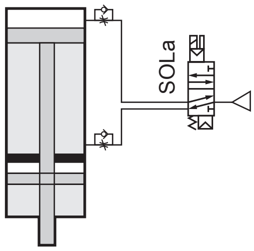
LCM
LCR
LCG
LCW
LCX
STM
STG
STS/STL
STR2
UCA2
ULK*
JSK/M2
JSG
JSC3/JSC4
USSD
UFCD
USC
UB
JSB3
LMB
LML
HCM
HCA
LBC
CAC4
UCAC2
CAC-N
UCAC-N
RCS2
RCC2
PCC
SHC
MCP
GLC
MFC
BBS
RRC
GRC
RV3*
NHS
HRL
LN
Hand
Chuk
MecHnd/Chuk
ShkAbs
FJ
FK
SpdContr
Ending

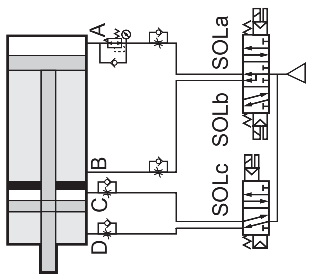
Control circuit

● Standard SHC / SHC-K (circuit 1)



Driven the same as general cylinder.

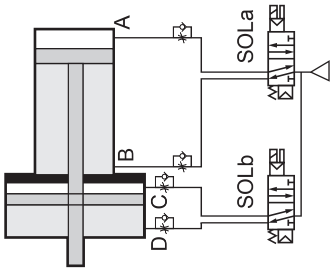
● Booster single control circuit SHC-A (circuit 2)



Solenoid valve	Travel stroke		Booster stroke
Operation status	SOLa	SOLb	SOLc
Travel stroke forward	ON	OFF	OFF
Travel stroke end	OFF	OFF	OFF
Standby for 0.1 sec or more	OFF	OFF	OFF
Booster stroke forward	ON	OFF	ON
Booster stroke backward	OFF	OFF	OFF
Standby for 0.1 sec or more	OFF	OFF	OFF
Travel stroke backward	OFF	ON	OFF

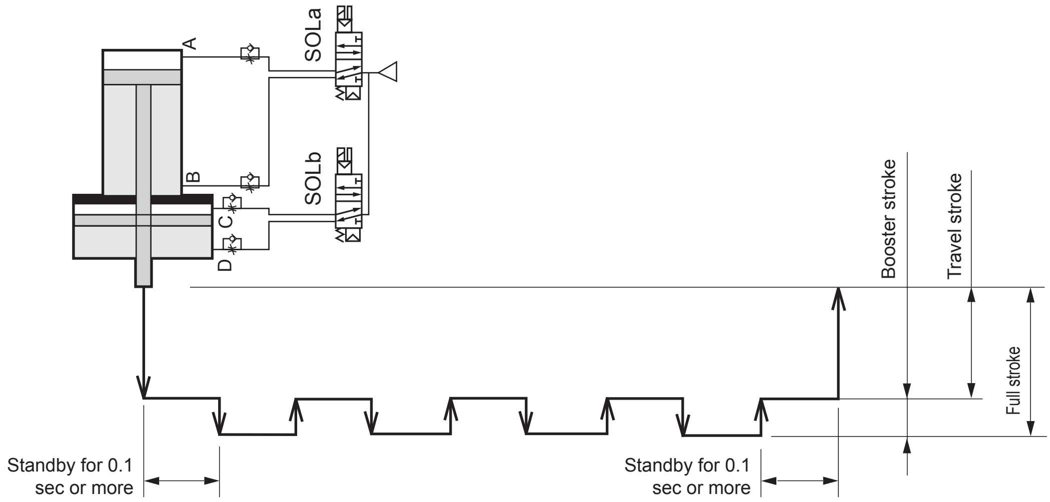
(Note) Attach the reverse regulator to the forward side (port A) of the moving cylinder, and vacuum it so that the port A and B sides can be balanced.
Otherwise, faulty operation at booster cylinder retraction may result.

● Booster single control circuit SHC-K-A (circuit 3)



Solenoid valve	Travel stroke	Booster stroke
Operation status	SOLa	SOLb
Travel stroke forward	ON	OFF
Travel stroke end	ON	OFF
Standby for 0.1 sec or more	ON	OFF
Booster stroke forward	ON	ON
Booster stroke backward	ON	OFF
Standby for 0.1 sec or more	ON	OFF
Travel stroke backward	OFF	OFF

Booster single control operational diagram



* Selection of solenoid valve is the same as selection of conventional bore size.
*1: When using a manifold, since upward load may allow back pressure from port D to enter port B, use individual exhaust spacers. Or control with a single unit.

