

# Shock absorber

## ACA, ACJ Series



### Product feature

1. Excellent and stable deceleration and shock absorbing; if impacted by load, the resistance will automatically adjust.
2. Outer body of integrated structure is treated by QPQ, which has optimum corrosion and wear resistance and can withstand high pressure; it is easy to install and adjust for all threaded outer body which has good heat dissipation.
3. With high hardness stainless steel shaft, the shock absorber has better impact and corrosion resistance, and it can work under adverse conditions.
4. Special oiling process leads to stable shock absorbing.
5. Compact structure and high max. absorbed energy.
6. We use Special lubricants as buffer medium, which adapts to wide temperature range and ensures stable cushioning.

### Specification

| Model   | Stroke (mm) | Max. energy absorbed (Nm) | Max. energy absorbed/hour (Nm/h) | Max. effective mass(kg) |              |           | Max. impact speed(m/s) |              |           | Weight (g) |
|---------|-------------|---------------------------|----------------------------------|-------------------------|--------------|-----------|------------------------|--------------|-----------|------------|
|         |             |                           |                                  | High speed              | Middle speed | Low speed | High speed             | Middle speed | Low speed |            |
| ACA0806 | 6           | 3                         | 5400                             | 5                       | 20           | 25        | 4                      | 2            | 1         | 12         |
| ACA1007 | 7           | 6                         | 14500                            | 10                      | 40           | 50        | 4                      | 2            | 1         | 26         |
| ACA1210 | 10          | 10                        | 30000                            | 18                      | 60           | 80        | 4                      | 2            | 1         | 40         |
| ACA1215 | 15          | 12                        | 35000                            | 20                      | 75           | 100       | 4                      | 2            | 1         | 48         |
| ACA1412 | 12          | 18                        | 36000                            | 30                      | 110          | 150       | 4                      | 2            | 1         | 70         |
| ACA1416 | 16          | 22                        | 39000                            | 40                      | 140          | 180       | 4                      | 2            | 1         | 78         |
| ACA1420 | 20          | 25                        | 45000                            | 45                      | 155          | 200       | 4                      | 2            | 1         | 85         |
| ACA2020 | 20          | 60                        | 50000                            | 240                     | 660          | 960       | 4                      | 2            | 1         | 175        |
| ACA2025 | 25          | 65                        | 54000                            | 260                     | 720          | 1040      | 4                      | 2            | 1         | 185        |
| ACA2030 | 30          | 70                        | 58000                            | 280                     | 780          | 1120      | 4                      | 2            | 1         | 210        |
| ACA2040 | 40          | 80                        | 65000                            | 320                     | 890          | 1280      | 4                      | 2            | 1         | 225        |
| ACA2525 | 25          | 100                       | 75000                            | 400                     | 1100         | 1600      | 4                      | 2            | 1         | 290        |
| ACA2550 | 50          | 150                       | 85000                            | 600                     | 1650         | 2400      | 4                      | 2            | 1         | 370        |
| ACA2725 | 25          | 140                       | 85000                            | 560                     | 1550         | 2240      | 4                      | 2            | 1         | 372        |
| ACA2750 | 50          | 250                       | 95000                            | 1000                    | 2780         | 4000      | 4                      | 2            | 1         | 475        |
| ACA3325 | 25          | 180                       | 100000                           | 720                     | 2000         | 2880      | 4                      | 2            | 1         | 596        |
| ACA3350 | 50          | 300                       | 120000                           | 1200                    | 3300         | 4800      | 4                      | 2            | 1         | 750        |
| ACA3625 | 25          | 220                       | 135000                           | 880                     | 2400         | 3500      | 4                      | 2            | 1         | 702        |
| ACA3650 | 50          | 350                       | 150000                           | 1400                    | 2500         | 5600      | 4                      | 2            | 1         | 889        |

