Konstrukcija i upravljanje pneumatske preše

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ZAVRŠNI RAD

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Zagreb, ožujak 2017.

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Središnje povjerenstvo za završne i diplomske ispite

Povjerenstvo za završne ispite studija strojarstva za smjerove:
proizvodno inženjerstvo, računalno inženjerstvo, industrijsko inženjerstvo i menadžment, inženjerstvo materijala i mehatronika i robotika

Sveučilište u Zagrebu Fakultet strojarstva i brodogradnje	
Datum	Prilog
Klasa:	
Ur.broj:	

ZAVRŠNI ZADATAK

Student: **NIKOLA RAJČIĆ** Mat. br.: 0035191881

Naslov rada na hrvatskom jeziku: **KONSTRUKCIJA I UPRAVLJANJE PNEUMATSKE PREŠE**

Naslov rada na engleskom jeziku: **THE CONSTRUCTION AND CONTROL OF A PNEUMATIC PRESS**

Opis zadatka:

Pneumatske preše mogu se koristiti za oblikovanje različitih materijala kod kojih je potrebna manja sila deformiranja. Konstrukcijska rješenja pneumatskih preša mogu se izvesti s različitim mehanizmima prijenosa sile. Upravljanje pneumatskih preša u industrijskoj primjeni najčešće je realizirano ručno, u otvorenom krugu, primjenom jednostavnih ventila za promjenu smjera gibanja. Suvremeni industrijski procesi traže rješenja pneumatskih preša s mogućnošću programiranog upravljanja gibanjem i/ili silom aktuatora, kao i mogućnost brze prilagodbe upravljačkih algoritama novim zahtjevima u tehnološkom procesu. U usporedbi s hidrauličkim prešama koje se koriste za ostvarenje velikih sila, pneumatske preše su ekološki prihvatljivije i jednostavnije su konstrukcijske izvedbe.

U zadatku je potrebno:

- projektirati sustav pneumatske preše koja koristi dvoradni pneumatski cilindar upravljan proporcionalnim tlačnim regulatorom za ostvarenje potrebne sile prešanja,
- izraditi nastavnu maketu pneumatske preše koja demonstrira način rada projektiranog sustava,
- dati tehnički opis korištenih komponenti mehaničkog, mjernog i upravljačkog dijela sustava,
- izraditi upravljački program i dati smjernice za daljni razvoj sustava.

Zadatak zadan:

30. studenog 2016.

Zadatak zadao:

Prof. dr. sc. Željko Šitum

Rok predaje rada:
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2. rok (izvanredni): 28. lipnja 2017.
3. rok: 22. rujna 2017.

Predviđeni datumi obrane:
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3. rok: 25.9. - 29. 09. 2017.

v.d. predsjednika Povjerenstva:

Izv. prof. dr. sc. Branko Bauer

Izjavljujem da sam ovaj rad izradio samostalno koristeći znanja stečena tijekom studija i navedenu literaturu.

Zahvaljujem se svom mentoru prof. dr. sc. Željku Šitumu na ukazanoj pomoći, uputama i savjetima tokom izrade završnog rada.

Nikola Rajčić

Sadržaj:

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Popis oznaka:

Oznaka	Jedinica	Opis:
b	mm	Dubina utora za noge na gornjoj ploči
H	mm	Visina postolja pneumatske preše
b_1	mm	Dubina uvrta za stupanjevani promjer cilindra
D	mm	Stupnjevani promjer cilindra
D_1	mm	Promjer klipa cilindra
d_1	mm	Promjer provrta za vijke
D_2	mm	Promjer na kojem su izbušeni provrti za senzor
d	mm	Promjer provrta za senzor
d_2	mm	Promjer provrta za vijke donje ploče
F	N	Sila koju može prenositi opruga
k	mm	Visina ležišta opruge
δ	mm	Debljina stijenke ležišta opruge
$D_{š2}$	mm	Vanjski promjer prihvata opruge
$D_{š1}$	mm	Unutarnji promjer prihvata opruge
D_3	mm	Promjer za urezani navoj M16×1.5
L	mm	Duljina opruge u početnom stanju
F_1	N	Sila prednapregnutosti opruge
G	N/mm^2	Modul klizanja patentirane žice
D_{sr}	mm	Srednji promjer opruge
f	mm	Duljina sabijanja opruge
i	-	Broj radnih navoja opruge
F_{dop}	N	Dopušteni iznos sile opterećenja senzora
D_c	mm	Promjer pneumatskog cilindra
l	mm	Duljina hoda pneumatskog cilindra
p	bar	Tlak napajanja sustava
A	mm^2	Poprečni presjek pneumatskog cilindra
I_1	A	Struja proporcionalnog tlačnog regulatora
U_1	V	Napon napajanja propor. tlačnog regulatora