LCM
LCR
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UCA2
ULK*
JSK/M2
JSG
JSC3/JSC4
USSD
UFCD
USC
UB
JSB3
LMB
LML
HCM
HCA
LBC
CAC4
UCAC2
CAC-N
UCAC-N
RCS2
RCC2
PCC
SHC
MCP
GLC
MFC
BBS
RRC
GRC
RV3*
NHS
HRL
LN
Hand
Chuk
MecHnd/Chuk
ShkAbs
FJ
FK
SpdContr
Ending

Air consumption (in standard condition)

A) For simple reciprocating operation

(1) Air consumption per reciprocation

$$V=Q_1x\frac{S_1}{100}+Q_2x\frac{S_2}{10}$$

(2) Air consumption per minute

$$Q=VxN=(Q_1x\frac{S_1}{100}+Q_2x\frac{S_2}{10})xN$$

B) For high frequency operation

(1) Air consumption per reciprocation

$$V=Q_1x\frac{S_1}{100}+Q_2x\frac{S_2}{10}xn$$

(2) Air consumption per minute

$$Q=VxN=(Q_1x\frac{S_1}{100}+Q_2x\frac{S_2}{10}xn)xN$$

V	Air consumption per reciprocation	ℓ(ANR)
Q	Air consumption per minute	ℓ/min(ANR)
Q_1	Air consumption of travel stroke section (Table 1)	ℓ(ANR)
Q_2	Air consumption of booster stroke section (Table 2)	ℓ(ANR)
S_1	Full stroke	mm
S_2	Booster stroke	mm
N	Full stroke reciprocating cycle per minute	cpm
n	Number of reciprocations of booster stroke	Cycle

Table 1. Air consumption of movement stroke section (common to SHC and SHC-K)

Bore size (mm)	1 reciprocating air consumption per stroke 100 mm: Q_1ℓ (ANR)							
	Working pressure MPa							
	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
ø40	0.60	0.80	1.00	1.20	1.40	1.60	1.80	2.00
ø50	0.96	1.28	1.59	1.91	2.23	2.55	2.87	3.18
ø63	1.57	2.09	2.61	3.13	3.65	4.17	4.69	5.21
ø80	2.62	3.48	4.35	5.22	6.09	6.96	7.83	8.69
ø100	4.09	5.44	6.80	8.16	9.52	10.87	12.23	13.59

Table 2. Air consumption of booster stroke section

Bore size (mm)		1 reciprocating air consumption per stroke 100 mm: Q_2ℓ (ANR)							
		Working pressure MPa							
		0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Double force SHC	ø40	0.08	0.11	0.14	0.17	0.20	0.22	0.25	0.28
	ø50	0.14	0.19	0.23	0.28	0.33	0.37	0.42	0.47
	ø63	0.20	0.26	0.33	0.39	0.46	0.52	0.59	0.65
	ø80	0.28	0.38	0.47	0.56	0.66	0.75	0.85	0.94
	ø100	0.42	0.56	0.70	0.84	0.98	1.12	1.26	1.41
Quad force SHC-K	ø40	0.27	0.35	0.44	0.53	0.62	0.71	0.80	0.88
	ø50	0.42	0.56	0.70	0.84	0.98	1.12	1.26	1.40
	ø63	0.66	0.88	1.10	1.33	1.55	1.77	1.99	2.21
	ø80	1.10	1.47	1.83	2.20	2.56	2.93	3.29	3.66
	ø100	1.73	2.30	2.87	3.45	4.02	4.59	5.16	5.74

Example of calculation

Example 1. Simple reciprocating operation

Model No.: SHC-00-63H-300-20

Full stroke S_1 = 300 mm

Booster stroke S_2 = 20 mm

Working pressure = 0.5 MPa

Full stroke reciprocating cycle per minute N = 10 cpm

(1) Air consumption per reciprocation

$$V=3.13x\frac{300}{100}+0.39x\frac{20}{10}=10.17\ ℓ(ANR)$$

(2) Air consumption per minute

Q=10.17x10=101.7 ℓ/min(ANR)

Example 2. High frequency operation

Model No.: SHC-00-63H-300-20

Full stroke S_1 = 300 mm

Booster stroke S_2 = 20 mm

Working pressure = 0.5 MPa

Full stroke reciprocating cycle per minute N = 1 cpm

Number of reciprocations of booster stroke n = 10 cycles

(1) Air consumption per reciprocation

$$V=3.13x\frac{300}{100}+0.39x\frac{20x10}{10}=17.19\ ℓ(ANR)$$

(2) Air consumption per minute

Q=17.19x1=17.19 ℓ/min(ANR)