| Model   | Stroke (mm) | Max. energy absorbed(Nm) | Max. energy absorbed/hour (Nm/h) | Max. effective mass(kg) | Max. impact speed(m/s) | Weight (g) |
|---------|-------------|--------------------------|----------------------------------|-------------------------|------------------------|------------|
| ACJ1007 | 7           | 6                        | 14500                            | 50                      | 4                      | 28         |
| ACJ1210 | 10          | 10                       | 30000                            | 80                      | 4                      | 43         |
| ACJ1412 | 12          | 20                       | 36000                            | 160                     | 4                      | 75         |
| ACJ2020 | 20          | 60                       | 50000                            | 960                     | 4                      | 189        |
| ACJ2525 | 25          | 100                      | 75000                            | 1600                    | 4                      | 308        |
| ACJ2550 | 50          | 150                      | 85000                            | 2400                    | 4                      | 395        |
| ACJ2725 | 25          | 140                      | 85000                            | 2240                    | 4                      | 396        |
| ACJ2750 | 50          | 250                      | 95000                            | 4000                    | 4                      | 510        |
| ACJ3325 | 25          | 180                      | 100000                           | 2880                    | 4                      | 540        |
| ACJ3350 | 50          | 300                      | 110000                           | 4800                    | 4                      | 800        |
| ACJ3625 | 25          | 220                      | 125000                           | 2500                    | 4                      | 750        |
| ACJ3650 | 50          | 350                      | 130000                           | 5600                    | 4                      | 950        |
| ACJ4225 | 25          | 350                      | 150000                           | 5600                    | 4                      | 1150       |
| ACJ4250 | 50          | 700                      | 180000                           | 11200                   | 4                      | 1420       |
| ACJ4275 | 75          | 1050                     | 210000                           | 16800                   | 4                      | 1720       |

### Ordering code

ACA 20 20-1 N

Model

ACA: Self-compensation type shock absorber

ACJ: Adjustable type shock absorber

Body male thread

08: M8

10: M10

12: M12

14: M14

20: M20

25: M25

27: M27

33: M33

36: M36

Prevention crash cap

|                  |                      |
|------------------|----------------------|
| Body male thread | Prevention crash cap |
| M20 and above    | Blank: Plastic cap   |
|                  | F: Iron cap          |
|                  | N: No cap            |
| M20 and below    | Blank: Plastic cap   |
|                  | N: No cap            |

Impact speed

|       |                              |
|-------|------------------------------|
| Model | Impact speed                 |
| ACA   | 1: High speed(Light load)    |
|       | 2: Middle speed(Middle load) |
|       | 3: Low speed(Heavy load)     |
| ACJ   | Not this code                |