Sažetak

U okviru ovog završnog rada potrebno je projektirati sustav pneumatske preše koja koristi dvoradni pneumatski cilindar upravljan proporcionalnim tlačnim regulatorom za ostvarenje potrebne sile prešanja i dati tehnički opis korištenih komponenti mehaničkog, mjernog i upravljačkog dijela sustava. Također, potrebno je konstrukcijski osmisliti put prijenosa sile od cilindra do senzora i izraditi upravljački program te dati smjernice za daljni razvoj sustava.

Ključne riječi: pneumatski cilindar, tlačni regulator, monostabilni razvodnik, senzor sile, upravljanje pneumatskom prešom

1 UVOD

Pneumatika kao znanstvena disciplina vrlo je zastupljena u svim segmentima inženjerskog djelovanja, tim više ako su za izvedbu sustava potrebne manje sile. Za razliku od hidraulike koja za radnu tvar koristi ulje, pneumatika koristi zrak koji je ekološki prihvatljiviji. Problem stlačivosti zraka, osnovni je razlog zbog kojeg se ostvaruju tako mali prijenosi sila, koji su nam često, i više nego dovoljni, za izvedbu različitih pneumatskih mehanizama.

Laboratorij za automatiku i robotiku, Fakulteta strojarstva i brodogradnje, surađuje s jednim od vodećih proizvođača pneumatske opreme u svijetu, tvrtkom *SMC*. Od postojeće opreme istoimene tvrtke, na raspolaganju su dvoradni pneumatski cilindar i proporcionalni tlačni regulator. Na bazi prethodna dva pneumatska elementa, te senzora sile i mikrokontrolera osmišljeno je idejno rješenje za izradu nastavne makete sustava pneumatske preše.

Završni rad započinje konstruiranjem dijelova postolja u programskom paketu *Catia V5*. Nakon sastavljanja sklopa, na samom postolju spaja se pneumatska shema koja je upravljana programirljivim logičkim kontrolerom *Siemens S7-200*. Takav mikrokontroler je podržan softwearom *Siemens Step-7* kojim je riješeno upravljanje pneumatske preše.

2 MEHANIČKI DIO PNEUMATSKE PREŠE

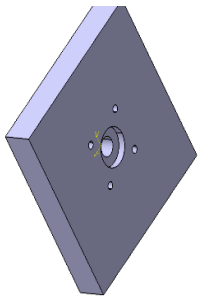
2.1. Postolje

Ideja nosivog dijela preše riješena je s dvije ploče i četiri noge. Radi dobivanja lakše konstrukcije, ploče su načinjene od iverice, dok su noge standardni šuplji čelični profili (20×20 mm). Spoj dviju ploča ostvaren je oblikom, utorima za noge dubine b=20 mm na obje ploče i vijčano L profilima dimenzija 40×40×20 mm na sve četiri noge pneumatske preše. Ukupna visina postolja iznosi H=234 mm.

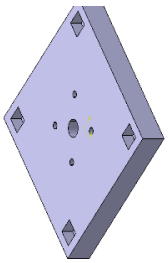
Slika 1: Postolje pneumatske preše

2.1.1. Gornja ploča

Gornja ploča dimenzija 200×200×40 mm, oblikom je prilagođena pneumatskom cilindru. U težištu ploče, s gornje strane, nalazi se uvrt b_1=10 mm promjera D=40 mm, u koji naliježe prirubnica cilindra, provrt D_1=20 mm kojim prolazi klip i četiri provrta promjera d_1=8 mm kojim prolaze vijci M8×55 mm i osiguravaju spoj između gornje ploče i pneumatskog cilindra.