LCM
LCR
LCG
LCW
LCX
STM
STG
STS/STL
STR2
UCA2
ULK*
JSK/M2
JSG
JSC3/JSC4
USSD
UFCD
USC
UB
JSB3
LMB
LML
HCM
HCA
LBC
CAC4
UCAC2
CAC-N
UCAC-N
RCS2
RCC2
PCC
SHC
MCP
GLC
MFC
BBS
RRC
GRC
RV3*
NHS
HRL
LN
Hand
Chuk
MecHnd/Chuk
ShkAbs
FJ
FK
SpdContr
Ending

Calculating travel and booster speed relationship

Standard

Code

Sz: Booster speed (mm/s)

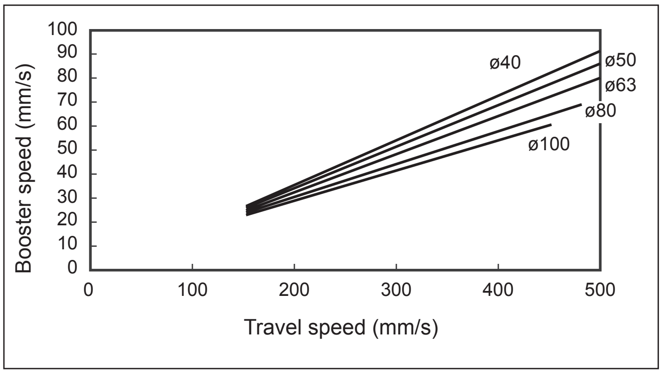
Si: Travel speed (mm/s)

a: Coefficient

b: Initial speed (when travel speed is 50 mm/s) (mm/s)

SHC Formula for 0.5 MPa supply pressure

Bore size (mm)	Booster speed formula (mm/s) Sz = a (Si-50) + b (50 ≤ Si ≤ max. travel speed)	Max. travel speed (mm/s)	
		0.5 [MPa]	0.9 [MPa]
ø40	Sz=0.186(Si-50)+7.2	540	640
ø50	Sz=0.173(Si-50)+8	520	620
ø63	Sz=0.157(Si-50)+9	510	610
ø80	Sz=0.135(Si-50)+10.3	480	570
ø100	Sz=0.123(Si-50)+11.1	450	540



Note that travel and booster speed change about 5% when pressure increases by 0.1 [MPa].

· Example of formula

Booster speed to move SHC-00-63H-300-20 cylinder at a pressure of 0.5 [MPa] and travel speed of 500 [mm/s].

With the above formula,

Sz = 0.157 x (500-50) + 9 = 79.6 (mm/s) ≈ 79 (mm/s)

there will be 5% change at about 0.1 [MPa] at pressure of 0.8 [MPa] and so

it will be Sz' = 1.15 x Sz = 91.6 (mm/s) ≈ 91 (mm/s)

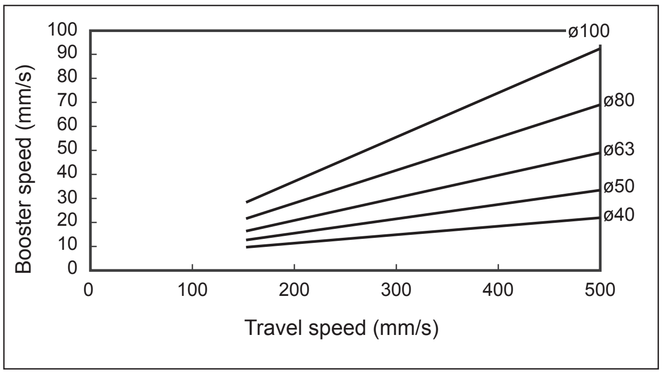
Since the max. travel speed also changes by about 5% as the pressure increases by 0.1 [MPa],

it will be SiMAX = 1.2 x Si = 612 (mm/s) ≈ 610 (mm/s)

The same formula applies when calculating the following.

SHC-K Formula for 0.5 MPa supply pressure

Bore size (mm)	Booster speed formula (mm/s) Sz = a (Si-50) + b (50 ≤ Si ≤ max. travel speed)	Max. travel speed (mm/s)	
		0.5 [MPa]	0.9 [MPa]
ø40	Sz=0.0149(Si-50)+2.3	540	640
ø50	Sz=0.025(Si-50)+2.6	520	620
ø63	Sz=0.0381(Si-50)+2.9	510	610
ø80	Sz=0.0553(Si-50)+3.3	480	570
ø100	Sz=0.0756(Si-50)+3.9	450	540