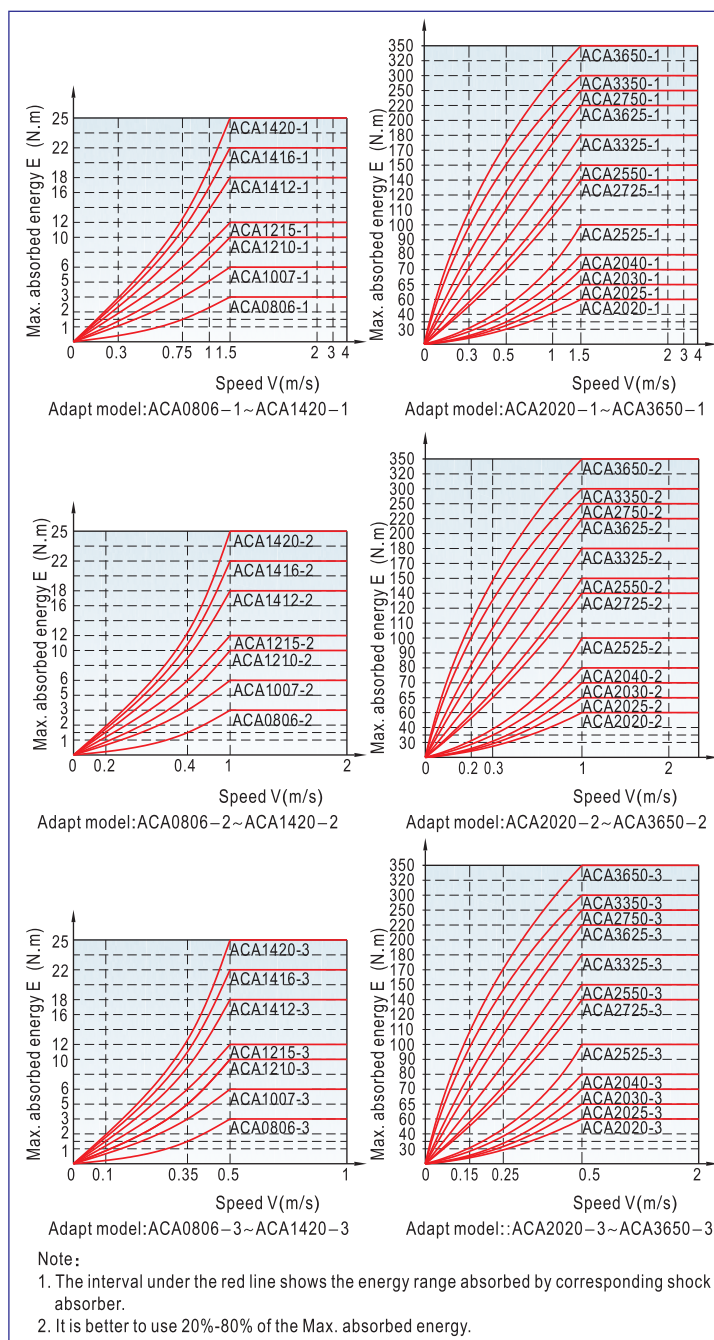
Stroke

The pecification for detail

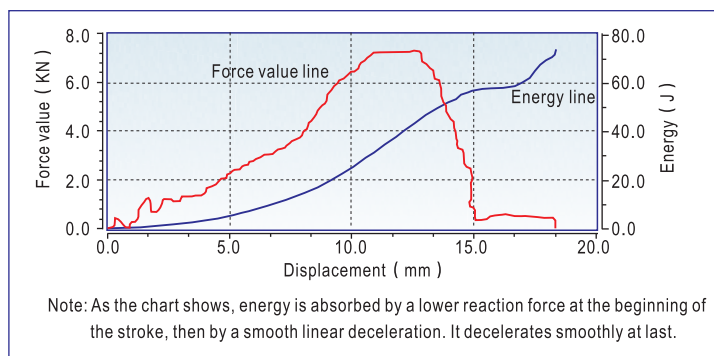
# Shock absorber

## ACA, ACJ Series

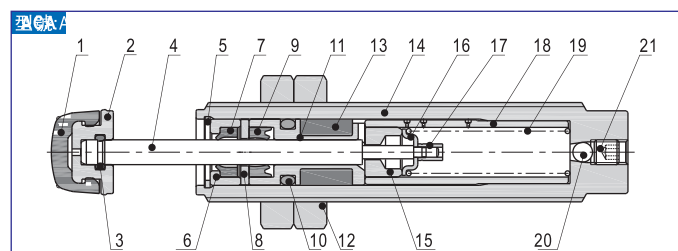
### Max. absorbed energy and speed curve



### Buffer curve

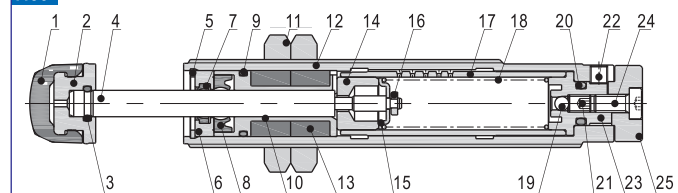


### Inner structure and material of major parts



| No. | Item               | Material                                            |
|-----|--------------------|-----------------------------------------------------|
| 1   | Bump cap           | PA66(M8)\TPU(M10~M14)\TPU or S45C(M20~M42)          |
| 2   | Bump cap(core)     | No(M8)\Cutting steel(Others)                        |
| 3   | O-ring             | NBR                                                 |
| 4   | Piston rod         | Stainless steel(M8~M27)\S45C (M33~M42)              |
| 5   | Clip               | No(M8~M10)\Spring steel(M12~M42)                    |
| 6   | Front cover        | Brass (M8)\ Cutting steel (M10)\Aluminum(M12~M42)   |
| 7   | Front cover gasket | No (M8)\ TPU(M10~M42)                               |
| 8   | Washer             | Spring steel                                        |
| 9   | Front cover gasket | NBR                                                 |
| 10  | O-ring             | NBR                                                 |
| 11  | Correcting body    | Brass                                               |
| 12  | Nut                | Ss41                                                |
| 13  | Accumulator        | Foamex                                              |
| 14  | Body               | Cutting steel                                       |
| 15  | Piston             | Brass                                               |
| 16  | Spring serat       | Spring steel                                        |
| 17  | Busher             | Copper(M8~M12)\Aluminum(M20~M27)                    |
| 18  | Inlet body         | Cutting steel (M8~M14)\Seamless steel tube(M20~M42) |
| 19  | Spring             | SWPB                                                |
| 20  | Steel ball         | GCr15                                               |
| 21  | Set screw          | Low alloy steel                                     |

