes.

Collision

Collision force applied to the damper pushes the piston via the piston rod and pressurizes oil in the cylinder. When generated hydraulics pass through the orifice and balance valve and flow into the damper case, shock is absorbed.
When the adjuster is turned clockwise, the adjust pin moves and the force of the balance valve spring increases. Oil flow is decreased and a larger collision force is withstood.
Note) With this product mechanism, internal pressure increases with workpiece speed during collision, generating resistance and absorbing energy. Resistance may thus appear low when pressed with a finger, but this poses no problem.

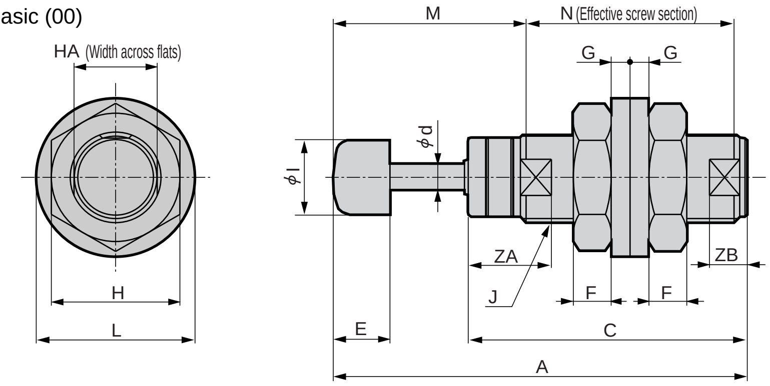
Return

When the colliding workpiece is removed, the piston rod is pushed out by the internal spring and the check valve is opened by pressure in the air chamber. Oil flows to the inner pipe and at completion, the check valve closes.

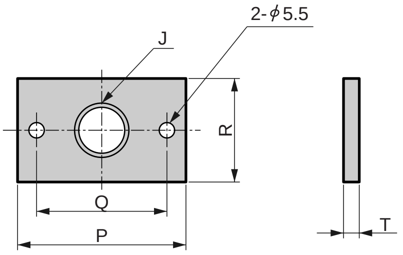
Dimensions

- SCK-**-0.005
  0.01
  0.03

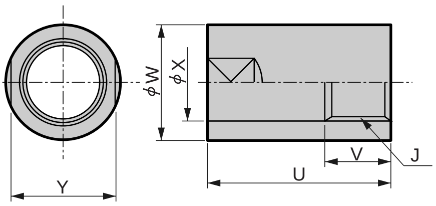
Basic (00)



Flange (FA)



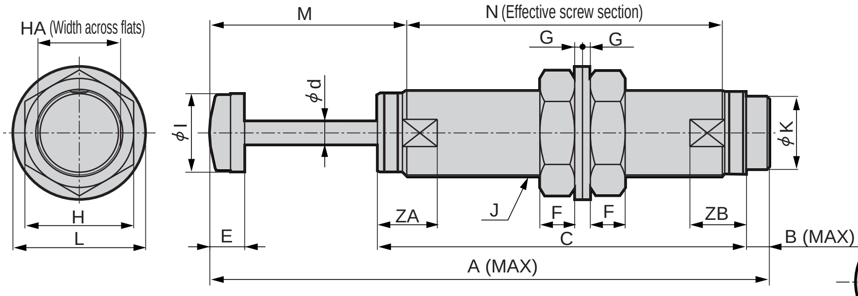
Stop nut (N1)



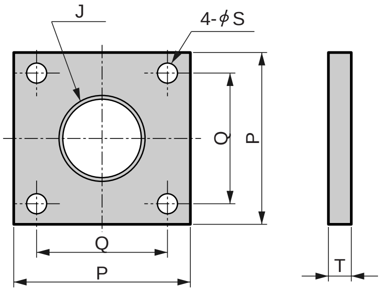
Symbol / Model no.	Basic (00)															Flange (FA)				Stop nut (N1)				
	A	C	E	F	G	H	I	J	L	M	N	d	HA	ZA	ZB	P	Q	R	T	U	V	W	X	Y
SCK-00-0.005	41.5	27	7	4	2	14	8	M10×1.0	18	21.3	18.5	3.0	9	9	4	42	30	20	2.3	17	10	15	11	13
SCK-00-0.01	55	37	7.5	5	2.5	17	10	M12×1.0	21	25.5	27.5	3.5	11	11	5	46	34	20	3.6	23	10	19	13	17
SCK-00-0.03	70	49.5	10.0	6.5	2.5	22	14	M16×1.0	27	28.3	39.5	4.0	15	12	6	52	40	32	4.5	23	10	22	17	19

- SCK-**-0.3 to 60, 0.25M to 1.0M
  (Screw pitch large)

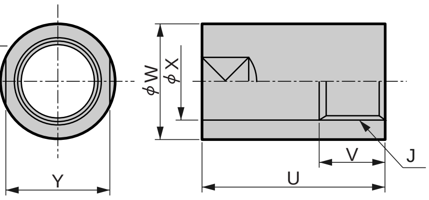
Basic (00)



Flange (FA)



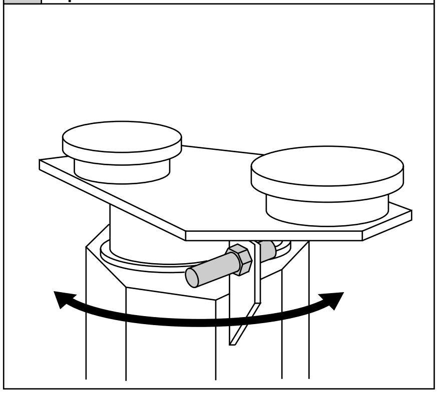
Stop nut (N1)



Symbol / Model no.	Basic (00)																Flange (FA)				Stop nut (N1)				
	A	B	C	E	F	G	H	I	J	K	L	M	N	d	HA	ZA	ZB	P	Q	S	T	U	V	W	X	Y
SCK-00-0.3	94.6	5.8	66.8	11	8	2.9	27	16	M20×1.0	13.5	33	33.5	45.7	5	17	17.5	16	52	38	6.5	6	32.5	15	26	21	24
SCK-00-0.6	94.6	5.8	66.8	11	8	2.9	27	16	M20×1.0	13.5	33	33.5	45.7	5	17	17.5	16	52	38	6.5	6	32.5	15	26	21	24
SCK-00-1.2	122.5	7.5	86	13	10	2.9	32	22	M25×1.5	19.5	39	40.5	65.4	6	24	21	18	52	38	6.5	6	35	15	32	26	30
SCK-00-2.6	122.5	7.5	86	13	10	2.9	32	22	M25×1.5	19.5	39	40.5	65.4	6	24	21	18	52	38	6.5	6	35	15	32	26	30
SCK-00-6.5	157.4	7.9	109.5	14	12	3.6	41	27	M30×1.5	23.5	50	51.5	89.4	8	27	21.5	19.5	66	48	8.5	6	40	15	40	31	36
SCK-00-8	157.4	7.9	109.5	14	12	3.6	41	27	M30×1.5	23.5	50	51.5	89.4	8	27	21.5	19.5	66	48	8.5	6	40	15	40	31	36
SCK-00-12	175.6	10.5	123.1	16	16	3.6	50	36	M40×1.5	33.5	61	55.5	98.5	11	38	27.5	26	84	64	10.5	9	69.5	20	50	41	46
SCK-00-20	205.6	10.5	138.1	16	16	3.6	50	36	M40×1.5	33.5	61	70.5	113.5	11	38	27.5	26	84	64	10.5	9	69.5	20	50	41	46
SCK-00-30	257.1	10.5	169.6	16	16	3.6	50	36	M40×1.5	33.5	61	90.5	145	11	38	27.5	26	84	64	10.5	9	69.5	20	50	41	46
SCK-00-40	277.1	10.5	179.6	16	16	3.6	50	36	M40×1.5	33.5	61	100.5	155	11	38	27.5	26	84	64	10.5	9	69.5	20	50	41	46
SCK-00-60	298.4	10.9	198.6	18	18	4.5	55	42	M45×1.5	37.5	67	102.9	172.5	12.5	43.5	31.5	30	84	64	10.5	9	70	20	60	46	55
SCK-00-0.25M	96.6	6.5	69.1	10	5.5	2.5	19	12	M14×1.5	10	24	26.1	53.5	4	12.4	10	15.5	52	38	6.5	6	26.5	10	20	15	17
SCK-00-0.5M	111.4	6.5	77.9	11	8	2.9	27	16	M20×1.5	13.5	33	33	60.8	5	17	12	17.5	52	38	6.5	6	36.5	15	26	21	24
SCK-00-1.0M	161.6	7.7	109.9	13	10	2.9	32	22	M27×3.0	19.5	39	50.5	90.3	6	24	15	22	52	38	6.5	6	45.5	15	35	28	32

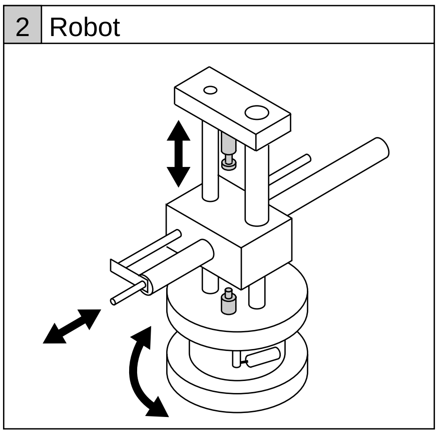
Example of shock absorber

1 Special index table



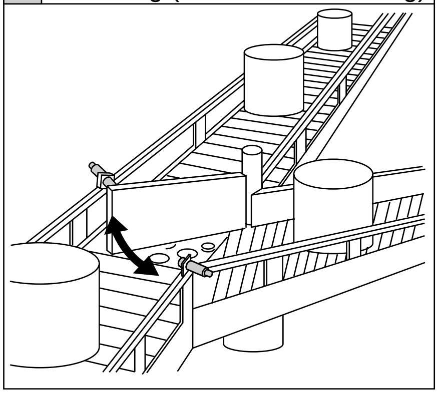
If used for special index table such as rim welding, etc. of wheel, index time can be reduced without damaging to machine.

2 Robot



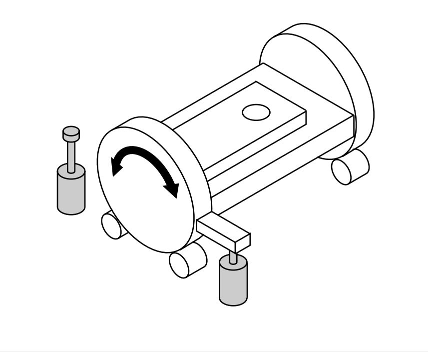
This absorbs impact according to diverse parts movement, and prevents part damage. Furthermore, production speed can be improved.

3 Switching (directional switching)



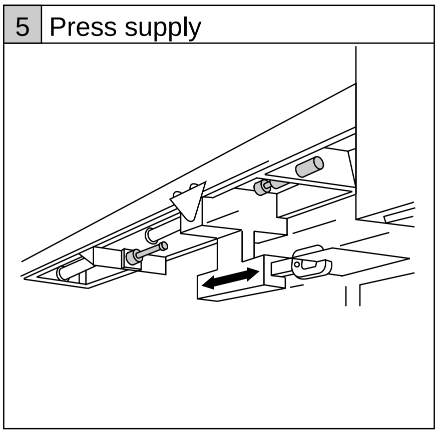
If used for mechanism of inspection and sorting for physical distribution, this absorbs impact caused by bound of gate, and prevents pneumatic cylinder etc. from damage.

4 Roll over



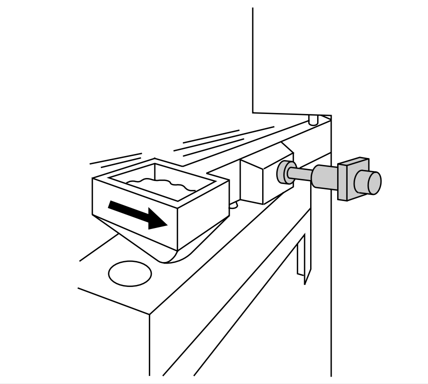
This can be used for automatic turn-over mechanism for parts after machining and welding etc. This reduces abrasion of driving section such as drive, gears and pinion, etc., and extends service life.

5 Press supply



This can be used with parts feeding mechanism to die of press (die and stamping model). Deceleration effect according to parts can be obtained without decreasing supply speeds of pneumatics cylinders etc.

6 Core mold



This can be used to stop swing arm in process that injects sand model material. This also increase cycle per unit time according to production number increase.

Selection guide

Setting of working conditions

Make following conditions clear for shock absorber selection.