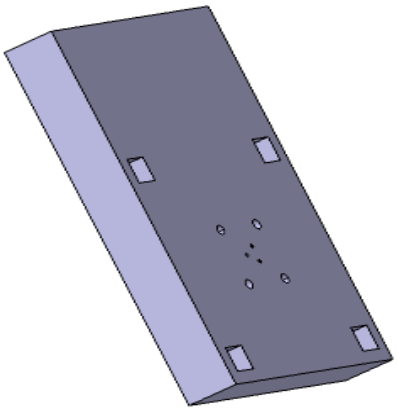
Slika 2: Gornja ploča 1



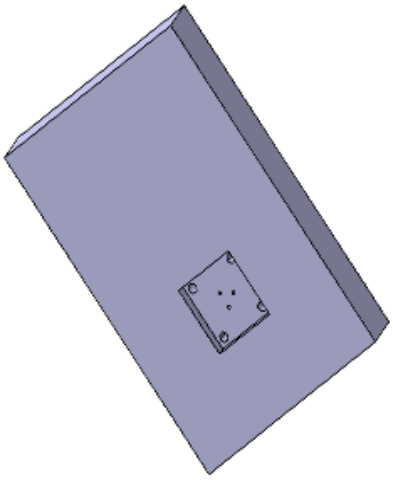
Slika 3: Gornja ploča 2

2.1.2. Donja ploča

Donja ploča ima dimenzije 200×300×40 mm i nešto je površinom veća od gornje. Razlog je taj što će na preostaloj površini biti spojeni ostali pneumatski elementi preše. Ploča je oblikom prilagođena senzoru sile, pa na promjeru D_2=15 mm sadrži tri provrta promjera d=3 mm kojim se ostvaruje spoj senzora s donjom pločom, vijcima M3×35 mm. Nadalje, izbušena su i četiri provrta d_2=30 mm za vijke M8×55 mm, koji spajaju donju ploču i donju šalicu, namjenjenu da ostvari kontakt sa senzorom. S druge strane ploče, nalazi se uvrt 60×60×10 mm kako bi u obzir uzeli visine glava vijaka.



Slika 4: Donja ploča 1



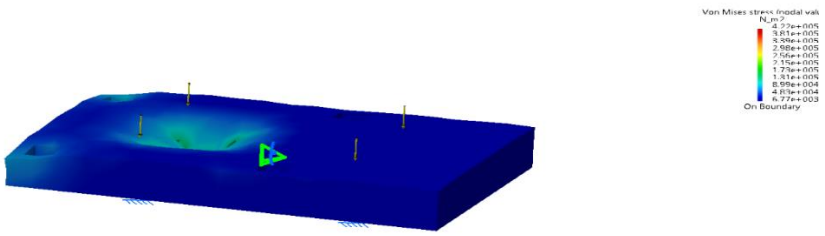
Slika 5: Donja ploča 2

2.1.1.1. Provjera čvrstoće donje ploče metodom konačnih elemenata

S obzirom da je gornja ploča opterećena samo težinom cilindra koja je za proračun čvrstoće zanemariva, ispitat ćemo čvrstoću donje ploče. Pretpostavit ćemo koncentrirano opterećenje silom F=1500 N u težištu i s obzirom na tu vrstu opterećenja odrediti naprezanja i deformacije ploče.

a) Naprezanja (Von Mises)

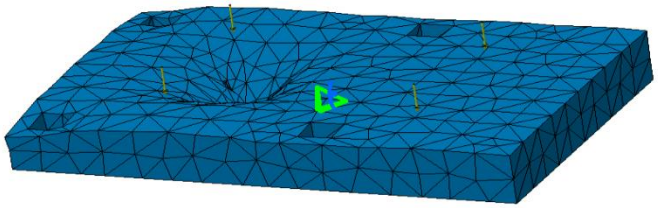
Rezultati dobiveni proračunom u programskom alatu *Catia* pokazuju kako je ploča dimenzionirana za još veća opterećenja od zadanih i shodno tome čvrstoća ploče zadovoljava tražene uvjete.



Slika 6: Naprezanja u donjoj ploči

b) Deformacije

Deformacije također zadovoljavaju uvjete opterećenja.



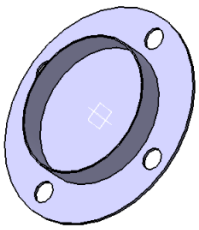
Slika 7: Deformacije u donjoj ploči

2.2. Elementi za prihvat opruge

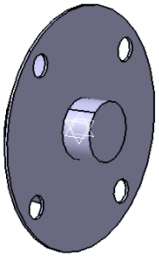
Opruga, kao odabrani način prijenosa opterećenja uležištena je između dvije dva elementa u obliku šalice, donje i gornje. Oba elementa izrađeni su iz konstrukcijskog čelika Č.0361, a svojim uvrtima osiguravaju oprugu od ispadanja tokom izvlačenja i uvlačenja klipa pneumatskog cilindra. Sa svake strane opruga je osigurana ležištem visokim 10 mm koje je izvedeno u obliku kružnog vijenca debljine δ=1 mm.