### ACJ

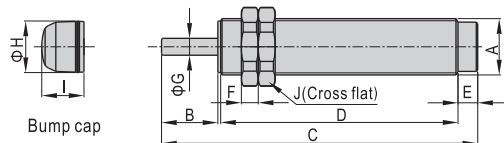


| No. | Item               | Material                                            |
|-----|--------------------|-----------------------------------------------------|
| 1   | Bump cap           | PA66(M8)\TPU(M10~M14)\TPU or S45C(M20~M42)          |
| 2   | Bump cap(core)     | No(M8)\Cutting steel(Others)                        |
| 3   | O-ring             | NBR                                                 |
| 4   | Piston rod         | Stainless steel (M8~M27)\S45C (M33~M42)             |
| 5   | Clip               | No(M8~M10)\Spring steel(M12~M42)                    |
| 6   | Front cover        | Brass (M8)\ Cutting steel (M10)\Aluminum(M12~M42)   |
| 7   | Front cover gasket | No (M8)\ TPU(M10~M42)                               |
| 8   | Front cover gasket | NBR                                                 |
| 9   | O-ring             | NBR                                                 |
| 10  | Correcting body    | Brass                                               |
| 11  | Nut                | SS41                                                |
| 12  | Body               | Cutting steel                                       |
| 13  | Accumulator        | Foamex                                              |
| 14  | Piston             | Brass                                               |
| 15  | Spring serat       | Spring steel                                        |
| 16  | Busher             | Copper(M8~M12)\Aluminum(M20~M27)                    |
| 17  | Inlet body         | Cutting steel (M8~M14)\Seamless steel tube(M20~M42) |
| 18  | Spring             | SWPB                                                |
| 19  | Ball               | GCr15                                               |
| 20  | O-ring             | NBR                                                 |
| 21  | Set screw          | Low alloy steel                                     |
| 22  | Set screw          | Low alloy steel                                     |
| 23  | Back cover         | Brass                                               |
| 24  | Screw              | Low alloy steel                                     |
| 25  | Knob               | Aluminum alloy                                      |

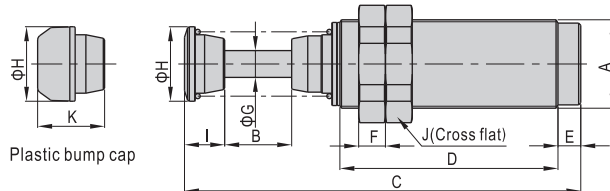
## ACA, ACJ Series

### ■ Dimensions

#### ACA

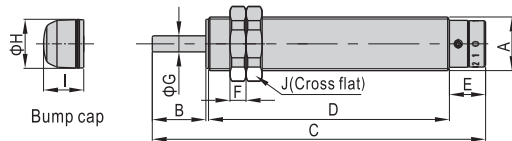


| Model\Item | A       | B  | C     | D     | E | F | G | H    | I   | J  |
|------------|---------|----|-------|-------|---|---|---|------|-----|----|
| ACA0806    | M8×1.0  | 6  | 45    | 31    | 5 | 4 | 3 | 6.5  | 6   | 11 |
| ACA1007    | M10×1.0 | 7  | 55    | 40    | 5 | 4 | 3 | 8.5  | 7.5 | 14 |
| ACA1210    | M12×1.0 | 10 | 62    | 46    | 5 | 4 | 3 | 10   | 7.5 | 17 |
| ACA1215    | M12×1.0 | 15 | 78    | 57    | 5 | 4 | 3 | 10   | 7.5 | 17 |
| ACA1412    | M14×1.5 | 12 | 80.5  | 62.5  | 5 | 6 | 4 | 12   | 12  | 19 |
| ACA1416    | M14×1.5 | 16 | 92.5  | 70.5  | 5 | 6 | 4 | 12   | 12  | 19 |
| ACA1420    | M14×1.5 | 20 | 103   | 77    | 5 | 6 | 4 | 12   | 12  | 19 |
| ACA2020    | M20×1.5 | 20 | 112.5 | 84.5  | 7 | 6 | 6 | 18   | 15  | 26 |
| ACA2025    | M20×1.5 | 25 | 122.5 | 89.5  | 7 | 6 | 6 | 18   | 15  | 26 |
| ACA2030    | M20×1.5 | 30 | 142   | 104   | 7 | 6 | 6 | 18   | 15  | 26 |
| ACA2040    | M20×1.5 | 40 | 167.5 | 119.5 | 7 | 6 | 6 | 18   | 15  | 26 |
| ACA2525    | M25×1.5 | 25 | 123   | 89    | 8 | 6 | 6 | 23   | 16  | 32 |
| ACA2550    | M25×1.5 | 50 | 183   | 124   | 8 | 6 | 6 | 23   | 16  | 32 |
| ACA2725    | M27×1.5 | 25 | 127   | 93    | 8 | 6 | 8 | 24.5 | 17  | 36 |
| ACA2750    | M27×1.5 | 50 | 192   | 133   | 8 | 6 | 8 | 24.5 | 17  | 36 |