(1) Load weight (kg)
(2) Colliding speed of instantaneous hit to shock absorber (m/s)
(3) If external force applies to load, that thrust (kgf)

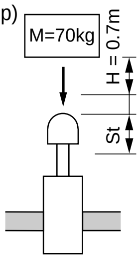
Symbol

D = Cylinder diameter (mm)
E = Kinetic energy (J)
P = Operation pressure (MPa)
K = Radius of gyration (m) (distance of load center to center of rotation)
ω = Colliding angular speed (rad/s)
I = Moment of inertia (kg/m2)
F = Thrust (N)
T = Torque (N·m)
V = Colliding speed (m/s)
H = Height (m)
St = Shock absorber stroke length (m)
M = Weight of workpiece (kg)
g = Gravity acceleration 9.8m/s^2

Example of calculation

(1) Vertical falling motion (free drop)

$$\boxed{E = \frac{1}{2} \cdot M \cdot V^2 + Mg \cdot St}$$



Where weight (M) of workpiece is 70kg and drop vertically from 0.7m high (H), check if SCK-00-60 can be used.

Find max. colliding speed under these conditions.

$$V = \sqrt{2 \cdot g \cdot H} = \sqrt{19.6 \times H}$$

$$V = \sqrt{19.6 \times 0.7} = 3.7\text{m/s} < 4\text{m/s}$$

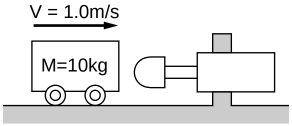
(SCK-00-60)

$$E = \frac{1}{2} \times 70 \times 3.7^2 + 70 \times 9.8 \times 0.07 = 527.2$$

Absorbed energy of SCK-00-60 is larger according to colliding speed characteristics graph of absorbed energy on Graph 1. Therefore, energy can be absorbed by SCK-00-60.

(2) Horizontal motion (inertia motion)

$$\boxed{E = \frac{1}{2} \cdot M \cdot V^2}$$



If weight (M) of workpiece is 10kg and colliding speed (V) 1.0m/s.

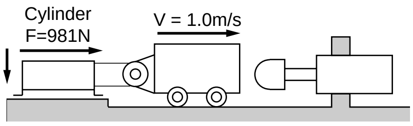
$$E = \frac{1}{2} \times 10 \times (1.0)^2 = 5.0\text{J}$$

SCK-00-1.2 can be used.

---

(3) Horizontal motion (for thrust)

$$\boxed{E = \frac{1}{2} \cdot M \cdot V^2 + F \cdot St}$$



If workpiece calculated at (2) is moved by pneumatic cylinder (D) 50mm dia. with (P) 0.5MPa, thrust of pneumatics cylinder is,

$$F = \frac{\pi}{4} \times D^2 \times P = \frac{\pi}{4} \times 50^2 \times 0.5 = 981\text{N}$$

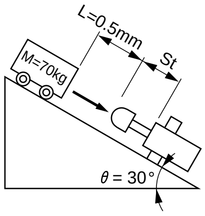
Check if SCK-00-6.5 can be used.

$$E = \frac{1}{2} \times 10 \times (1.0)^2 + 981 \times 0.025$$

$$\fallingdotseq 29.5$$

Therefore, energy can be absorbed by SCK-00-6.5.

(4) Slope dropping motion



$$E = (\frac{1}{2} MV^2) + (Mg/St/\sin\theta)$$

Where 70kgf weight workpieces drop on 30° slope, check if SCK-00-40 can be used. Find max. colliding speed under same conditions.

$$V = \sqrt{19.6 \times H}\ (H = 0.5 \times \sin 30°)$$

$$= \sqrt{19.6 \times 0.5 \times \sin 30°}$$

$$= 2.2\text{m/s} < 3\text{m/s}$$

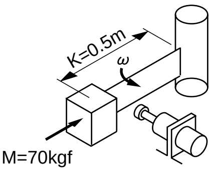
$$E = (\frac{1}{2} \times 70 \times 2.2^2) + (70 \times 9.8 \times 0.07 \times \sin 30°)$$

$$\fallingdotseq 193.4\text{J}$$

Therefore, energy can be absorbed by SCK-00-20.

(6) Horizontal rotary motion (inertia motion)

$$\boxed{\begin{array}{c} I = WK^2 \\ E = \frac{1 \cdot \omega^2}{2} \end{array}}$$



Where 70kgf workpiece, radius of gyration (K) 0.5m, and colliding angular speed 1 rad/s, check if SCK-00-1.2 can be used.

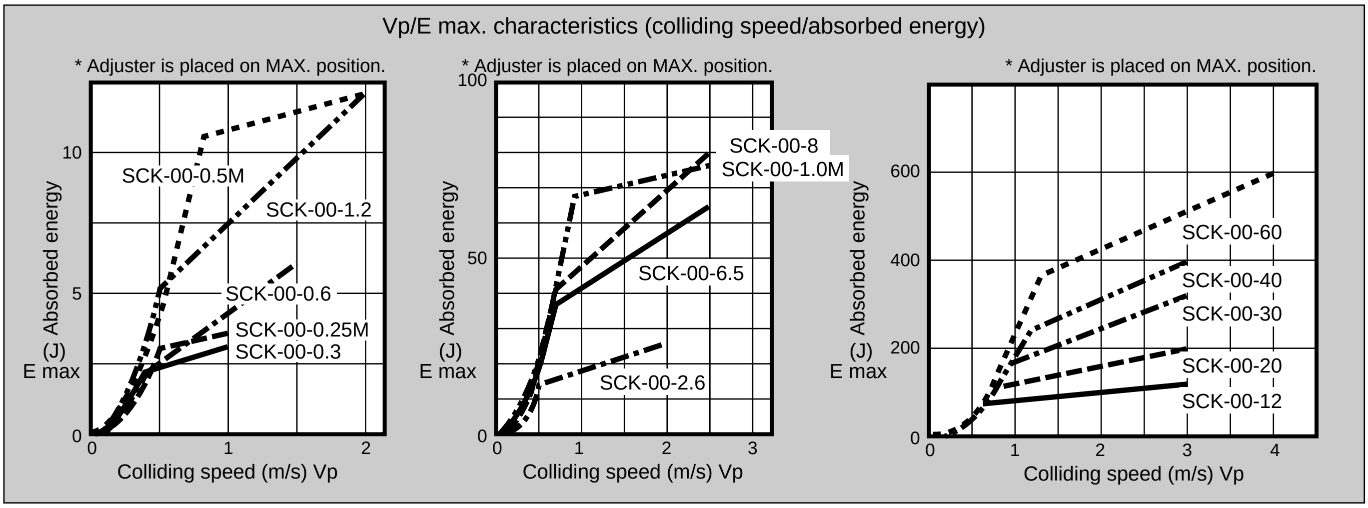
$$I = 70 \times (0.5)^2 = 17.5\text{kg/m}^2$$

$$E = \frac{(1)^2}{2} = \frac{17.5 \times (1)^2}{2}$$

$$= 8.8\text{J}$$

Therefore, energy can be absorbed by SCK-00-1.2.

(Graph 1)


Vp/E max. characteristics (colliding speed/absorbed energy)

* Absorption energy drops at low speed.

RRC
GRC
RV3*
NHS
HR
LN
FH100
HAP
BSA2
BHA/BHG
LHA
LHAG
HKP
HLA/HLB
HLAG/HLBG
HEP
HCP
HMF
HMFB
HFP
HLC
HGP
FH500
HBL
HDL
HMD
HJL
BHE
CKG
CK
CKA
CKS
CKF
CKJ
CKL2
CKL2-*-HC
CKH2
CKLB2
NCK/SCK/FCK
FJ
FK
Ending

3 stages of low, medium and high speed are available.

3 stages of rush speed and 3 types of mechanism

Low speed: single hole orifice structure, Medium speed: porous irregular orifice structure, High speed: multiple orifice structure is provided according to porous orifice structure and rush speed.

With non-rotating mechanism

Lock screw is used for adjusting mechanism not to be out of order during operation. (Not available for some small models)

Easy installation enabled by outer diameter thread

Nut is attached to outer diameter thread type of M10 to M27 for low speed, and of M10 to M42 for medium/high speed. Easy installation and position adjustment.

Cap is available. (Excluding some sizes)

High efficiency screw machining

Large surface area, since outer pipe is machined with thread, increases outgoing radiation effect.

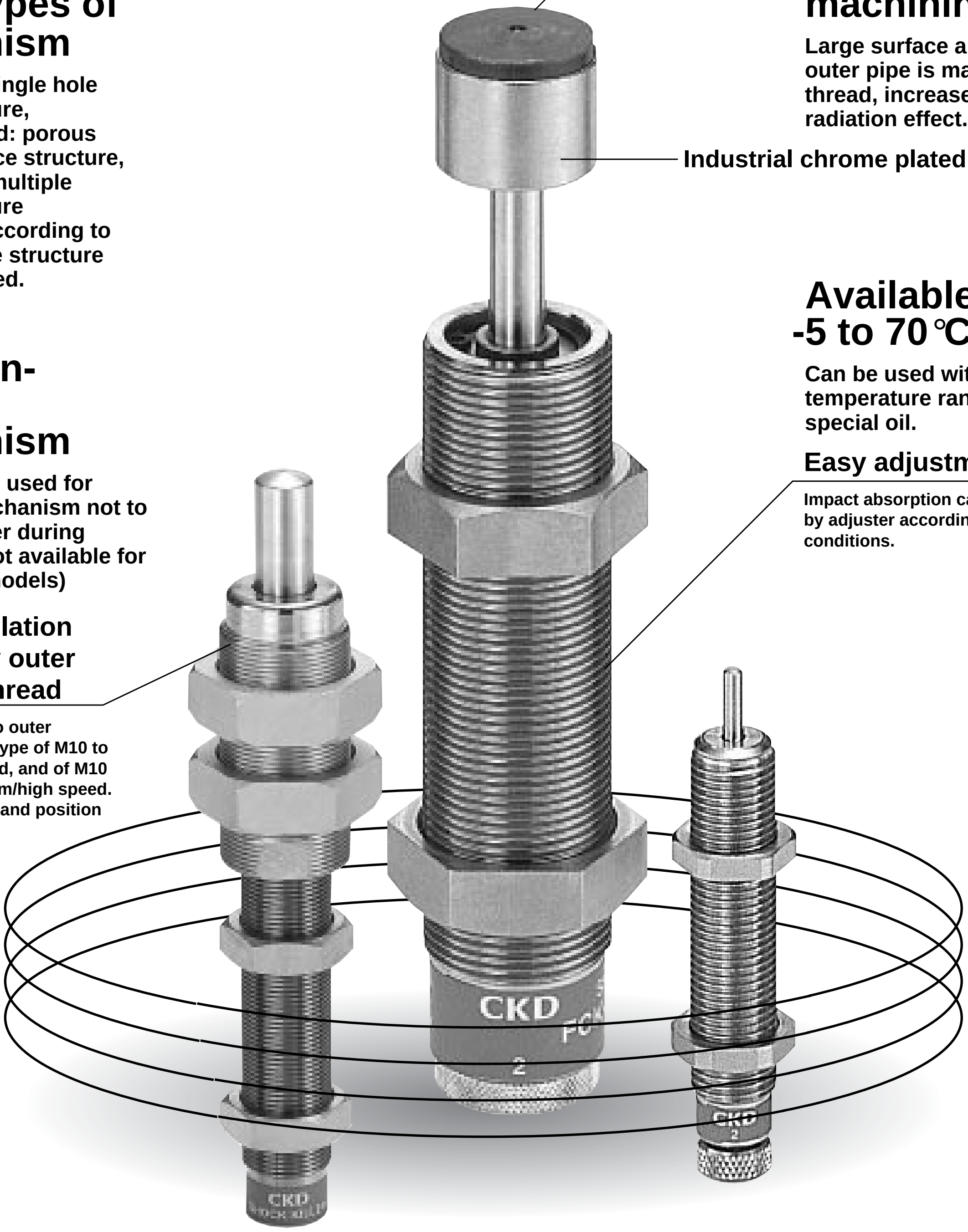
Industrial chrome plated piston rod

Available within -5 to 70℃

Can be used with wide temperature range due to special oil.

Easy adjustment

Impact absorption can be adjusted by adjuster according to colliding conditions.