2.2.1. Donji prihvat opruge

Izvedba donjeg prihvata izrađena je tako da, osim što služi kao prihvat opruge, ostvaruje i kontakt sa senzorom. Kontakt je ostvaren pomoću valjka istih dimenzija kao i senzor, ali bez kalote koja detektira djelovanje sile. Razlog takve izvedbe je izbjegavanje radijalnog opterečćnja na kalotu senzora koje bi potencijalno dovelo do puknuća. Vanjski promjer prihvata je $D_{š2}$=80 mm, a debljina iznosi δ=1 mm. Na tom promjeru izbušena su četiri provrta d_2=8 mm za vijke M8×60 mm kojim se ostvaruje spoj senzora i donje šalice uz pomoć matice i kontramatice.



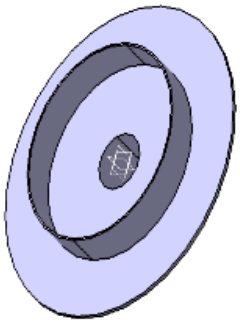
Slika 8: Strana šalice za prihvat opruge



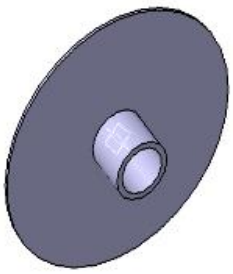
Slika 9: Strana šalice za ostvarenje kontakta sa senzorom

2.2.2. Gornji prihvat opruge

Gornja šalica, osim što ostvaruje prednapregnutost opruge (kao dodatno osiguranje), sa svoje gornje strane u promjeru D_3=18 mm ima urezan navoj M16×1.5 koji se spaja na vrh klipa cilindra i na taj način omogućuje prijenos sile i gibanja od aktuatora preko opruge do senzora sile na dnu preše. Gornja šalica je za visinu h_1=5 mm veća radi potrebne visine fino urezanog navoja.



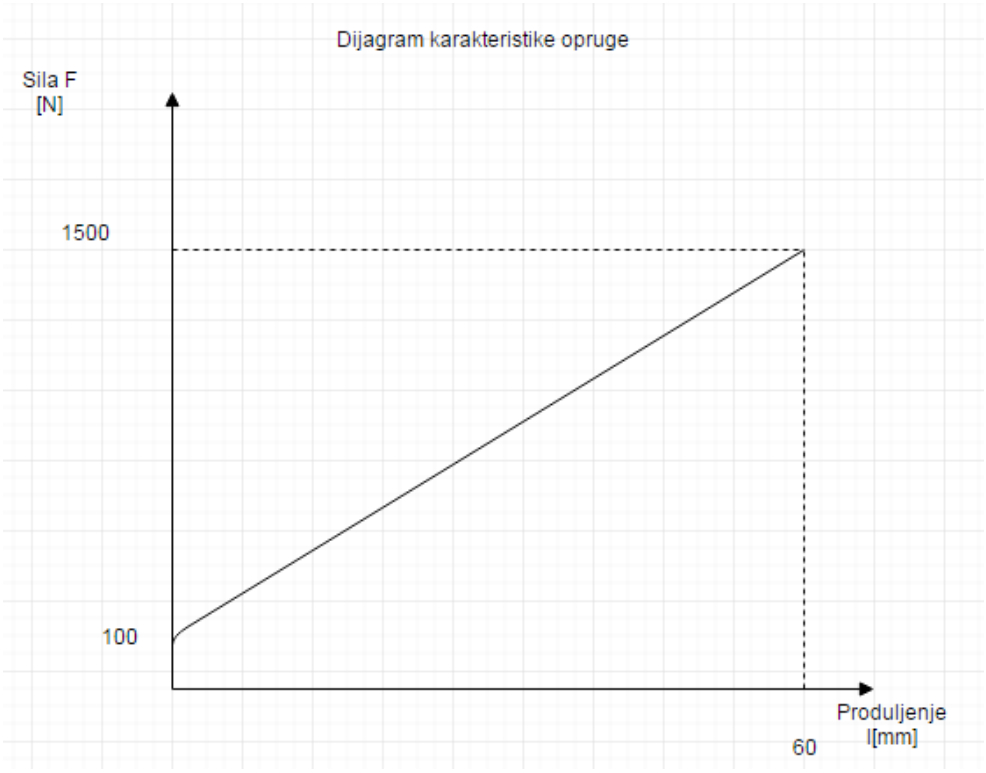
Slika 10: Gornja prihvat opruge 1



Slika 11: Gornja šalica prihvat opruge 2

2.3. Opruga

Kao što je već ranije spomenuto, odabrani element za prijenos sile je tlačna opruga duljine L=110 mm. S obzorim da je riječ o tlačnoj opruzi njena karateristika, (ili specifična sila) je linearna, što predočavamo grafom:



Slika 12: Karakteristika opruge

Zbog prednaprezanja opruge silom od F_1=100 N graf je pomaknut prema gore za taj iznos. Opruga je izrađena od patentirane žice modula klizanja G=83 000 N/mm^2 i u sljedećim koracima proračunat ćemo neke njene osnovne karakteristike.