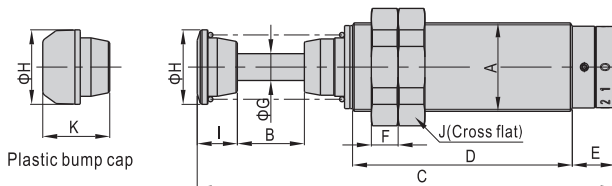


| Model\Item | A       | B  | C   | D     | E   | F  | G  | H    | I  | J  | K  |
|------------|---------|----|-----|-------|-----|----|----|------|----|----|----|
| ACA3325    | M33×1.5 | 25 | 148 | 81.5  | 8.5 | 10 | 10 | 27.8 | 15 | 41 | 25 |
| ACA3350    | M33×1.5 | 50 | 213 | 121.5 | 8.5 | 10 | 10 | 27.8 | 15 | 41 | 25 |
| ACA3625    | M36×1.5 | 25 | 148 | 81.5  | 8.5 | 10 | 10 | 27.8 | 15 | 46 | 25 |
| ACA3650    | M36×1.5 | 50 | 213 | 121.5 | 8.5 | 10 | 10 | 27.8 | 15 | 46 | 25 |

#### ACJ



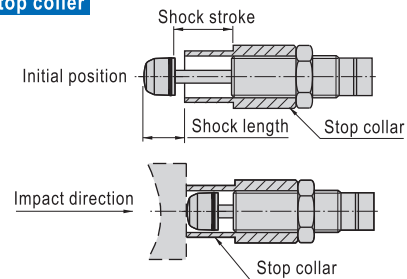
| Model\Item | A       | B  | C     | D     | E    | F | G | H    | I   | J  |
|------------|---------|----|-------|-------|------|---|---|------|-----|----|
| ACJ1007    | M10×1.0 | 7  | 66    | 45    | 11   | 4 | 3 | 8.5  | 7.5 | 14 |
| ACJ1210    | M12×1.0 | 10 | 73    | 51    | 11   | 4 | 3 | 10   | 7.5 | 17 |
| ACJ1412    | M14×1.5 | 12 | 91    | 66.5  | 11.5 | 6 | 4 | 12   | 12  | 19 |
| ACJ2020    | M20×1.5 | 20 | 124.5 | 90    | 13.5 | 6 | 6 | 18   | 15  | 26 |
| ACJ2525    | M25×1.5 | 25 | 132.5 | 92    | 14.5 | 6 | 6 | 23   | 16  | 32 |
| ACJ2550    | M25×1.5 | 50 | 192.5 | 127   | 14.5 | 6 | 6 | 23   | 16  | 32 |
| ACJ2725    | M27×1.5 | 25 | 137   | 96.5  | 14.5 | 6 | 8 | 24.5 | 17  | 36 |
| ACJ2750    | M27×1.5 | 50 | 202   | 136.5 | 14.5 | 6 | 8 | 24.5 | 17  | 36 |



| Model\Item | A       | B  | C     | D     | E  | F  | G  | H    | I  | J  | K  |
|------------|---------|----|-------|-------|----|----|----|------|----|----|----|
| ACJ3325    | M33×1.5 | 25 | 156   | 82    | 16 | 10 | 10 | 27.8 | 15 | 41 | 25 |
| ACJ3350    | M33×1.5 | 50 | 221   | 122   | 16 | 10 | 10 | 27.8 | 15 | 41 | 25 |
| ACJ3625    | M36×1.5 | 25 | 156   | 82    | 16 | 10 | 10 | 27.8 | 15 | 46 | 25 |
| ACJ3650    | M36×1.5 | 50 | 221   | 122   | 16 | 10 | 10 | 27.8 | 15 | 46 | 25 |
| ACJ4225    | M42×1.5 | 25 | 161.5 | 85.5  | 16 | 12 | 12 | 34.8 | 15 | 50 | 25 |
| ACJ4250    | M42×1.5 | 50 | 226.5 | 125.5 | 16 | 12 | 12 | 34.8 | 15 | 50 | 25 |
| ACJ4275    | M42×1.5 | 75 | 291.5 | 165.5 | 16 | 12 | 12 | 34.8 | 15 | 50 | 25 |

### ■ Accessories

#### How to set stop collar

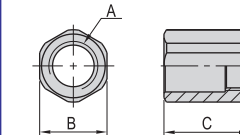


#### Ordering code

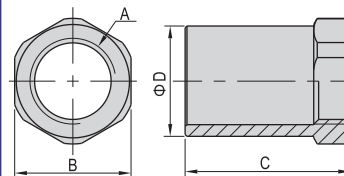
#### F-ACA 08 LM

| Accessory       | Accessories type   |
|-----------------|--------------------|
| LM: Stop collar |                    |
| FA: Flange      |                    |
| Model           | Female thread size |
|                 | 08: M8             |
|                 | 10: M10            |
|                 | 12: M12            |
|                 | 14: M14            |
|                 | 20: M20            |
|                 | 25: M25            |
|                 | 27: M27            |
|                 | 33: M33            |
|                 | 36: M36            |
|                 | 42: M42            |