Booster single control

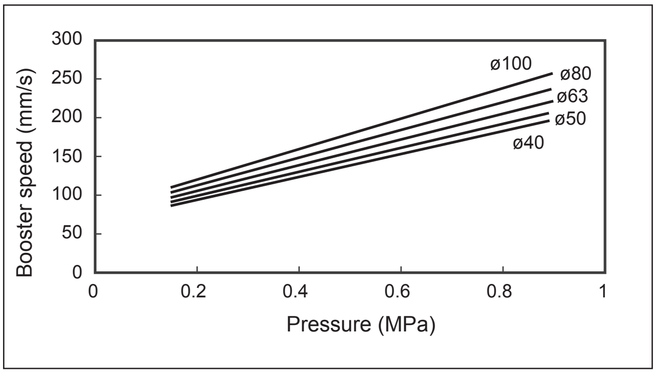
The booster cylinder reciprocates independently, so boosting speed changes with changes in supply pressure.

Code

Sz : Booster speed (mm/s)
P : Pressure (MPa)
c : Coefficient
d : Booster speed coefficient (mm/s)

SHC-A

Bore size (mm)	Booster speed formula (mm/s) Sz = cP + d (0.15 ≤ P ≤ 0.9 [MPa])
ø40	Sz=144P+67.3
ø50	Sz=152.1P+69.8
ø63	Sz=162.7P+73
ø80	Sz=176.6P+77.3
ø100	Sz=193P+82.3



· Example of formula

Booster speed to move SHC-00-40-300-20-A cylinder at pressure of 0.5 [MPa].

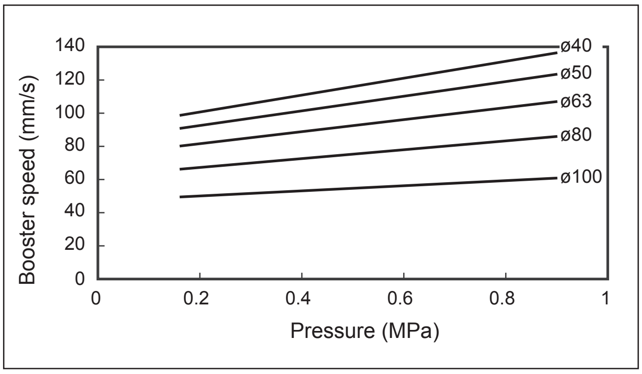
With the above formula,

it will be Sz = 144 x 0.5 + 67.3 = 139.3 (mm/s) ≈ 139 (mm/s)

The same formula applies when calculating the following.

SHC-K-A

Bore size (mm)	Booster speed formula (mm/s) Sz = cP + d (0.15 ≤ P ≤ 0.9 [MPa])
ø40	Sz=48.4P+92.6
ø50	Sz=42.7P+85.3
ø63	Sz=35.2P+75.7
ø80	Sz=25.5P+63.2
ø100	Sz=14.1P+48.6



Travel speed and time to reach 90% thrust

Standard

Code

t: Time to reach 90% thrust (time to reach 90% thrust after contacting object) (s)

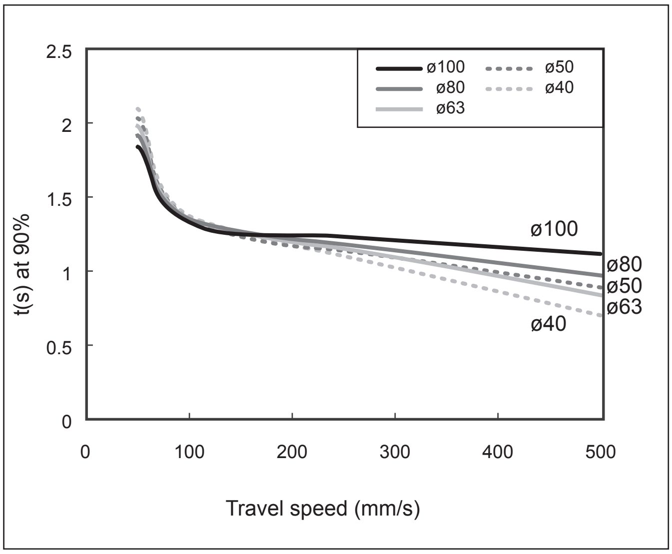
e, e': Coefficient

Si: Travel speed (mm/s)

f, f', f'': Time (s) at travel speed of 50, 100 and 300 mm/s

SHC Formula for 0.5 MPa supply pressure

Bore size (mm)	Formula for time to reach 90% thrust at 50 to 100 mm/s travel speed (s) t = e (Si-50) + f (50 ≤ Si ≤ 100)	Formula for time to reach 90% thrust at 100 mm/s or higher travel speed (s) t = e (Si-100) + f (100 ≤ Si ≤ max. travel speed)	Max. travel speed (mm/s)
ø40	t=-0.0146(Si-50)+2.1	t=-0.00167(Si-100)+1.37	540
ø50	t=-0.013(Si-50)+2.05	t=-0.0013(Si-100)+1.4	520
ø63	t=-0.013(Si-50)+1.93	t=-0.00125(Si-100)+1.35	510
ø80	t=-0.0118(Si-50)+1.93	t=-0.000934(Si-100)+1.34	480
ø100	t=-0.0104(Si-50)+1.85	t=-0.0005625(Si-100)+1.33	450