2.2.1. Proračun tlačne opruge

Ulazni podaci su:

F-sila koja opterećuje oprugu [N] → 1500 N
l-početna duljina opruge [mm] → 110 mm
f-opruženje (hod opruge) [mm] → 60 mm
d- promjer žice [mm] → 5 mm

Prema sljedećem izrazu dobijamo potreban broj radnih navoja opruge:

$$i = \frac{G \cdot d^4 \cdot f}{8 \cdot Dsr^3 \cdot F} \quad (1)$$

Dobivenu vrijednost i=2.498 iz konstrukcijskih razloga zaokružujemo na 3 radna navoja. Radni navoji predstavljaju one navoje koji naliježu jedan na drugog u slučaju maksimalnog opterećenja.

Specifična sila opruge proizlazi iz izraza:

$$c = \frac{F}{f} = \frac{G \cdot d^4}{8 \cdot Dsr^3 \cdot i} \quad (2)$$

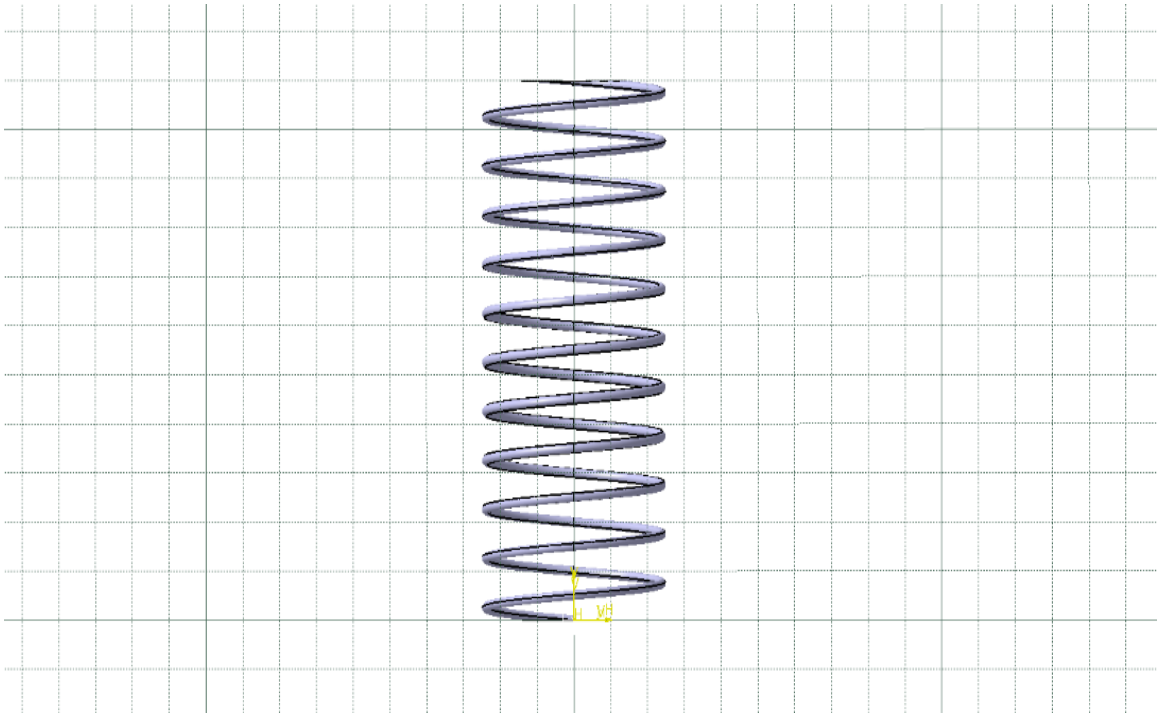
Njen iznos je c=25 N/mm

Iznos progiba f za tlak p=5 bara:

$$f = \frac{p \cdot A}{c} = 39.27\ mm$$

Iznos progiba f za maksimalan tlak p_{max}=9 bar:

$$f\ \max = \frac{p\ max \cdot A}{c} = 70.68\ mm$$



Slika 13: Tlačna opruga

3 MJERNI DIO PNEUMATSKE PREŠE

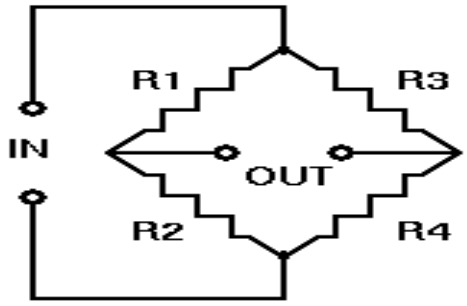
3.1. Senzor sile

Slika 14: Senzor sile

Na slici 14, prikazana je posebna izvedba senzora sile koji će biti ugrađen na prešu. Općenito su senzori sila izrađeni za mjerenje sile uslijed vlačnog opterećenja, dok ovaj senzor mjeri silu tlaka na kalotu. Odabrani senzor ima sposobnost pretvaranja 2000 N sile u naponski signal. Riječ je o vrlo jednostavno konstruiranom elektroničkom elementu koji će se vijcima učvrstiti za donju ploču pneumatske preše.

3.1.1. Princip rada senzora

Senzor radi na principu tenzometarske trake. Djelovanjem sile na kalotu dolazi do deformacije Wheatstoneovog mosta. Wheatstoneov most predstavlja elektroničku shemu s četiri otpornika čiji se otpor mijenja ovisno o iznosu sile koja djeluje na senzor. Na posljetku promjena otpora stvara naponski signal u voltima koji će detektirati mikrokontroler.



Slika 15: Wheatstoneov most

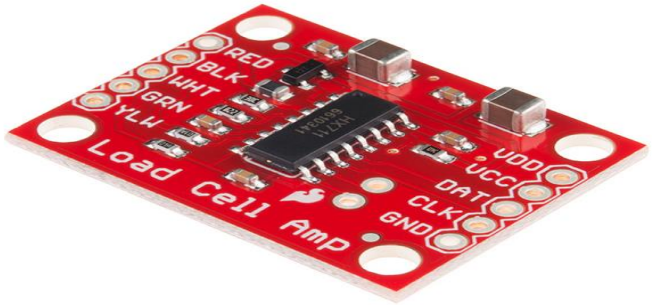
3.1.2. Karakteristike senzora

Tablica 1: Karakteristike senzora

Dozvoljeno opterećenje	Kg	200
Preporučeno opterećenje	Kg	150
Napon napajanja	Vdc	9-15
Pojačanje	mV/V	1.0-2.0
Ulazni otpor	Ω	385
Izlazni otpor	Ω	350
Točnost	Vdc	±0.5
Temperaturni interval	℃	-20- +65
Način spajanja	Kabel	4 PVC žice promjera 3 mm i duljine 2000 mm

3.1.3. Pojačalo

Pojačalo predstavlja elektronićluku pločicu koja se postavlja između senzora i mikrokontrolera s ciljem pojačanja izlaznog signala senzora kojeg mikrokontroler treba prihvatiti za daljnju obradu. Uobičajeno je da se pojačalo nalazi u konstrukciji senzora, međutim ovaj senzor je nešto jeftiniji pa je potrebno naručiti pojačalo kao poseban element u elektroničkom krugu. Kada se postupkom lemljenja pojačalo spoji na senzor, sila koja se prenosi preko opruge pneumatske preše biti će detektirana kao naponski signal odnosno ulaz u mikrokontroler.



Slika 16: Pojačalo HX711

4 PNEUMATSKI SUSTAV PREŠE

4.1. Pneumatski cilindar

Na raspolaganju je pneumatski cilindar proizvođača *SMC* i riječ je o dvoradnom cilindru, što znači da se klip cilindra izvlači i uvlači djelovanjem stlačenog zraka. Model C92LADB promjera je D_c=50 mm, a hod klipa iznosi l=80 mm. Na klipu je istokaren fini navoj M16×1.5 mm na koji će se spojiti gornja šalica.

Slika 17: Pneumatski cilindar

4.1.1. Proračun sile cilindra

Sila koju ostvaruje cilindar ovisit će o iznosu tlaka na izlazu proporcionalnog tlačnog regulatora. U Laboratoriju za automatiku i robotiku nalazi se kompresor koji uobičajeno daje tlak od 5 bara i s tim tlakom ulazimo u proračun.