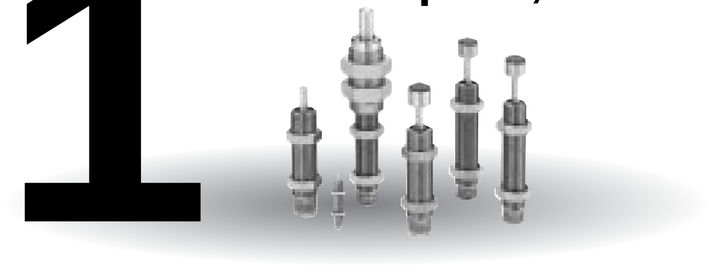
SHOCK

RRC
GRC
RV3*
NHS
HR
LN
FH100
HAP
BSA2
BHA/BHG
LHA
LHAG
HKP
HLA/HLB
HLAG/HLBG
HEP
HCP
HMF
HMFB
HFP
HLC
HGP
FH500
HBL
HDL
HMD
HJL
BHE
CKG
CK
CKA
CKS
CKF
CKJ
CKL2
CKL2-*-HC
CKH2
CKLB2
NCK/SCK/FCK
FJ
FK
Ending
Shock absorber Related products

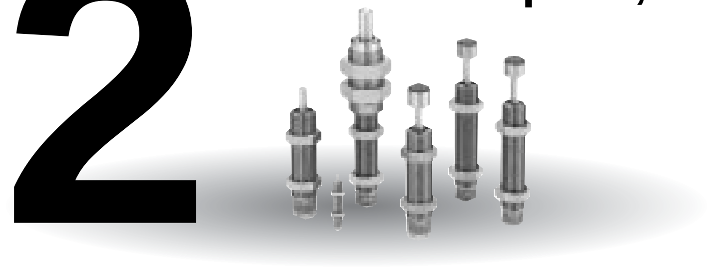
32

New shock absorber FCK series available with wide variation. Appropriate impact absorption matching to colliding conditions and characteristics.

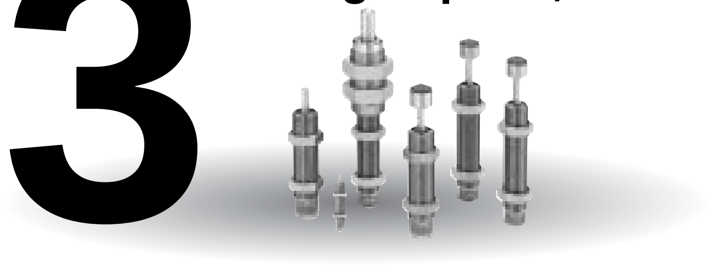
0.3 to 1 m/s low speed, 8 models



0.3 to 2 m/s medium speed, 12 models

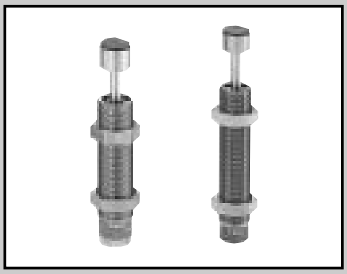


0.7 to 3 m/s high speed, 12 models



Shock absorber 5 merits

(1) Stop colliding object safely.
(2) Increase manufacture cycle.
(3) Extend service life of machine equipment.
(4) Improve environment of machine equipment, and reduce noise level.
(5) Prevent machine from failure.



Shock absorber

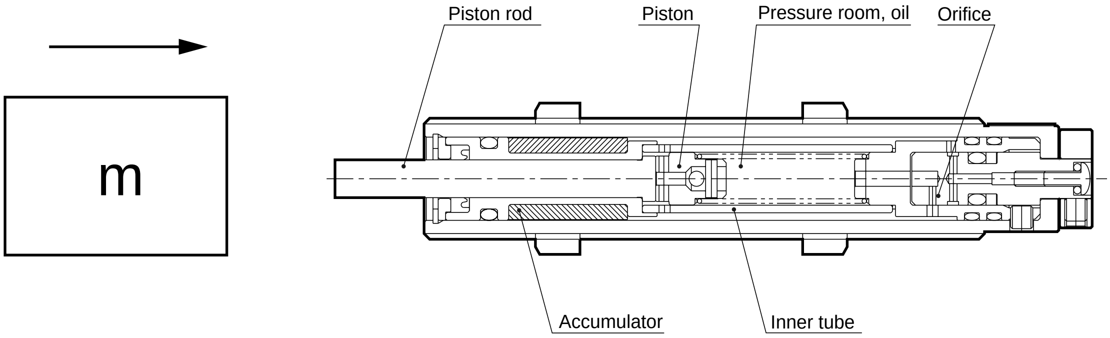
FCK Series

● Maximum energy absorption: 1.5 to 720J

Specifications

Descriptions		FCK														
Series		0.15	0.18	0.3	0.5	0.4	0.6	1	3	5	6.5	8.1	20	40	45	73.5
Type/classification		With adjuster Spring return type														
Maximum energy absorption J		1.5	1.8	2.9	4.9	3.9	5.9	9.8	29.4	49	63.7	79.3	196	392	441	720
Stroke length mm		8		10				12	16	30	40	25	35	50		80
Max. energy absorption per hour kJ/hour		3.5		5.9		8.8		14.1	20.6	29.4	38.2	32.3	70.5	141.1	164.6	264.6
Max. colliding speed	L m/s	0.3 to 1	-	0.3 to 1	-	0.3 to 1	-	0.3 to 1					-	-	-	-
	M m/s	-	0.3 to 2	-	0.3 to 2	-	0.3 to 2	0.3 to 2					0.3 to 2			
	H m/s	-	0.7 to 3	-	0.7 to 3	-	0.7 to 3	0.7 to 3					0.7 to 3			
Max. repeating cycle (20℃) Cycle/min.		60											30		10	6
Ambient temperature ℃		-5 to 70														
Max. load (resistance)	L N	637		1,470		1,813		2,646	4,900			6,370	16,660	23,520	27,028	
	M N								3,528	3,920						
	H N															
Return time S		0.5 or less											1 or less		2 or less	
Product weight	Without cap g	26.5		44		68		108	180	406	-	411	710	1300	-	-
	Capped g	27		47		73		117	202	436	459	460	760	1410	1560	2010
Recoiling force	Extended N	2.9		4.9		4.5		5.4	12.0	16.6	23.8	16.2	19.6	22.5	24.5	
	Compressed N	5.9		9.8				14.7	18.0	33.1	71.4	27.2	44.1	68.6	83.3	98.0

Operational principle



If body collides to piston rod, that action is transmitted to oil in pressure room enclosed by piston and inner tube.
Oil in pressure room flows out from orifice provided in inner tube.
Resistance F shown by following formula occurs at that time.
$F = av^2 + bv + cx$ (v is colliding speed, and x is moving stroke. a . b . c are constants.)

No. 1 shows speed square resistance, and places large percentage in resistance.
No. 2 shows viscosity resistance, and places large percentage, if colliding speed is small.
No. 3 shows return force of piston rod. (This can be ignored usually, since value is very small compared with No. 1, No. 2)
The product of resistance generated at this time and the piston rod stroke is the shock absorber absorption energy.
The shock absorber realizes ideal impact absorption by controlling No. 1 and 2.

How to order

● Low speed type

FCK-L - 0.15 - C

● Medium speed type

FCK-M - 0.18 - C

● High speed type

FCK-H - 0.18 - C

Ⓐ Model no.

Ⓑ Series (max. energy absorption)

Ⓒ Option
*1

		Ⓐ Model no.		
		Low speed type	Medium speed type	High speed type
Symbol	Descriptions	FCK-L	FCK-M	FCK-H
Ⓑ Series (max. energy absorption)				
0.15	1.5J	●	▨	▨
0.18	1.8J	▨	●	●
0.3	2.9J	●	▨	▨
0.4	3.9J	●	▨	▨
0.5	4.9J	▨	●	●
0.6	5.9J	▨	●	●
1	9.8J	●	●	●
3	29.4J	●	●	●
5	49J	●	●	●
6.5	63.7J	●	●	●
8.1	79.3J	●	●	●
20	196J	▨	●	●
40	392J	▨	●	●
45	441J	▨	●	●
73.5	720J	▨	●	●
Ⓒ Option				
Blank	Without cap	●	●	●
C	Capped	●	●	●

* 1: No cap is not available for 6.5 (63.7J), 45 (441 J), 73.5 (720J).

▨ is not available.

<Example of model number>

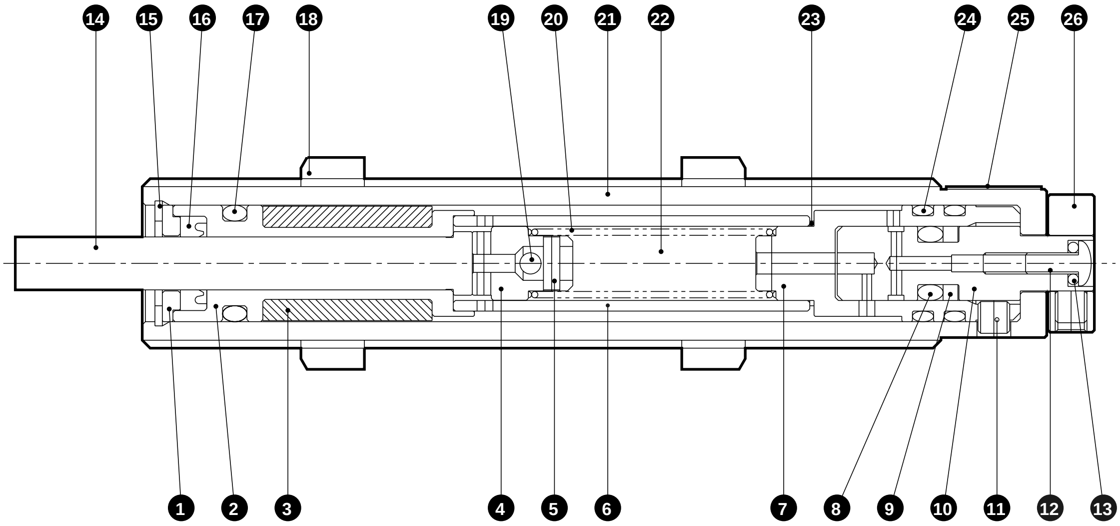
FCK-M-0.18-C

Ⓐ Model no.: Shock absorber medium speed type
Ⓑ Series : MAX energy 1.8J
Ⓒ Option : Capped

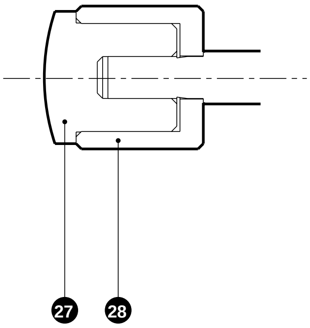
Internal structure and parts list

● FCK-*-*

Basic type (without cap)



Capped



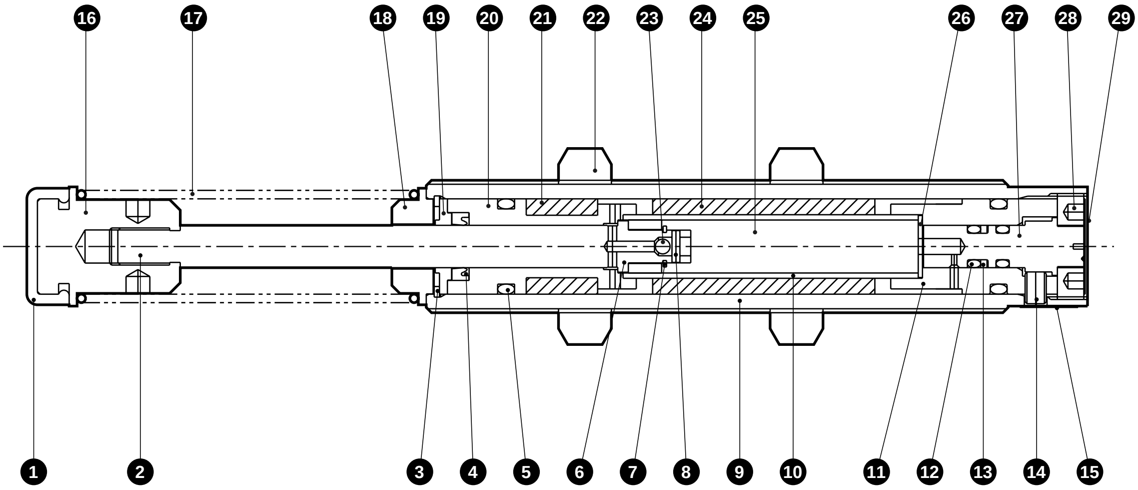
Parts list

No.	Parts name	Material	No.	Parts name	Material
1	Packing seal retainer	Copper alloy	15	Snap ring	Steel
2	Guide	Copper alloy	16	U packing seal	Nitrile rubber
3	Accumulator	Nitrile rubber	17	O ring	Nitrile rubber
4	Piston	Copper alloy	18	Hexagon nut	Steel
5	Spring pin	Stainless steel	19	Steel ball	Bearing steel
6	Inner tube	Steel	20	Spring	Piano wire
7	Bottom	Copper alloy	21	Outer tube	Steel
8	O ring	Nitrile rubber	22	Oil	Oil
9	Back up ring	Resin	23	Spacer	Nitrile rubber
10	Adjustment shaft	Copper alloy	24	O ring	Nitrile rubber
11	Hexagon socket head set screw	Alloy steel	25	Product name plate	
12	Stopped cross headed set screw	Alloy steel	26	Dial	Copper alloy
13	O ring	Nitrile rubber	27	Rod cap	Resin
14	Piston rod	Alloy steel	28	Stiffening ring	Steel

Note: Some structure differs per model.