#### Dimensions

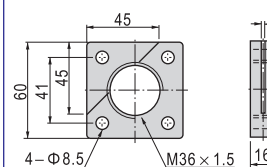


| Model\Item | A       | B  | C  |
|------------|---------|----|----|
| F-ACA08LM  | M8×1.0  | 11 | 14 |
| F-ACA10LM  | M10×1.0 | 14 | 16 |
| F-ACA12LM  | M12×1.0 | 17 | 20 |

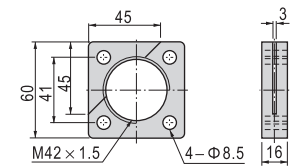


| Model\Item | A       | B  | C  | D  |
|------------|---------|----|----|----|
| F-ACA14LM  | M14×1.5 | 19 | 27 | 18 |
| F-ACA20LM  | M20×1.5 | 26 | 35 | 25 |
| F-ACA25LM  | M25×1.5 | 32 | 45 | 31 |
| F-ACA27LM  | M27×1.5 | 36 | 50 | 35 |
| F-ACA33LM  | M33×1.5 | 41 | 80 | 40 |
| F-ACA36LM  | M36×1.5 | 46 | 80 | 45 |

#### F-ACA36FA



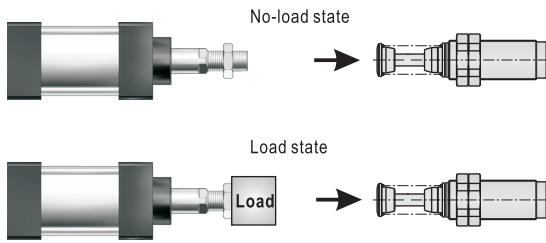
#### F-ACA42FA



#### Selecting list

| Model     | Compatible absorber                         |
|-----------|---------------------------------------------|
| F-ACA08LM | ACA0806                                     |
| F-ACA10LM | ACA1007, ACJ1007                            |
| F-ACA12LM | ACA1210, ACA1215, ACJ1210                   |
| F-ACA14LM | ACA1412, ACA1416, ACA1420, ACJ1412          |
| F-ACA20LM | ACA2020, ACA2025, ACA2030, ACA2040, ACJ2020 |
| F-ACA25LM | ACA2525, ACA2550, ACJ2525, ACJ2550          |
| F-ACA27LM | ACA2725, ACA2750, ACJ2725, ACJ2750          |
| F-ACA33LM | ACA3325, ACA3350, ACJ3325, ACJ3350          |
| F-ACA36LM | ACA3625, ACA3650, ACJ3625, ACJ3650          |
| F-ACA36FA | ACA3625, ACA3650, ACJ3625, ACJ3650          |
| F-ACA42FA | ACJ4225, ACJ4250, ACJ4275                   |

### How to select



Theoretical energy parameter table for cylinders under no-load state Unit: J (N.m)

| Stroke(mm)     | 6   | 7     | 10    | 12    | 15    | 16    | 20    | 25    | 30     | 40     | 50     | 75     |
|----------------|-----|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|
| Bore size (mm) | 6   | 0.102 | 0.119 | 0.170 | 0.203 | 0.254 | 0.271 | 0.339 | 0.424  | 0.509  | 0.678  | 0.848  |
|                | 8   | 0.181 | 0.211 | 0.301 | 0.362 | 0.452 | 0.482 | 0.603 | 0.754  | 0.904  | 1.21   | 1.51   |
|                | 10  | 0.283 | 0.330 | 0.471 | 0.565 | 0.707 | 0.754 | 0.942 | 1.18   | 1.413  | 1.88   | 2.36   |
|                | 12  | 0.407 | 0.475 | 0.678 | 0.814 | 1.017 | 1.085 | 1.36  | 1.70   | 2.035  | 2.71   | 3.39   |
|                | 16  | 0.723 | 0.844 | 1.21  | 1.45  | 1.809 | 1.929 | 2.41  | 3.01   | 3.617  | 4.82   | 6.03   |
|                | 20  | 1.13  | 1.32  | 1.88  | 2.26  | 2.826 | 3.014 | 3.77  | 4.71   | 5.652  | 7.54   | 9.42   |
|                | 25  | 1.77  | 2.06  | 2.94  | 3.53  | 4.416 | 4.710 | 5.89  | 7.36   | 8.831  | 11.8   | 14.7   |
|                | 32  | 2.89  | 3.38  | 4.82  | 5.79  | 7.235 | 7.717 | 9.65  | 12.1   | 14.47  | 19.3   | 24.1   |
|                | 40  | 4.52  | 5.28  | 7.54  | 9.04  | 11.3  | 12.06 | 15.1  | 18.8   | 22.6   | 30.1   | 37.7   |
|                | 50  | 7.07  | 8.24  | 11.8  | 14.1  | 17.7  | 18.84 | 23.6  | 29.4   | 35.33  | 47.1   | 58.9   |
|                | 63  | 11.2  | 13.1  | 18.7  | 22.4  | 28.0  | 29.91 | 37.4  | 46.7   | 56.08  | 74.8   | 93.5   |
|                | 80  | 18.1  | 21.1  | 30.1  | 36.2  | 45.2  | 48.23 | 60.3  | 75.4   | 90.43  | 120.6  | 150.7  |
|                | 100 | 28.3  | 33.0  | 47.1  | 56.5  | 70.7  | 75.36 | 94.2  | 117.8  | 141.3  | 188.4  | 235.5  |
|                | 125 | 44.2  | 51.5  | 73.6  | 88.3  | 110.4 | 117.8 | 147.2 | 184.0  | 220.8  | 284.0  | 352.0  |
|                | 160 | 72.3  | 84.4  | 120.6 | 144.7 | 180.9 | 192.9 | 241.2 | 301.4  | 361.7  | 482.3  | 602.9  |
|                | 200 | 113.0 | 131.9 | 188.4 | 226.1 | 282.6 | 301.4 | 376.8 | 471.0  | 565.2  | 753.6  | 942.0  |
|                | 250 | 176.6 | 206.1 | 294.4 | 353.3 | 441.6 | 471.0 | 588.5 | 735.9  | 883.1  | 1177.5 | 1471.9 |
|                | 320 | 289.4 | 337.6 | 482.3 | 578.8 | 723.5 | 771.7 | 964.6 | 1205.8 | 1446.9 | 1929.2 | 2411.5 |