A – površina cilindra
p – tlak
F – sila

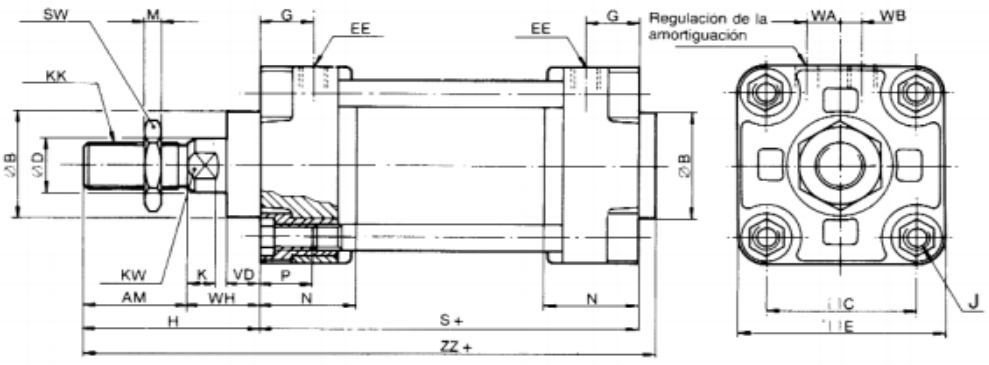
$$A = \frac{Dc^2 \cdot \pi}{4} = \frac{0.05^2 \cdot \pi}{4} = 0.001963 \text{ m}^2$$

$$F = p \cdot A = 981.5 \approx 1000\ N$$

4.1.1.1. Tlak pri ulazu i izlazu iz cilindra

U izrazu u kojem smo izračunali silu, za pretpostavku je uzeto da su sila uvlačenja i sila izvlačenja jednakih vrijednosti. Međutim, površine s prednje i stražnje strane cilindra nisu jednake. Prednja površina iznosi A_1=1963 mm^2, a stražnja A_2=1649 mm^2. Iz toga slijedi, da je gore izračunata sila izvlačenja klipa, a potrebna sila uvlačenja za površinu A_2 iznosi F_2=825 N.

4.1.2. Konstrukcijske značajke cilindra



Bore (mm)	AM	øB	C	ØD	E	EE	G	KK	H	J	K	KW	M	N	P	S	SW	VD	WA	WB	WH	ZZ
32	22	30	33	12	46	G1/8	13,5	M10 X 1.25	58	M6	6	10	5	23	11	74	17	10	7	6	36	136
40	24	32	44	16	60	G1/4	15,5	M12 X 1.25	64,5	M6	6	14	7	27	11	84	19	10	10	6	40,5	153,5
50	32	40	52	20	70	G1/4	17	M16 X 1.5	77	M8	7	18	8	30	14	90	24	10	11	10	45	173
63	32	40	64	20	85	G3/8	17	M16 X 1.5	80,5	M8	7	18	8	31	14	98	24	10	11	10	48,5	184,5
80	40	52	78	25	103	G3/8	22	M20 X 1.5	92	M10	11	22	10	37	19	116	30	14	11	16	52	215
100	40	52	92	30	116	G1/2	19,5	M20 X 1.5	97	M10	11	26	10	40	19	126	30	14	12	20	57	231
125	54	60	110	32	140	G1/2	25	M27 X 2	119	M12	15	27	13	45	42	160	41	26	20	15	65	287
160	72	65	140	40	180	G3/4	30	M36 X 2	152	M16	17	36	16	55	52	180	55	31	25	15	80	340

Iz konstrukcijskih razloga potrebno je znati karakteristične udaljenosti na cilindru jer će cilidar biti postavljen vertikalno na gornju ploču, a iz danog presjeka vidi se da je cilindar stupnjevan.

4.1.3. Pomoćni elementi za dovod zraka prema cilindru

S obzirom da je riječ o dvoradnom cilindru potrebne su dvije navojne redukcije i dva voda. Navojnim redukcijama ¼ ostvaren je spoj cilindra i vodova za zrak. Vodovi su izrađeni od poliuretana dok su redukcije posebne izvedbe gdje se pomoću sigurnosnih sklopki može ručno prekinuti dovod i odvod zraka cilindru.