Internal structure and parts list

6.5
● FCK-*- 45 -C (capped)
73.5



Parts list

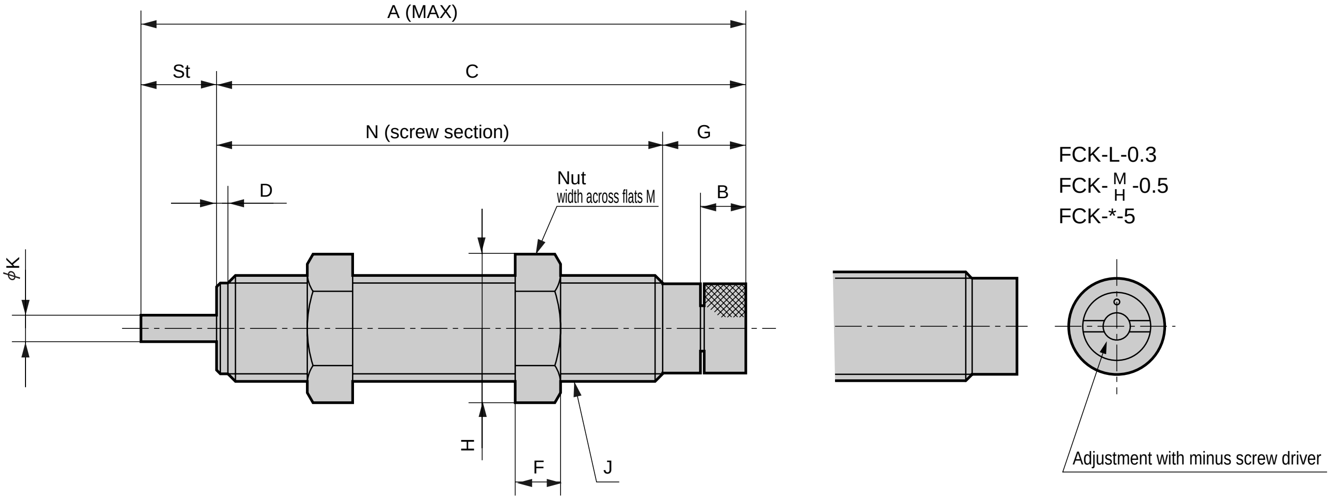
No.	Parts name	Material	No.	Parts name	Material
1	Rod cover	Urethane rubber	16	Spring guide	Steel
2	Piston rod	Alloy steel	17	Spring	Piano wire
3	Snap ring (round R type)	Steel	18	Spring guide	Steel
4	U packing seal	Nitrile rubber	19	Packing seal retainer	Copper alloy
5	O ring	Nitrile rubber	20	Guide	Copper alloy
6	Piston	Copper alloy	21	Accumulator	Nitrile rubber
7	Snap ring (E type)	Steel	22	Hexagon nut	Steel
8	Spring pin	Stainless steel	23	Steel ball	Bearing steel
9	Outer tube	Steel pipe	24	Accumulator	Nitrile rubber
10	Inner tube	Steel pipe	25	Oil	Oil
11	Bottom	Copper alloy	26	Washer	Steel
12	O ring	Nitrile rubber	27	Adjustment axis	Copper alloy
13	Back up ring	Resin	28	Holder screw	Steel
14	Hexagon socket head set screw	Alloy steel	29	Label	Steel
15	Product name plate				

Note 1: Some structure differs per model.
Note 2: The rod cover (plastic) cap cannot be attached to the 45 and 73.5 sizes.

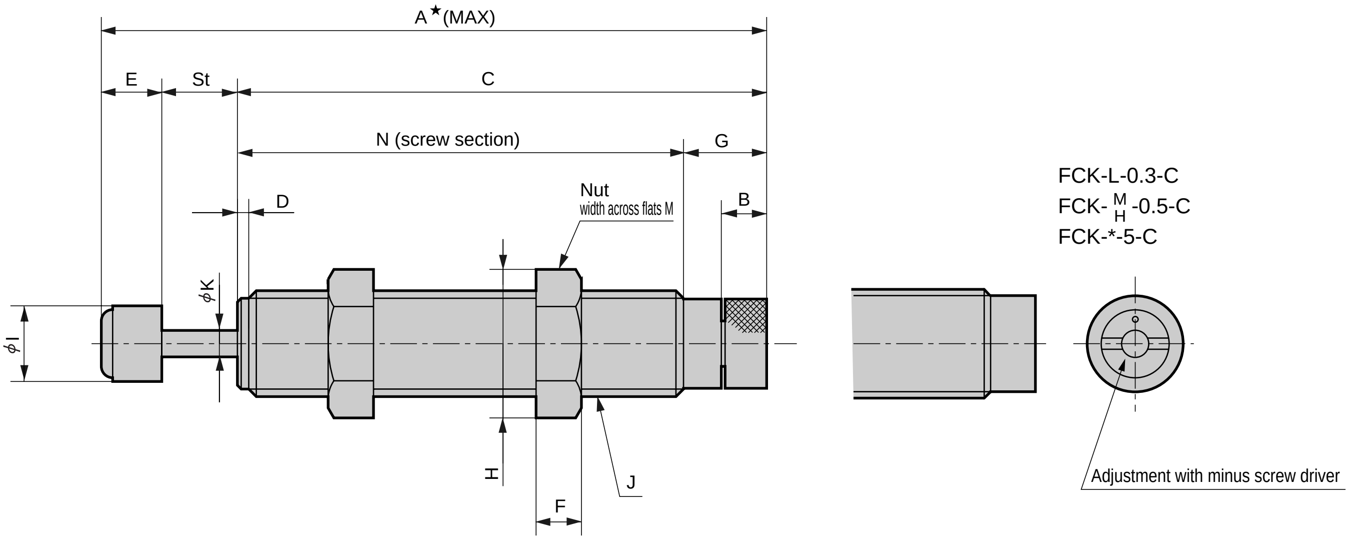
RRC
GRC
RV3*
NHS
HR
LN
FH100
HAP
BSA2
BHA/BHG
LHA
LHAG
HKP
HLA/HLB
HLAG/HLBG
HEP
HCP
HMF
HMFB
HFP
HLC
HGP
FH500
HBL
HDL
HMD
HJL
BHE
CKG
CK
CKA
CKS
CKF
CKJ
CKL2
CKL2-*-HC
CKH2
CKLB2
NCK/SCK/FCK
FJ
FK
Ending

Dimensions

- Standard (FCK-*-*)



- Capped (FCK-*-*-C)

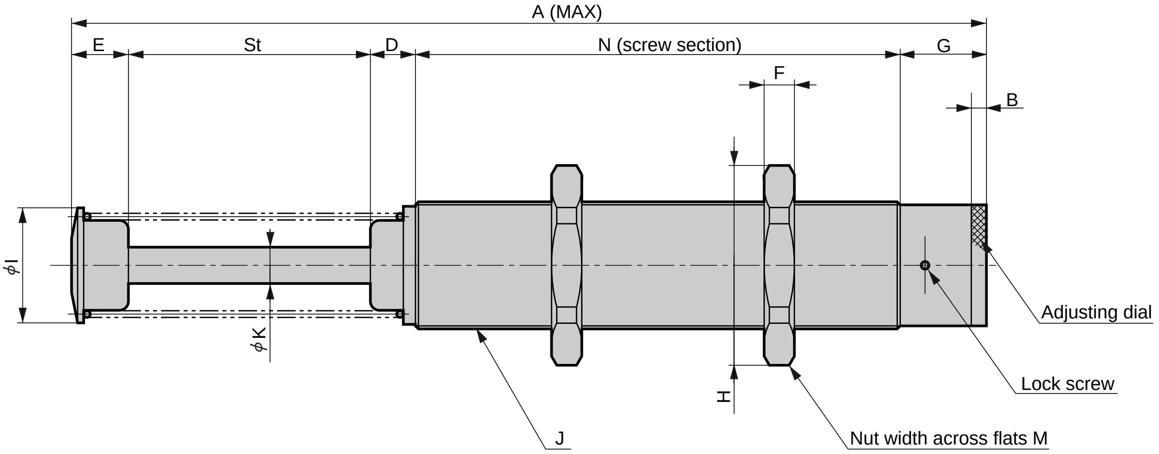


Model no.	A	A★	B	C	St	D	E	F	G	H	I	J	K	N	M
FCK-L-0.15	58.9	65.2	3.5	50.9	8	1.5	6.3	3	8.7	14.2	6	M10×1	2.4	42.2	13
FCK-$^{M}_{H}$-0.18															
FCK-L-0.3	76	84	-	66	10	1.5	8	4	5	16.2	8	M12×1	3.5	61	14
FCK-$^{M}_{H}$-0.5															
FCK-L-0.4	80	88	6	70	10	1.5	8	6	11	19.6	10	M14×1.5	3.5	59	17
FCK-$^{M}_{H}$-0.6															
FCK-*-1	102	117	4.5	90	12	-	15	6	14.5	20	13.5	M16×1.5	5	75.5	19
FCK-*-3	110	127	4	94	16	-	17	8	18	27.7	18	M20×1.5	6	76	24
FCK-*-5	155	173	-	125	30	-	18	10	15	37	22	M25×1.5	8	110	32
FCK-*-8.1	136	156	5	111	25	-	20	10	20	37	24	M27×1.5	8	91	32
FCK-$^{M}_{H}$-20	188	206.5	5	153	35	-	18.5	14	25	41.6	27	M30×1.5	10	128	36
FCK-$^{M}_{H}$-40	235	254.5	5	185	50	-	19.5	15	25	53.1	33	M36×1.5	12	160	46

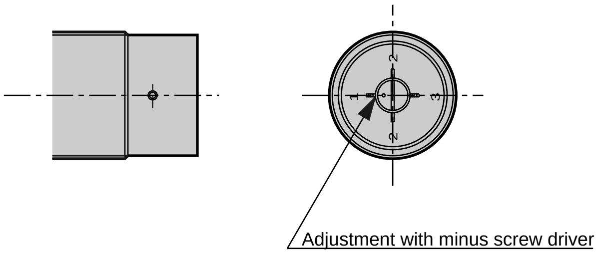
Note: The above table * shows low speed (L), medium speed (M), and high speed (H).

Dimensions

● FCK-*- 6.5 / 45 / 73.5 -C

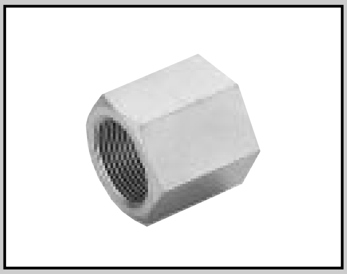


FCK-*-6.5-C
FCK-$^{M}_{H}$-45-C



Model no.	A	B	St	D	E	F	G	H	I	J	K	N	M
FCK-*-6.5-C	200.5	-	40	6.5	29	10	15	37	22	M25×1.5	8	110	32
FCK-$^{M}_{H}$-45-C	212.5	-	50	7	19	25	23	66	38	M42×1.5	12	113.5	60
FCK-$^{M}_{H}$-73.5-C	302.5	5	80	15	19	25	28.5	66	38	M42×1.5	12	160	60

Note: The above table * shows low speed (L), medium speed (M), and high speed (H).