Note that the time to reach 90% thrust takes about 5 to 10% longer when supply pressure rises by 0.1 [MPa]. The max. travel speed increases about 5% when pressure rises by 0.1 [MPa].

· Example of calculation

Time to reach 90% thrust when SHC-00-63H-300-20 cylinder is moved at a pressure of 0.5 [MPa] and travel speed of 500 [mm/s].

With the above formula,

t = -0.00125 x (500-100) + 1.35 = 0.85 (s) ≈ 0.8 (s)

Since there is a 5 to 10% change at about 0.1 [MPa] at pressure of 0.8 [MPa],

t' = (1.15 to 1.3) t = 0.98 to 1.1 (s) ≈ 1.0 (s)

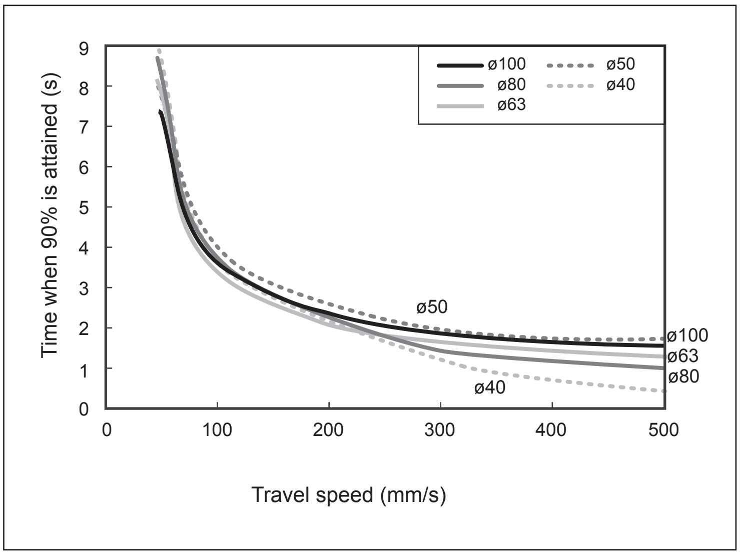
is a guideline. When using the double force, time is not varied much by the full stroke. The K (quad force) below has a separate functional expression because the time to attain thrust differs slightly with the full stroke (full stroke < 300 and full stroke ≥ 300). The time for the booster stroke 10 [mm] and 20 [mm] does not vary much.

SHC-K Formula for 0.5 MPa supply pressure

· Full stroke < 300 mm

Bore size (mm)		Formula for time to reach 90% thrust at 50 to 100 mm/s travel speed (s) t = e (Si−50) + f (50 ≤ Si ≤ 100)	Formula for time to reach 90% thrust at 100 to 300 mm/s travel speed (s) t = e (Si-100) + f (100 ≤ Si ≤ max. travel speed)	Formula for time to reach 90% thrust at 300 mm/s or higher travel speed (s) t = e" (Si-300) + f" (300 ≤ Si ≤ max. travel speed)	Max. travel speed (mm/s)
ø40	Note	t=-0.094(Si-50)+8.7	t=-0.014(Si-100)+4	t=-0.0034(Si-300)+1.2	540
ø50		t=-0.1(Si-50)+8.9	t=-0.01(Si-100)+3.9	t=-0.00078(Si-300)+1.9	520
ø63		t=-0.095(Si-50)+8.51	t=-0.009885(Si-100)+3.76	t=-0.0011(Si-300)+1.783	510
ø80		t=-0.0886(Si-50)+8	t=-0.0097(Si-100)+3.57	t=-0.00152(Si-300)+1.63	480
ø100		t=-0.081(Si-50)+7.4	t=-0.0095(Si-100)+3.35	t=-0.002(Si-300)+1.45	450