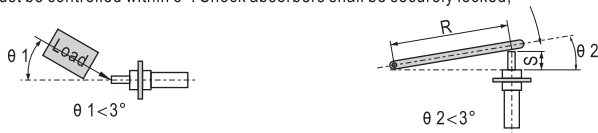
For example:

When the pressure is 0.6MPa, bore size of  $\phi 40$  under no-load state plus shock stroke of 12mm can produce energy of 9.04 N.m. Refer to the specification table, you will find ACA1412 fits.

Note: Cylinders under full-load state can produce as twice as the energy shown above.

### Installation and Operation

- The scale range of adjustable shock absorbers is 0 to 9 (8). Factory set is at 6 (4) position. 0 means the softest, while 9 means the hardest;
- Correct selection of shock absorbers can ensure a smooth deceleration and good shock-absorbing properties;
- If there exists rebounding at the beginning of the stroke, it shows the effective weight is too high. In this case, self-compensation type shall be replaced by high speed type (-1), while adjustable type shall be adjusted to softer, that is closer to 0;
- If there exists rebounding at the end of the stroke, it shows the effective weight is too low. In this case, self-compensation type shall be replaced by low speed type (-3), while adjustable type shall be adjusted to harder, that is closer to 9;
- In the work process, lateral load should be avoided as possible as one can. Eccentric angle must be controlled within  $3^\circ$ . Shock absorbers shall be securely locked;



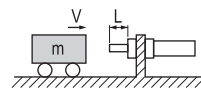
- The operating temperature range shall be  $-10$  to  $80^\circ\text{C}$ ;
- To extend the service life, piston shall be stopped 1mm before reaching the end. It is better to install set screw with positioning and precise adjustment;
- If two or more shock absorbers are installed at the same side, please make sure that they act synchronously;
- No painting, welding or cleaning with corrosive substance on the body as well as the piston rod.
- When installed the absorber, the moment forced on absorber can't be out of the range given in below list or may cause the absorber damage.

| Compatible absorber                         | Male thread Spec(of body) | Max. Assembly Force on Absorber(N.m) |
|---------------------------------------------|---------------------------|--------------------------------------|
| ACA0806                                     | M8 $\times$ 1.0           | 2.0                                  |
| ACA1007, ACJ1007                            | M10 $\times$ 1.0          | 3.5                                  |
| ACA1210, ACA1215, ACJ1210                   | M12 $\times$ 1.0          | 8.0                                  |
| ACA1412, ACA1416, ACA1420, ACJ1412          | M14 $\times$ 1.5          | 11.0                                 |
| ACA2020, ACA2025, ACA2030, ACA2040, ACJ2020 | M20 $\times$ 1.5          | 24.0                                 |
| ACA2525, ACA2550, ACJ2525, ACJ2550          | M25 $\times$ 1.5          | 40.0                                 |
| ACA2725, ACA2750, ACJ2725, ACJ2750          | M27 $\times$ 1.5          | 63.0                                 |