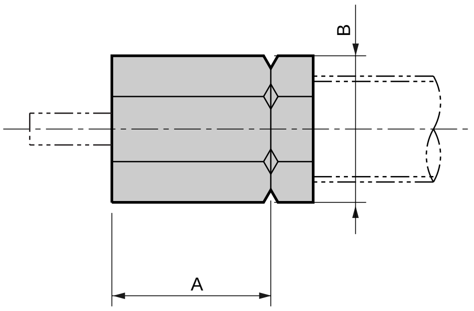
Shock absorber FCK Series optional parts

FCK-*-N1/FCK-*-C-N1

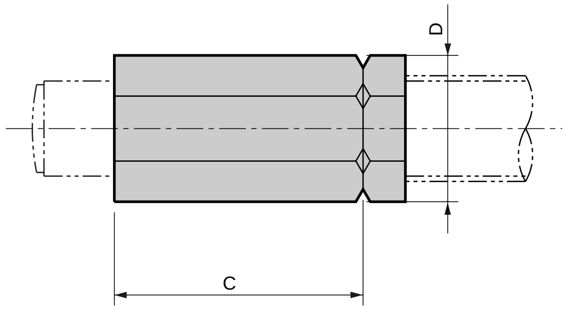
(Stopper nut)

Dimensions

● FCK-*-N1 (standard type)



● FCK-*-C-N1 (capped type)



(Standard type)

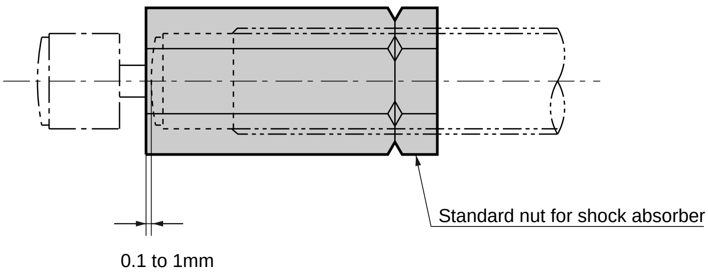
Model no.	Applicable model	A	B
FCK-0.18-N1	FCK-L-0.15 FCK-M-0.18 FCK-H-0.18	10	15
FCK-0.5-N1	FCK-L-0.3 FCK-M-0.5 FCK-H-0.5	12	16.2
FCK-0.6-N1	FCK-L-0.4 FCK-M-0.6 FCK-H-0.6	12	19.6
FCK-1-N1	FCK-L-1 FCK-M-1 FCK-H-1	15	21.9
FCK-3-N1	FCK-L-3 FCK-M-3 FCK-H-3	30	27.7
FCK-5-N1	FCK-L-5 FCK-M-5 FCK-H-5	20	37
FCK-8.1-N1	FCK-L-8.1 FCK-M-8.1 FCK-H-8.1	35	37
FCK-20-N1	FCK-M-20 FCK-H-20	38	41.6
FCK-40-N1	FCK-M-40 FCK-H-40	45	53.1

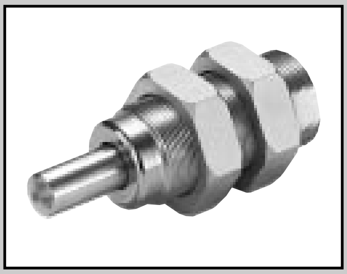
(Capped type)

Model no.	Applicable model	C	D	E	F
FCK-0.18-C-N1	FCK-L-0.15-C FCK-M-0.18-C FCK-H-0.18-C	16	15	13	M10×1
FCK-0.5-C-N1	FCK-L-0.3-C FCK-M-0.5-C FCK-H-0.5-C	16	16.2	14	M12×1
FCK-0.6-C-N1	FCK-L-0.4-C FCK-M-0.6-C FCK-H-0.6-C	20	19.6	17	M14×1.5
FCK-1-C-N1	FCK-L-1-C FCK-M-1-C FCK-H-1-C	30	21.9	19	M16×1.5
FCK-3-C-N1	FCK-L-3-C FCK-M-3-C FCK-H-3-C	47	27.7	24	M20×1.5
FCK-5-C-N1	FCK-L-5-C FCK-M-5-C FCK-H-5-C	32	37	32	M25×1.5
FCK-6.5-C-N1	FCK-L-6.5-C FCK-M-6.5-C FCK-H-6.5-C	50	37	32	M25×1.5
FCK-8.1-C-N1	FCK-L-8.1-C FCK-M-8.1-C FCK-H-8.1-C	55	37	32	M27×1.5
FCK-20-C-N1	FCK-M-20-C FCK-H-20-C	58	41.6	36	M30×1.5
FCK-40-C-N1	FCK-M-40-C FCK-H-40-C	65	53.1	46	M36×1.5

1 When using stopper nut, please note on following points.

- If no caps, use this with extending 0.1mm to 1mm forward to piston rod direction from shock absorber (cylinder top).
  If capped, uses this with extending cap length plus 0.5mm to 1mm forward to piston rod direction from shock absorber (cylinder section).
- Fix with standard nut for shock absorber after stopper nut is installed.
- This can not be used with deflection angle adaptor.





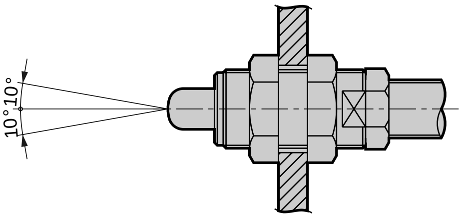
Shock absorber FCK Series optional parts

FCK-*-A

(Deflection angle adaptor)

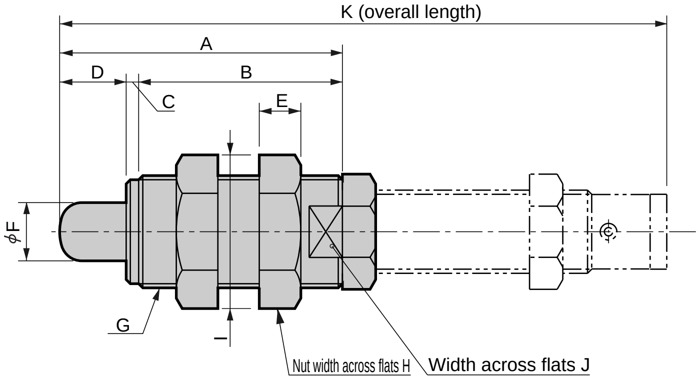
Specifications

Max. working deflection angle ±10°



Dimensions

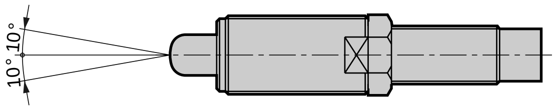
● FCK-*-A



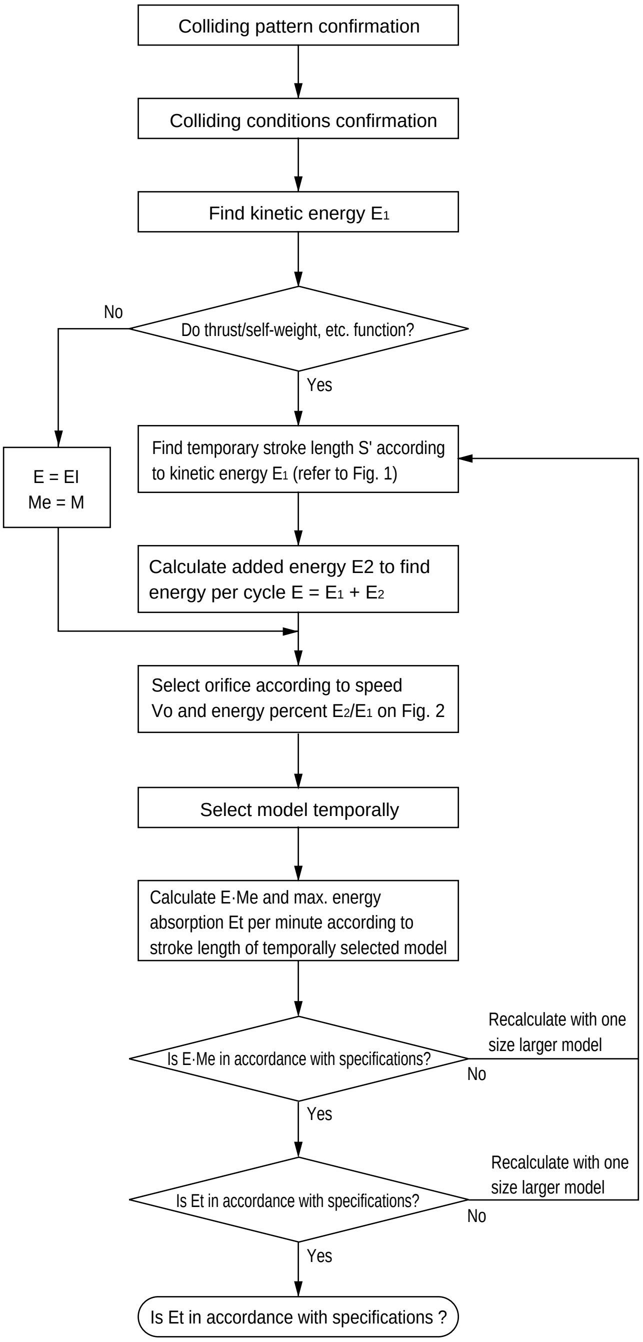
Model no.	Applicable model	A	B	C	D	E	F	G	H	I	J	K	End section material
FCK-0.18-A	FCK-L-0.15 FCK-M-0.18 FCK-H-0.18	38	28	2	8	6	8	M16×1.5	19	21.9	13	75.7	Plastic (POM)
FCK-0.5-A	FCK-L-0.3 FCK-M-0.5 FCK-H-0.5	48	35	3	10	5	10	M18×1.5	21	24.3	14	97.8	
FCK-0.6-A	FCK-L-0.4 FCK-M-0.6 FCK-H-0.6	51	38	3	10	7	11	M22×1.5	24	27.7	19	103	
FCK-1-A	FCK-L-1 FCK-M-1 FCK-H-1	60	45	3	12	7	12	M22×1.5	24	27.7	19	129	
FCK-3-A	FCK-L-3 FCK-M-3 FCK-H-3	68	49	3	16	10	14	M27×1.5	32	37	24	146	Iron system
FCK-5-A	FCK-L-5 FCK-M-5 FCK-H-5	107.5	67.5	10	30	15	16	M36×1.5	46	53.1	32	212	
FCK-8.1-A	FCK-L-8.1 FCK-M-8.1 FCK-H-8.1	97	62	10	25	15	16	M36×1.5	46	53.1	32	188	
FCK-20-A	FCK-M-20 FCK-H-20	127	82	10	35	15	18	M40×1.5	50	57.7	36	255	
FCK-40-A	FCK-M-40 FCK-H-40	167	107	10	50	15	20	M45×1.5	55	63.5	41	322	

1 When using deflection angle adaptor, please note on following points.

- To be ±10℃ or less from center line of cap section of adaptor for deflection angle.
- This can not be used with stopper nut.
- Not available for capped type.

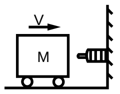
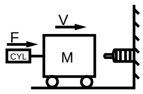
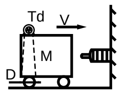
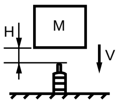
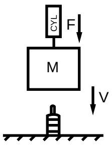
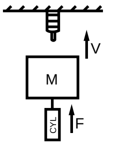
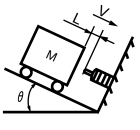
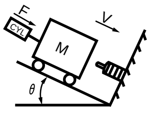
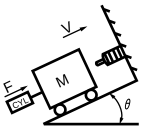
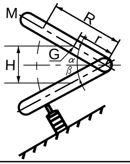
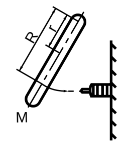
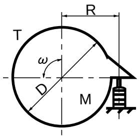


Selection guide flow chart



Symbol	Working conditions	Unit
E	Absorbed energy	J
E_1	Kinetic energy	J
E_2	Thrust/self-weight energy	J
G	Position of center of gravity	
S	FCK stroke length	m
g	Gravity acceleration (9.8)	m/s^2
N	Number of rotation	rpm
Me	Colliding object equivalent weight	kg
Td	Motor start torque	N·m
K	Reduction ratio	