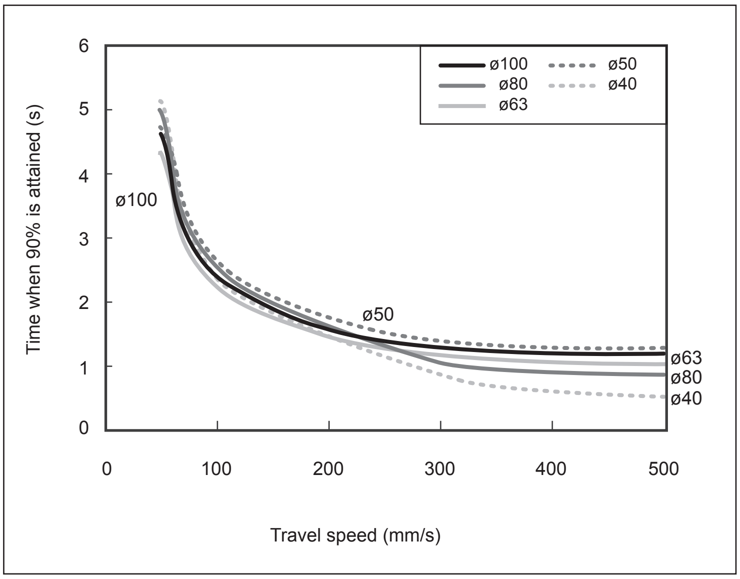
Note For SHC-K-40 only, when travel speed is 500 [mm/s] and over, there is almost no time variation until thrust attains 90%.



· Full stroke ≥ 300 mm

Bore size (mm)		Formula for time to reach 90% thrust at 50 to 100 mm/s travel speed (s) t = e (Si−50) + f (50 ≤ Si ≤ 100)	Formula for time to reach 90% thrust at 100 to 300 mm/s travel speed (s) t = e (Si-100) + f (100 ≤ Si ≤ max. travel speed)	Formula for time to reach 90% thrust at 300 mm/s or higher travel speed (s) t = e" (Si-300) + f" (300 ≤ Si ≤ max. travel speed)	Max. travel speed (mm/s)
ø40	Note	t=-0.049(Si-50)+5.15	t=-0.00925(Si-100)+2.7	t=-0.0017(Si-300)+0.85	540
ø50		t=-0.051(Si-50)+5.21	t=-0.0063(Si-100)+2.66	t=-0.00039(Si-300)+1.4	520
ø63		t=-0.0484(Si-50)+4.98	t=-0.0062(Si-100)+2.56	t=-0.000548(Si-300)+1.32	510
ø80		t=-0.045(Si-50)+4.68	t=-0.00612(Si-100)+2.43	t=-0.000765(Si-300)+1.206	480
ø100		t=-0.041(Si-50)+4.33	t=-0.006(Si-100)+2.28	t=-0.001(Si-300)+1.08	450

Note For SHC-K-40 only, when travel speed is 500 [mm/s] and over, there is almost no time variation until thrust attains 90%.



Booster single control

Individually reciprocating booster cylinder part varies the time until thrust is generated by supply pressure. The time until thrust generated applies only to the booster cylinder section.

Code

t: Time to reach 90% thrust (time to reach 90% thrust after contacting object) (s)

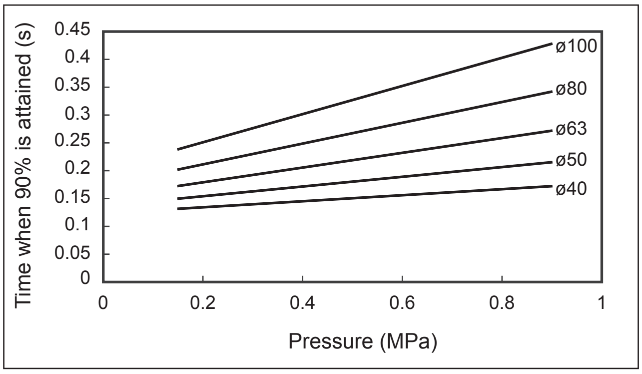
G: Coefficient

P: Pressure (MPa)

H: Time coefficient (s) until thrust attains 90%

SHC-A

Bore size (mm)	Formula for time to reach 90% thrust (s) t = GP + H (0.15 ≤ P ≤ 0.9 [MPa])
ø40	t=0.05P+0.123
ø50	t=0.0826P+0.135
ø63	t=0.125P+0.1525
ø80	t=0.18P+0.174
ø100	t=0.245P+0.2



· Example of calculation

Time to reach 90% thrust when SHC-00-63H-300-20-A cylinder is moved at a pressure of 0.5 [MPa].