### Calculation of energy under load state

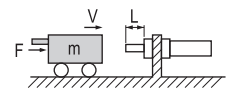
#### Horizontal impact

##### ① Horizontal impact



|                   |          |                               |
|-------------------|----------|-------------------------------|
| Impact weight     | (kg):    | m                             |
| Impact speed      | (m/s):   | v                             |
| Kinetic energy    | (J(N.m): | $E1 = \frac{m \times v^2}{2}$ |
| Propelling energy | (J(N.m): | $E2 = 0$                      |
| Gross energy      | (J(N.m): | $E = E1 + E2$                 |

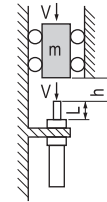
##### ② Horizontal impact with cylinder thrust



|                   |          |                               |
|-------------------|----------|-------------------------------|
| Impact weight     | (kg):    | m                             |
| Impact speed      | (m/s):   | v                             |
| Kinetic energy    | (J(N.m): | $E1 = \frac{m \times v^2}{2}$ |
| Propelling energy | (J(N.m): | $E2 = F \times L$             |
| Gross energy      | (J(N.m): | $E = E1 + E2$                 |

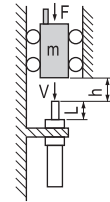
#### Vertical impact

##### ① Free fall



|                   |          |                            |
|-------------------|----------|----------------------------|
| Impact weight     | (kg):    | m                          |
| Impact speed      | (m/s):   | v                          |
| Kinetic energy    | (J(N.m): | $E1 = m \times g \times h$ |
| Propelling energy | (J(N.m): | $E2 = m \times g \times L$ |
| Gross energy      | (J(N.m): | $E = E1 + E2$              |

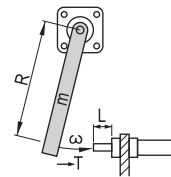
##### ② Push-down by cylinder



|                   |          |                               |
|-------------------|----------|-------------------------------|
| Impact weight     | (kg):    | m                             |
| Impact speed      | (m/s):   | v                             |
| Kinetic energy    | (J(N.m): | $E1 = \frac{m \times v^2}{2}$ |
| Propelling energy | (J(N.m): | $E2 = (mg + F) \times L$      |
| Gross energy      | (J(N.m): | $E = E1 + E2$                 |

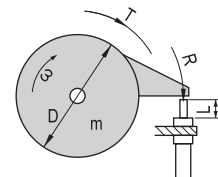
#### Rotation impact

##### ① Rocker



|                   |          |                                    |
|-------------------|----------|------------------------------------|
| Impact weight     | (kg):    | m                                  |
| Impact speed      | (m/s):   | $v = R \times \omega$              |
| Kinetic energy    | (J(N.m): | $E1 = \frac{I \times \omega^2}{2}$ |
| Propelling energy | (J(N.m): | $E2 = \frac{T \times L}{R}$        |
| Gross energy      | (J(N.m): | $E = E1 + E2$                      |

##### ② Rotation



|                   |          |                                    |
|-------------------|----------|------------------------------------|
| Impact weight     | (kg):    | m                                  |
| Impact speed      | (m/s):   | $v = R \times \omega$              |
| Kinetic energy    | (J(N.m): | $E1 = \frac{I \times \omega^2}{2}$ |
| Propelling energy | (J(N.m): | $E2 = \frac{T \times L}{R}$        |
| Gross energy      | (J(N.m): | $E = E1 + E2$                      |

#### Code explanation

| Code | Explanation                               | Unit                   | Code     | Explanation                                                                  | Unit                       |
|------|-------------------------------------------|------------------------|----------|------------------------------------------------------------------------------|----------------------------|
| m    | Impact weight                             | kg                     | L        | Shock stroke                                                                 | m                          |
| V    | Impact speed                              | m/s                    | h        | Height                                                                       | m                          |
| E    | Gross energy                              | J(N.m)                 | T        | Torque                                                                       | N.m                        |
| E1   | Kinetic energy (Potential energy)         | J(N.m)                 | N        | Round per Minute                                                             | rpm                        |
| E2   | Propelling energy                         | J(N.m)                 | R        | Distance from rotation center to impact point                                | m                          |
| g    | Gravity acceleration                      | 9.8(m/s <sup>2</sup> ) | I        | Moment of Inertia ( $I = m \times r^2 / 2$ )                                 | kg $\times$ m <sup>2</sup> |
| F    | Thrust( $(\pi \times D^2 \times P) / 4$ ) | N                      | $\omega$ | Angular velocity( $\omega = 2\pi N / 60$ ) ( $90^\circ = 1.57\text{rad/s}$ ) | rad/s                      |
| D    | Nore size                                 | mm                     |          |                                                                              |                            |
| P    | Air pressure                              | MPa                    |          |                                                                              |                            |