Example of colliding pattern

	Horizontal colliding		
	a. Simple horizontal colliding	**b.** Thrust of cylinder applies	**c.** Drive force of motor applies
Applications			
Kinetic energy E_1 (J)	$E_1 = \frac{1}{2}\cdot M\cdot V^2$	$E_1 = \frac{1}{2}\cdot M\cdot V^2$	$E_1 = \frac{1}{2}\cdot M\cdot V^2$
Thrust/self energy E_2 (J)	——	$E_2 = F\cdot S$	$E_2 = 2\cdot\frac{K}{D}\cdot Td\cdot S$
All absorbed energy E (J)	$E = E_1$	$E = E_1 + E_2$	$E = E_1 + E_2$
Colliding object equiv. weight Me (kg)	$Me = M$	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}$
Absorbed energy per hour E_t (J/h)	$E_t = 60\cdot E\cdot n$	$E_t = 60\cdot E\cdot n$	$E_t = 60\cdot E\cdot n$
	Vertical colliding		
	d. Free drop	**e.** Cylinder lower limit stopper	**f.** Cylinder upper limit stopper
Applications			
Kinetic energy E_1 (J)	$E_1 = \frac{1}{2}\cdot M\cdot V^2$	$E_1 = \frac{1}{2}\cdot M\cdot V^2$	$E_1 = \frac{1}{2}\cdot M\cdot V^2$
Thrust/self energy E_2 (J)	$E_2 = M\cdot g\cdot S$	$E_2 = (M\cdot g + F)\cdot S$	$E_2 = (F\text{-}M\cdot g)\cdot S$
All absorbed energy E (J)	$E = E_1 + E_2$	$E = E_1 + E_2$	$E = E_1 + E_2$
Colliding object equiv.weight Me (kg)	$Me = \frac{2\cdot E}{V^2}(V = \sqrt{2\cdot g\cdot H})$	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}$
Absorbed energy per hour E_t (J/h)	$E_t = 60\cdot E\cdot n$	$E_t = 60\cdot E\cdot n$	$E_t = 60\cdot E\cdot n$
	Slope colliding		
	g. Free drop	**h.** Thrust of cylinder applies	**i.** Thrust of cylinder applies
Applications			
Kinetic energy E_1 (J)	$E_1 = \frac{1}{2}\cdot M\cdot V^2$	$E_1 = \frac{1}{2}\cdot M\cdot V^2$	$E_1 = \frac{1}{2}\cdot M\cdot V^2$
Thrust/self energy E_2 (J)	$E_2 = M\cdot g\cdot S\cdot \sin\theta$	$E_2 = (M\cdot g\cdot \sin\theta + F)\cdot S$	$E_2 = (F\text{-}M\cdot g\cdot \sin\theta)\cdot S$
All absorbed energy E (J)	$E = E_1 + E_2$	$E = E_1 + E_2$	$E = E_1 + E_2$
Colliding object equiv. weight Me (kg)	$Me = \frac{2\cdot E}{V^2}(V = \sqrt{2\cdot g\cdot L\cdot \sin\theta})$	$Me = \frac{2\cdot E}{V^2}$	$Me = \frac{2\cdot E}{V^2}$
Absorbed energy per hour E_t (J/h)	$E_t = 60\cdot E\cdot n$	$E_t = 60\cdot E\cdot n$	$E_t = 60\cdot E\cdot n$
	Oscillation colliding		**Rotation colliding**
	j. Free drop	**k.** Motor, etc. torque applies	**l.** Motor, etc. torque applies
Applications			
Kinetic energy E_1 (J)	$E_1 = M\cdot g\cdot H$	$E_1 = \frac{J\cdot\omega^2}{2}$ or $\frac{1}{2}\cdot M\cdot V^2$	$E_1 = \frac{J\cdot\omega^2}{2} = \frac{M\cdot D^2\cdot\omega^2}{16}$
Thrust/self energy E_2 (J)	$E_2 = \frac{r}{R}\cdot M\cdot g\cdot S$	$E_2 = \frac{T}{R}\cdot S$	$E_2 = \frac{T}{R}\cdot S$
All absorbed energy E (J)	$E = E_1 + E_2$	$E = E_1 + E_2$	$E = E_1 + E_2$
Colliding object equiv. weight Me (kg)	$Me = \frac{2\cdot E}{V^2}(V = \frac{R}{r}\sqrt{\frac{3\cdot g\cdot H}{2}})$	$Me = \frac{2\cdot E}{V2}$ $(V = \omega\cdot R)$	$Me = \frac{2\cdot E}{V2}(V = \omega R,\ \omega = \frac{2\pi\cdot N}{60})$
Absorbed energy per hour E_t (J/h)	$E_t = 60\cdot E\cdot n$	$E_t = 60\cdot E\cdot n$	$E_t = 60\cdot E\cdot n$

Shock absorber selection guide

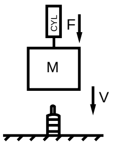
1 Make colliding pattern of device clear

- Horizontal motion
  - a. Simple horizontal colliding
  - b. Colliding with thrust of cylinder
  - c. Colliding with drive force of motor
- Vertical motion
  - d. Colliding by free drop
  - e. Colliding with thrust of cylinder (down)
  - f. Colliding with thrust of cylinder (up)
- Slope motion
  - g. Colliding by free slide
  - h. Colliding with thrust of cylinder (down)
  - i. Colliding with thrust of cylinder (up)
- Oscillation/rotary motion
  - j. Colliding by free oscillating drop
  - k. Colliding with motor, etc. torque (oscillation)
  - l. Colliding with motor, etc. torque (rotation)

Note: Refer to "Example of colliding pattern".

Example of selection

Make colliding pattern of device clear

Applications	Vertical colliding e. Cylinder lower limit stopper 
Kinetic energy E_1 (J)	$E_1 = \frac{1}{2} \cdot M \cdot V^2$
Thrust/gravity energy E_2 (J)	$E_2 = (Mg + F)/S$
All absorbed energy E (J)	$E = E_1 + E_2$
Colliding object equivalent weight Me (kg)	$Me = \frac{2 \cdot E}{V^2}$
Absorbed energy per hour E_t (J/h)	$E_t = 60 \cdot E \cdot n$

2 Make required conditions/descriptions clear to calculate energy

● Horizontal colliding

Symbol	Working conditions	Unit
M	Colliding object weight	kg
V	Colliding speed	m/s
F	Pressure	N
n	Frequency	cycle/min.
t	Ambient temperature	℃
Rt	Return time	s

Vertical colliding

Symbol	Working conditions	Unit
M	Colliding object weight	kg
V	Colliding speed	m/s
F	Pressure	N
n	Frequency	cycle/min.
t	Ambient temperature	℃
Rt	Return time	s
H	Drop height	m

Slope colliding

Symbol	Working conditions	Unit
M	Colliding object weight	kg
V	Colliding speed	m/s
F	Pressure	N
n	Frequency	cycle/min.
t	Ambient temperature	℃
Rt	Return time	s
L	Colliding object moving distance	m
θ	Angle degree	deg

Vibration/rotation colliding

Symbol	Working conditions	Unit
M	Colliding object weight	Kg
V	Colliding speed	m/s
T	Torque	N·m
n	Frequency	cycle/min.
t	Ambient temperature	℃
Rt	Return time	s
ω	Angular speed	rad/s
J	Moment of inertia	$kg \cdot m^2$
R	*1	m
r	*2	m
$\alpha \cdot \beta$	Angle degree	deg
H	Drop height	m
D	Rotor diameter	m

*1 Distance from center of rotation to colliging point
*2 Distance from center of rotation to center of gravity

Colliding object weight : M = 15kg
Colliding speed : V = 1.42m/s
Pressure : F = 245.5N
Frequency : n = 10 cycle/min.
Ambient temperature : t = 23℃
Return time : Rt = 2s (hour up to re-colliding)

3 Calculate kinetic energy E_1 according to "Example of colliding pattern"

● Calculate kinetic energy E_1 according to "Example of colliding pattern" (page 538).

$$E = \frac{1}{2} M \cdot V^2 = \frac{1}{2} \times 15 \times 1.42^2$$

$$= 15.1J$$

4 Select temporary stroke length according to temporary selection graph

● Select temporary stroke length on figure 1 (page 541).

S' = 30

5 Calculate absorbed energy E according to "Example of colliding pattern"

- Calculate thrust/self weight energy E_2 according to "Example of colliding pattern".
  Calculate S (stroke length of FCK) in expression with temporary stroke length S' selected at Step 4.
  Calculate absorbed energy E according to "Example of colliding pattern".

6 Shock absorber temporary selection

- Select orifice type according to energy percent (thrust/self weight energy, kinetic energy) on Fig. 2 (page 541), then select a model temporally according to calculated absorbed energy E.

  Note 1: Allowable energy absorption may vary depending on colliding speed. Refer to pages 542 to 543.

7 Re-calculate absorbed energy E with temporally selected model

- Calculate absorbed energy E_2 according to "Example of colliding pattern".
  Calculate S (stroke length of FCK) in expression with temporary stroke length S' selected at Step 6.
- Calculate absorbed energy E according to "Example of colliding pattern".

8 Calculate energy Et per hour

- Calculate energy per hour Et according to "Example of colliding pattern".

9 Check colliding object equivalent weight M

- Calculate colliding object equivalent weight M according to "example of colliding pattern".

10 Selection confirmation

- If calculated absorbed energy, energy per hour, colliding object equivalent weight, cycle rate, ambient temperature and return time are in accordance with specifications of selected shock absorber, it is OK. If exceeding specifications range, select one size larger shock absorber according to model, selected before, then recalculate conditions.

Example of selection

$E_2 = (M \cdot g + F) \cdot S = (15 \times 9.8 + 245.5) \times 0.03$
$= 11.8J$

$E = E_1 + E_2 = 15.1 + 11.8 = 26.9J$

$$\frac{E_2}{E_1} = \frac{11.8}{15.1} = 0.8$$

Select porous orifice (FCK-H-3) from model larger than E = 26.9 temporally.

$E_2 = (15 \times 9.8 + 245.5) \times 0.016 = 6.28J$

$E = 15.1 + 6.28 = 21.4J$

$Et = 60 \cdot E \cdot n = 60 \times 21.4 \times 10 = 1284J/h$

$$Me = \frac{2E}{V^2} = \frac{2 \times 21.4}{1.42^2} = 21.2kg$$

		Calculated value	FCK-H-3 specified value	Judgment
E	J	21.4	29.4 or less	OK
Et	J/h	1284	20580 or less	OK
Me	kg	21.2	29 or less	OK
n	cycle/min.	10	60 or less	OK
t	℃	23	-5 to 70	OK
Rt	S	2	0.5 and over	OK

(CAUTION)
Use colliding speed just before colliding to shock absorber to select shock absorber by calculation. This speed differs from average speed (cylinder stroke/moving time).
Calculate speed just before colliding or find actual speed, or use 1.5 to twice average speed for selecting model by calculation.

Fig. 1. Temporary selection graph

Obtain temporary stroke S' from kinetic energy E1.

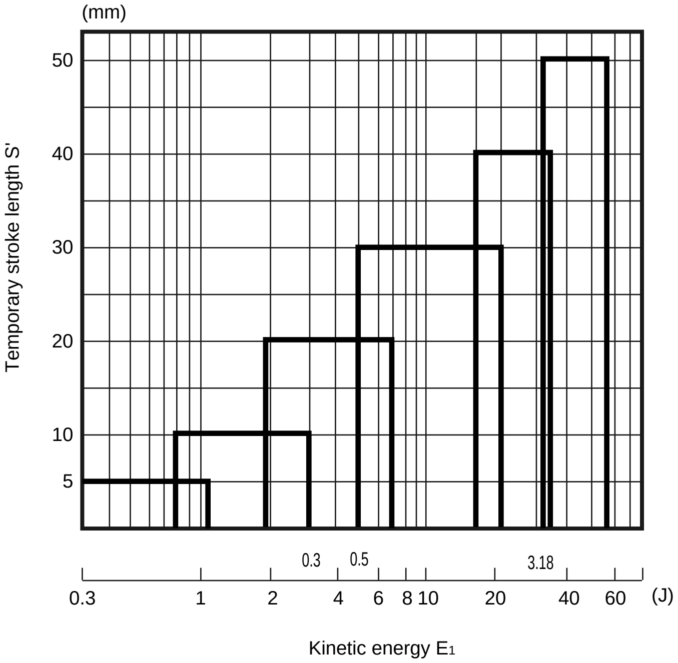
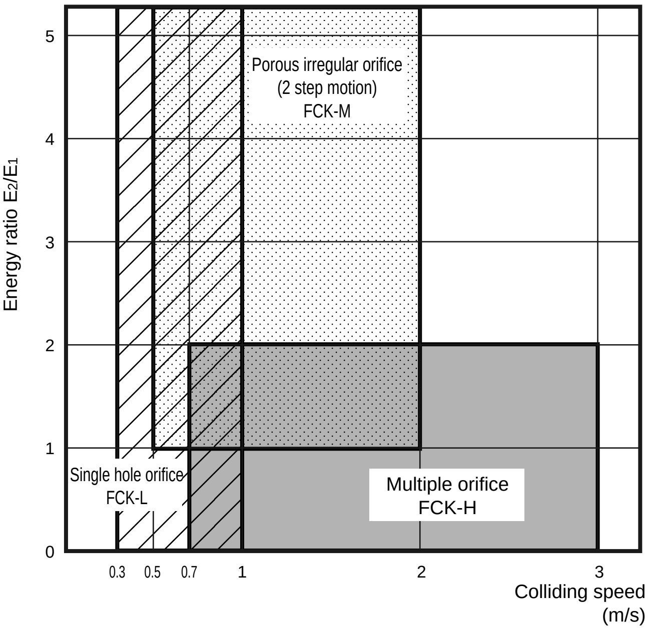
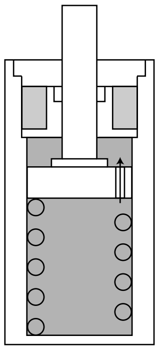
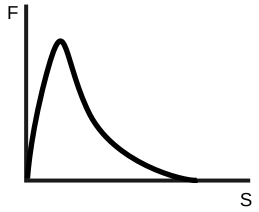
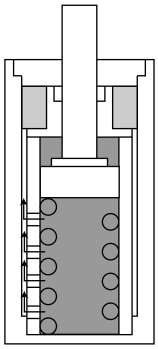
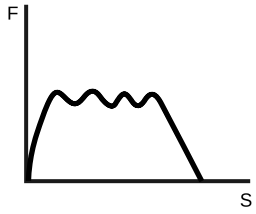
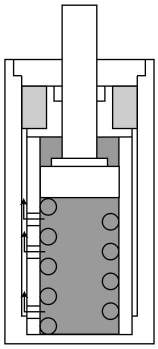
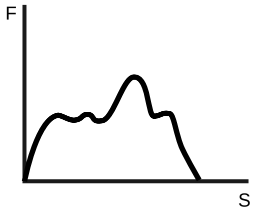


Fig. 2. Energy ratio (thrust/self weight energy, inertia energy E1)

Refer to the following diagram to select the orifice.