With the above formula,

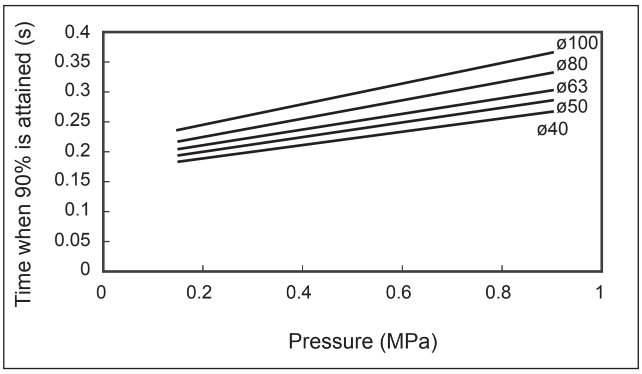
it will be t = 0.125 x 0.5 + 0.1525 = 0.215 (s) ≈ 0.2 (s)

The time for the booster stroke 10 [mm] and 20 [mm] does not vary much.

The same formula applies when calculating the following.

SHC-K-A

Bore size (mm)	Formula for time to reach 90% thrust (s) t=GP+H (0.15 ≤ P ≤ 0.9 [MPa])
ø40	t=0.11P+0.165
ø50	t=0.121P+0.172
ø63	t=0.135P+0.181
ø80	t=0.153P+0.193
ø100	t=0.175P+0.2075



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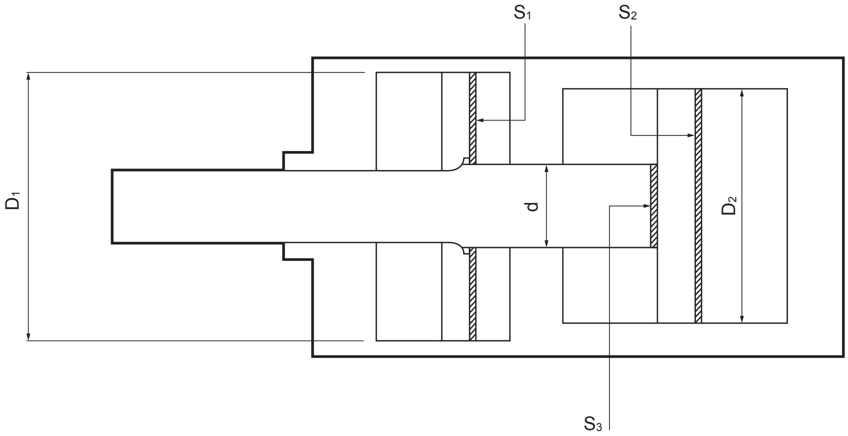
ULK*
JSK/M2
JSG
JSC3/JSC4
USSD
UFCD
USC
UB
JSB3
LMB
LML
HCM
HCA
LBC
CAC4
UCAC2
CAC-N
UCAC-N
RCS2
RCC2
PCC
SHC
MCP
GLC
MFC
BBS
RRC
GRC
RV3*
NHS
HRL
LN
Hand
Chuk
MecHnd/Chuk
ShkAbs
FJ
FK
SpdContr
Ending

Theoretical thrust formula

SHC pressurized area table



● SHC

Bore size (mm)	S_1 [cm^2]	S_2 [cm^2]	S_3 [cm^2]	D_1 [mm]	D_2 [mm]	d [mm]
ø40	13.4	12.5	6.15	ø50	ø40	ø28
ø50	23.1	19.6	8.04	ø63	ø50	ø32
ø63	31.6	31.1	12.5	ø75	ø63	ø40
ø80	43.9	50.2	19.6	ø90	ø80	ø50
ø100	66.7	78.5	28.2	ø110	ø100	ø60

● SHC-K

Bore size (mm)	S_1 [cm^2]	S_2 [cm^2]	S_3 [cm^2]	D_1 [mm]	D_2 [mm]	d [mm]
ø40	44.1	12.5	6.15	ø80	ø40	ø28
ø50	70.4	19.6	8.04	ø100	ø50	ø32
ø63	110.1	31.1	12.5	ø125	ø63	ø40
ø80	181.4	50.2	19.6	ø160	ø80	ø50
ø100	285.8	78.5	28.2	ø200	ø100	ø60

$S_1 = \frac{\pi}{4}(D_1^2 - d^2)$ $S_2 = \frac{\pi}{4} D_2^2$ $S_3 = \frac{\pi}{4} d^2$

Formula

Theoretical thrust = low thrust (booster section) effective cross-sectional area * air pressure

Example: Theoretical thrust when a ø63 cylinder is operated at 0.5 [MPa]

- Theoretical thrust of thrust section for push
  $F = S_2 P = 31.1(cm^2) x 10^{-4} x 0.5(MPa) x 10^6 = 1558(N)$

- Theoretical thrust of booster section for push
  $F = (S_1 + S_2)P = (31.6 + 31.1)(cm^2) x 10^{-4} x 0.5(MPa) x 10^6 = 3139(N)$

- Theoretical thrust of thrust section for pull
  $F = (S_2 - S_3)P = (31.1 - 12.5)(cm^2) x 10^{-4} x 0.5(MPa) x 10^6 = 930(N)$

- Theoretical thrust of booster section for pull
  $F = \{S_1 + (S_2 - S_3)\} P = \{31.6 + (31.1 - 12.5)\} (cm^2) \text{ x } 10^{-4} \text{ x } 0.5 (MPa) \text{ x } 10^6 = 2511 (N)$

Below decimal point is rounded up.

LCM
LCR
LCG
LCW
LCX
STM
STG
STS/STL
STR2
UCA2
ULK*
JSK/M2
JSG
JSC3/JSC4
USSD
UFCD
USC
UB
JSB3
LMB
LML
HCM
HCA
LBC
CAC4
UCAC2
CAC-N
UCAC-N
RCS2
RCC2
PCC
SHC
MCP
GLC
MFC
BBS
RRC
GRC
RV3*
NHS
HRL
LN
Hand
Chuk
MecHnd/Chuk
ShkAbs
FJ
FK
SpdContr
Ending

Pneumatic components

Safety Precautions

Be sure to read this section before use.
Refer to Intro Page 73 for general information of the cylinder, and to Intro Page 80 for general information of the cylinder switch.

Product-specific cautions: High power cylinder SHC Series

Design/selection

⚠ WARNING

■ Intermediate stop

Do not use it for braking due to its structure. The stopping position will become extremely unstable.

⚠ CAUTION

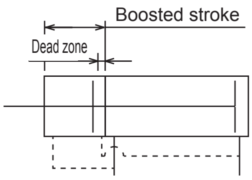
■ Use within the max. stroke.

■ Do not use an ABR port connection solenoid valve for the independent control of the booster.

B and D port passages are connected in the cylinder when the booster cylinder retracts, so air is exhausted from the R port of the solenoid valve.

■ Set the boosted stroke at a position exceeding the dead zone below.

Using it at the dead zone stroke may compromise the thrust of the booster.



Refer to boosted stroke dead zone dimensions on pages 1144 and 1154.

■ Use discrete solenoid valves in the booster control single circuit. Also, use a separate exhaust spacer when embedding it to a manifold.

The booster port exhaust may flow into the travel port and cause operation faults.

■ Provide a lag of 0.1 seconds or longer at the movement stroke end in the independent control of the booster.

If A and C ports are pressurized simultaneously, the booster piston and coupling collar cannot be connected and will lead to malfunctions. When operating, pressurize A port, then provide a 0.1 second or longer lag at the travel stroke limit before pressurizing the C port.

■ Do not allow a supply pressure differential between port B side and ports C and D side in the independent control of the booster.

Otherwise, disrupted air flow may cause malfunctions. Consult with CKD if a pressure difference must be set.

■ Select in consideration of impact at the time of cylinder coupling.

Due to the product structure, impact is generated when the booster piston and coupling collar connect. Take impact into consideration when designing the equipment. Consult with CKD because the impact value differs with working conditions.

Bore size	Impact value (m/s^2)
ø40	147
ø50	147
ø63	147
ø80	196
ø100	196

■ Note that thrust differs when the boosted stroke cylinder is advancing and retracting.

When the booster starts to retract, a thrust equivalent to double or 4-fold is applied. However, due to the product structure, the thrust is about 70% of the theoretical thrust during travel. Note that the dead zone stroke may compromise the booster thrust in both advancing and retracting.

■ Do not apply an eccentric load to the piston rod.

The booster piston and connecting collar cannot be connected and will lead to malfunctions due to the structure. Be sure to provide guides, floating fittings and the like so as to prevent eccentric load from being applied.

■ Mount a speed controller on the cylinder.

If each cylinder is used at a speed exceeding the working piston speed, correct coupling is not possible and operation faults may occur.
In addition, contact CKD if the load factor is high as inertia may cause the load to reach the end of the force-increasing stroke and strike the workpiece.

■ Do not use multiple synchronized cylinders.

The booster piston and connecting collar cannot be connected and will lead to malfunctions.

■ Note that the piston rod may pop out when decoupling the cylinder.

When using the cylinder with the rod facing upward, if the load factor for the rapid feed section thrust is high, the back pressure of the rapid feed section will decrease when the coupling is released when the rod is lowered, possibly causing the popping out phenomenon. With a high load factor, use of the independent control of the booster "-A" is recommended.

■ Do not apply a reaction force on the piston rod during the travel stroke.

The booster piston and connecting collar cannot be connected and will lead to malfunctions due to the structure.