Absorbing characteristics structure

Constant orifice	Single hole orifice structure		Single hole orifices include a dash pot structure that uses the clearance between the piston and cylinder tube, a single tube structure that has an orifice on the piston, and a double tube single hole structure (adjustable). Each type has similar resistance characteristics. The common single tube structure is explained here. The piston, which has a single orifice, slides in the cylinder tube filled with oil. The orifice area is constant throughout the full stroke, so resistance increases immediately after collision, and decreases as the stroke advances and speed drops.	
Displacement reliant orifice	Multiple orifice structure		This orifice has a double structure consisting of an outer and inner tubes. The piston slides along the inner wall of the inner tube. This inner tube has several orifices set in the direction of the stroke. The orifice area gradually decreases as the stroke advances and speed drops. Resistance thus fluctuates in a wave, but maximum resistance is suppressed at a low level. Based on orifice design, absorption characteristics are matched to individual collision conditions.	
	Porous irregular orifice structure		Structurally, this type is basically the same as the multiple orifice above, but by changing the orifice, energy is absorbed based on the purpose instead of with constant attenuation force. For example, the orifice in the FCK-M Series absorbs kinetic energy with the first half of the stroke and controls speed with the second half. Energy is absorbed ideally for cylinder thrust.	

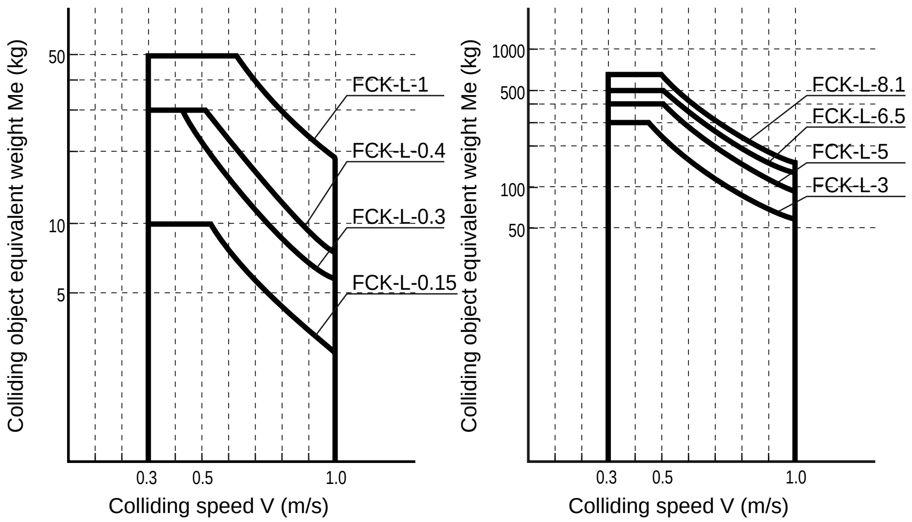
Colliding object equivalent weight / colliding speed characteristics graph

Colliding object equivalent weight:
Weight obtained by calculating all cylinder thrust and weight mass as inertial energy.

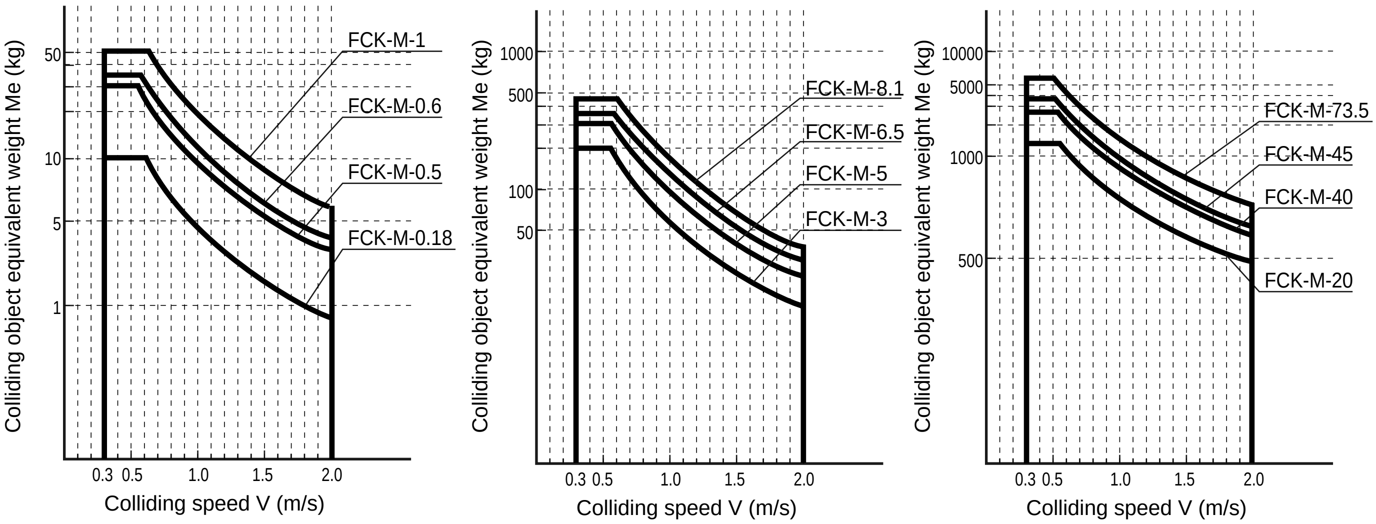
$$\frac{1}{2}MV^2 + F \cdot S = E = MeV^2$$

M: Colliding object weight
F: Self weight of cylinder thrust or weight
Me: Colliding object equivalent weight

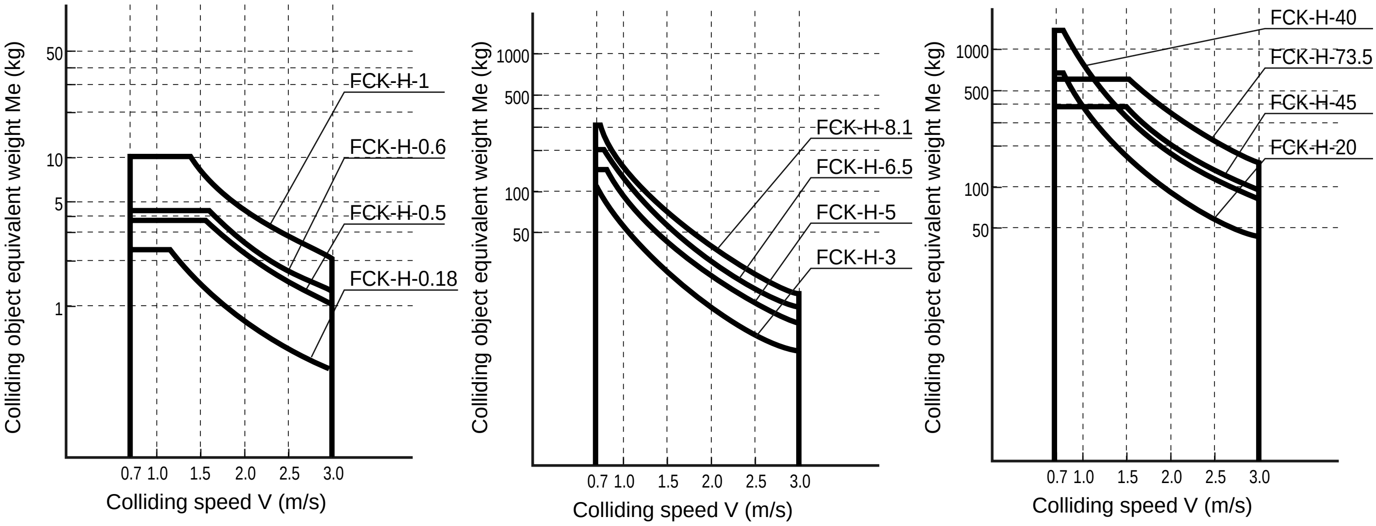
Single hole orifice (FCK-L)



Porous irregular orifice (FCK-M)

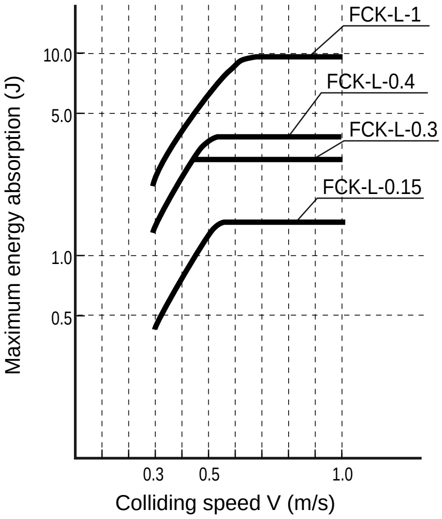


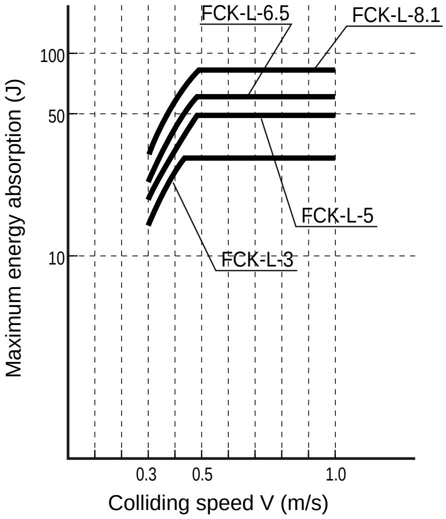
Multiple orifice (FCK-H)



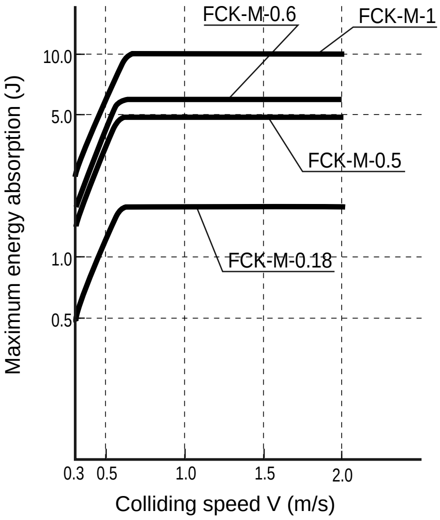
Absorbed energy / colliding speed characteristics graph

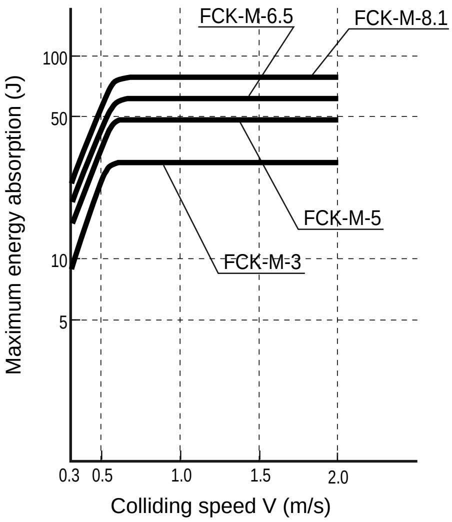
Single hole orifice (FCK-L)

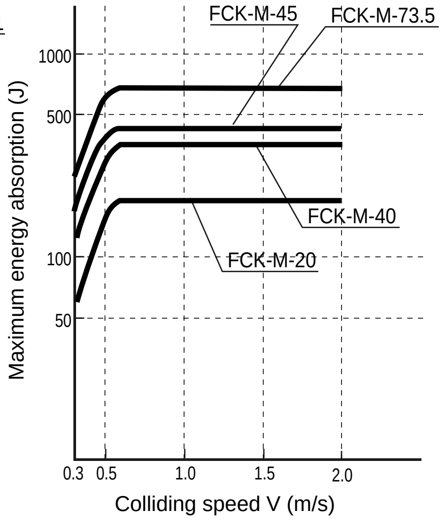




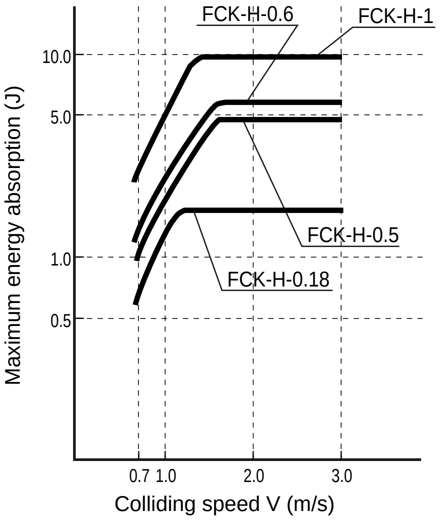
Porous irregular orifice (FCK-M)

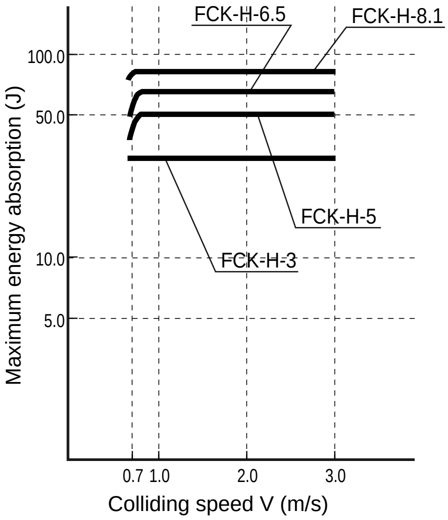


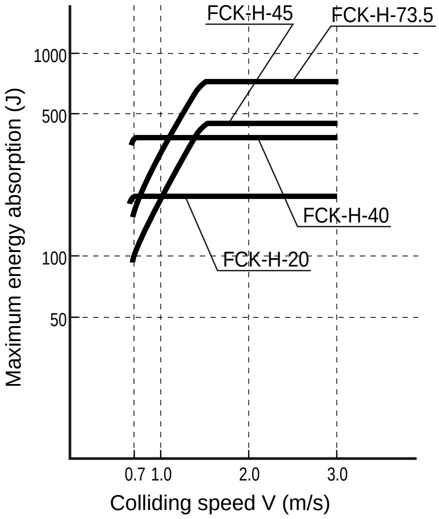




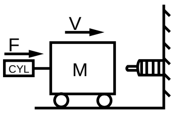
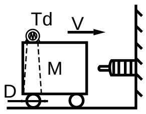
Multiple orifice (FCK-H)

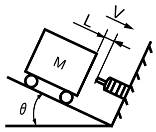
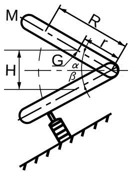


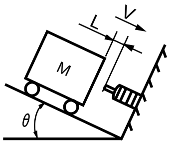
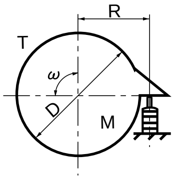




Example of selecting model by calculation

	Selection example 1	Selection example 2
1. Applications	Horizontal colliding with thrust of cylinder  Cylinder bore size = ϕ 40 Pressure = 0.5MPa	Horizontal colliding with drive force of motor  Motor start torque Td = 0.196N·m Wheel diameter of carriage D = 50mm Reduction ratio of carriage K = 10
2. Colliding conditions	M = 30kg V = 0.6m/s F = 628.3N $(F = \frac{\pi}{4} \times 40^2 \times 0.5 = 628.4N)$ n = 20 cycle/min. t = 23℃ Rt = 3S	M = 150kg V = 0.785m/s F = 78.4N $(F = 2 \cdot \frac{K}{D} \cdot Td = 2 \times \frac{10}{0.05} \times 0.196 = 78.4N)$ n = 5 cycle/min t = 23℃ Rt = 2S
3. Kinetic energy E_1	$E_1 = \frac{1}{2} MV^2 = \frac{1}{2} \times 30 \times 0.6^2 = 5.4J$	$E1 = \frac{1}{2} MV^2 = \frac{1}{2} \times 150 \times 0.785^2 = 46.2J$
4. Temporary stroke length S'	S' = 20mm from Fig. 1	S' = 50mm from Fig. 1
5. Thrust/self-weight Energy E_2 Absorbed energy E	$E_2 = F \cdot S = 628.3 \times 0.02 = 12.57J$ $E = E_1 + E_2 = 5.4 + 12.57 = 17.97J$	$E_2 = 2 \cdot \frac{K}{D} \cdot Td \cdot S = 2 \times \frac{10}{0.05} \times 0.196 \times 0.05$ $= 3.92J$ $E = E_1 + E_2 = 46.2 + 3.92 = 50.12J$
6. Temporary selection	$\frac{E_2}{E_1} = \frac{12.57}{5.4} = 2.3$ Select porous irregular orifice (FCK-M-3) temporally	$\frac{E_2}{E_1} = \frac{3.92}{46.2} = 0.08$ Select multiple orifice (FCK-H-6.5) temporally
7. Recalculation of absorbed energy	$E_2 = F \cdot S = 628.3 \times 0.016 = 10.05J$ $E = E_1 + E_2 = 15.45J$	$E_2 = 2 \cdot \frac{K}{D} \cdot Td \cdot S = 2 \times \frac{10}{0.05} \times 0.196 \times 0.04$ $= 3.14J$ $E = E_1 + E_2 = 49.34J$
8. Energy per hour Et	$Et = 60 \cdot E \cdot n \times E \cdot n = 60 \times 15.45 \times 20 = 18540J/h$	$Et = 60 \times E \cdot n = 60 \times 49.34 \times 5 = 14802J/h$
9. Colliding object equivalent weight Me	$Me = \frac{2E}{V^2} = 85.8kg$	$Me = \frac{2E}{V^2} = \frac{2 \times 49.34}{0.785^2} = 160kg$
10. Confirmation	All of E, Et, Me, n, t and Rt are OK Determine FCK-M-3	All of E, Et, Me, n, t and Rt are OK Determine FCK-H-6.5

Selection example 3	Selection example 4
Carriage dropping slope  L = 1m $\theta = 2°$	Body performing rotational free drop  $\alpha = 15°$ $\beta = 5°$
M = 100kg V = 0.83m/s $(V = \sqrt{2 \cdot g \cdot L \cdot \sin\theta} = \sqrt{2\times 9.8\times 1\times \sin2°} = 0.83\text{m/s})$ n = 10 cycle/min. t = 23℃ Rt = 5S	M = 2kg R = 0.5m H = 0.1m r = 0.3m $(V = \frac{R}{r} = \sqrt{\frac{3 \cdot g \cdot H}{2}} = \frac{0.5}{0.3}\sqrt{\frac{3\times 9.8\times 0.1}{2}} = 2.02\text{m/s})$ n = 50 cycle/min. t = 20℃ Rt = 0.6S
$E_1 = \frac{1}{2} \cdot M \cdot V^2 = \frac{1}{2} \times 100 \times 0.83^2 = 34.4\text{J}$	$E_1 = M \cdot g \cdot H = 2\times 9.8\times 0.1 = 1.96\text{J}$
S' = 50mm from Fig. 1	S' = 10mm from Fig. 1
$E_2 = M \cdot g \cdot S \cdot \sin\theta = 100\times 9.8\times 0.05\times \sin2° = 1.71\text{J}$ $E = E_1 + E_2 = 34.4 + 1.71 = 36.1\text{J}$	$E_2 = \frac{r}{R} \cdot M \cdot g \cdot S \cdot \cos\beta = \frac{r}{R} \times 2\times 9.8\times 0.01\times \cos5℃ = 0.11\text{J}$ $E = E_1 + E_2 = 1.96 + 0.11 = 2.07\text{J}$
$\frac{E_2}{E_1} = \frac{1.71}{34.4} = 0.05$ Select multiple orifice (FCK-H-5) temporally	$\frac{E_2}{E_1} = \frac{0.11}{1.96} = 0.06$ Select multiple orifice (FCK-H-0.5) temporarily
$E_2 = M \cdot g \cdot S \cdot \sin\theta = 100\times 9.8\times 0.03\times \sin2° = 1.03\text{J}$ $E = E_1 + E_2 = 35.4\text{J}$	$E_2 = \frac{r}{R} \cdot M \cdot g \cdot S \cdot \cos\beta = 0.11\text{J}$ $E = E_1 + E_2 = 1.96 + 0.11 = 2.07\text{J}$
$Et = 60 \cdot E \cdot n = 60\times 35.4\times 10 = 21240\text{J/h}$	$Et = 60 \cdot E \cdot n = 60\times 2.07\times 50 = 6210\text{J/h}$
$Me = \frac{2E}{V^2} = \frac{2\times 35.4}{0.83^2} = 102.7\text{kg}$	$Me = \frac{2E}{V^2} = \frac{2\times 2.07}{2.02^2} = 1.0\text{kg}$
All of E, Et, Me, n, t and Rt are OK. Determine FCK-H-5	E, Me, n, t and Rt are OK. However, recalculate with one size larger FCK-H-0.6, since Et is overflow.

Selection example 5	Selection example 6
Body falling slope down  L = 0.45m θ = 5°	Horizontal rotational colliding with torque 
M = 1.0kg V = 0.88m/s (V = $\sqrt{2\cdot g\cdot L\cdot \sin\theta} = \sqrt{2\times 9.8\times 0.45\times \sin 5°} = 0.88$m/s) n = 15 cycle/min. t = 23℃ Rt = 2S	J = 204.1kgm^2 ω = 0.6rad/s R = 1.25m n = 10 cycle/min. T = 68.6N·m t = 20℃ Rt = 3s
$E_1 = \frac{1}{2}\cdot M\cdot V^2 = \frac{1}{2}\times 1.0\times 0.88^2 = 0.387J$	$E_1 = \frac{J\cdot\omega^2}{2} = \frac{204.1\times 0.6^2}{2} = 36.7J$
S' = 5mm from Fig. 1	S' = 50mm from Fig. 1
$E_2 = M\cdot g\cdot S\cdot \sin\theta = 1\times 9.8\times 0.005\times \sin 5° = 0.004J$ $E = E_1 + E_2 = 0.387 + 0.004 = 0.391J$	$E_2 = \frac{T}{R}\cdot S = \frac{68.6}{1.25}\times 0.05 = 2.74J$ $E = E_1 + E_2 = 36.7 + 2.74 = 39.44J$
$\frac{E_2}{E_1} = \frac{0.004}{0.387} = 0.01$ Select single hole orifice (FCK-L-0.15) temporally	$\frac{E_2}{E_1} = \frac{2.74}{36.7} = 0.07$ $V = \omega\cdot R = 0.6\times 1.25 = 0.75$m/s Select multiple orifice (FCK-H-5) temporally
$E_2 = M\cdot g\cdot S\cdot \sin\theta = 1\times 9.8\times 0.008\times \sin 5° = 0.007J$ $E = E_1 + E_2 = 0.394J$	$E_2 = \frac{T}{R}\cdot S = \frac{68.6}{1.25}\times 0.03 = 1.65J$ $E = E_1 + E_2 = 38.6J$
$Et = 60\cdot E\cdot n = 60\times 0.394\times 15 = 354.6$J/h	$Et = 60\cdot E\cdot n = 60\times 38.6\times 10 = 23160$J/h
$Me = \frac{2E}{V^2} = \frac{2\times 0.394}{0.88^2} = 1.02$kg	$Me = \frac{2E}{V^2} = \frac{2\times 38.6}{0.75^2} = 137.2$kg
All of E, Et, Me, n, t and Rt are OK. Determine FCK-L-0.15	E, Et, Me, n, t and Rt are OK. Determine FCK-H-5.