Slika 18: Priključak za zrak

Slika 19: Poliuretanski vodovi

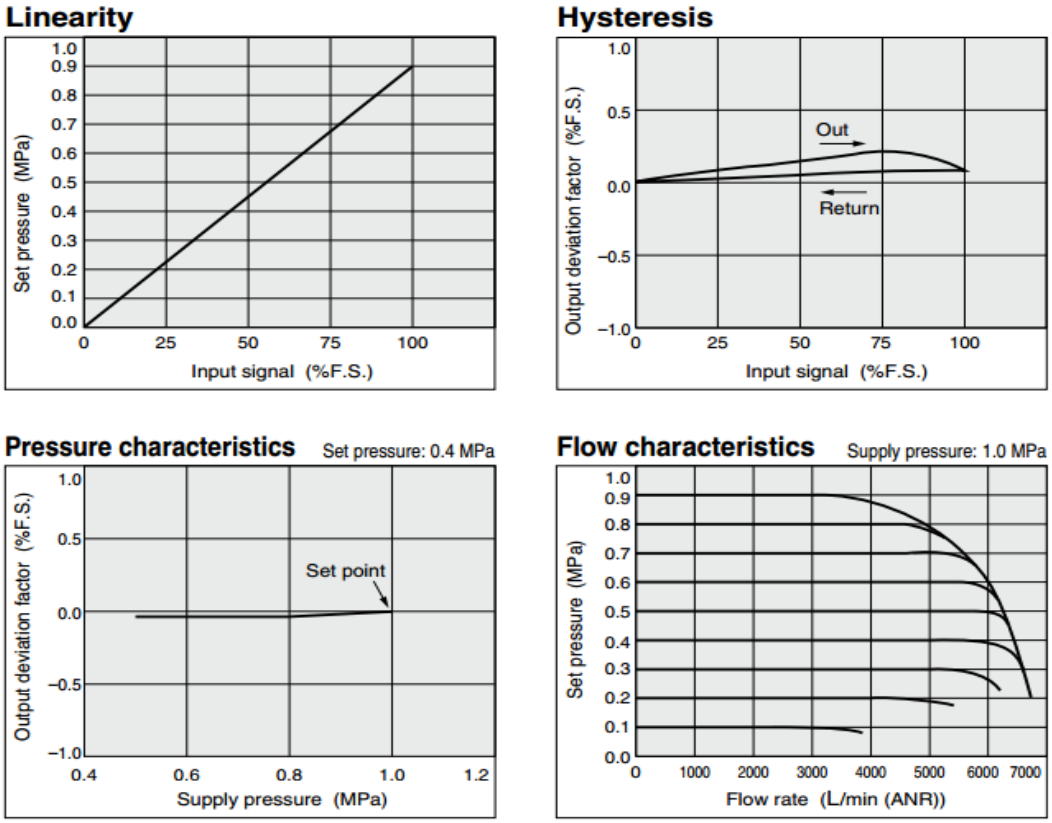
4.2. Proporcionalni tlačni regulator

Uloga proporcionalnog tlačnog regulatora je reguliranje izlaznog tlaka pomoću strujnog signala na ulazu. U pravilu su tlačni regulatori naponski upravljani, ali industrija se sve više usmjerava prozvodnji i uporabi strujno upravljanih regulatora. Takav je i *ITV3050-01F4N-Q* model na izrađivanoj pneumatskoj preši. Regulator sadrži 3 ulaza. Prvi ulaz spaja regulator s kompresorom, drugi regulator s cilindrom, dok treći predstavlja vod za rasterećenje grane u smjeru kompresora. Regulator je u normalnom stanju otvoren i spaja se direktno na cilindar pneumatske preše. Funkcija regulatora je ograničenje sile aktuatora koja ovisi o iznosu tlaka koji regulator ostvaruje.

Slika 20: Proporcionalni tlačni regulator

4.2.1. Značajke proporcionalnog tlačnog regulatora

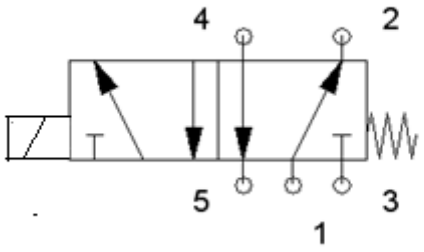
Ulazni signal tlačnog regulatora je struja u intervalu od 4-20 mA istosmjerne struje, a izlaz je tlak u rasponu 0.005-0.9 MPa. Iz izlaza regulatora vidljivo je da je maksimalna izlazna vrijednost 9 bara, međutim kompresor u laboratoriju daje tlak od 5 bara što znači da je krajnja vrijednost izlaznog tlaka za spomenutu prešu 0.5 MPa. Regulator se napaja s 24 Vdc. Izlazna karakteristika tlaka je linearna, a histereza i ponovljivost iznose 0,5%. Interval radne temperature je od 0-50 ℃.



Slika 21: Značajke proporcionalnog tlačnog regulatora prema katalogu proizvođača

4.3. Monostabilni razvodnik

Monostabilni razvodnik 5/2 predstavlja element koji preusmjerava protok zraka prema cilindru (izvlačenje klipa) ili od cilindra (uvlačenje klipa). Izvedba razvodnika omogućuje upravljanje brzinom uvlačenja i izvlačenja klipnjače putem prigušnica. Razvodnik napajamo s 24 V istosmjernog napona. U pneumatskoj shemi oznaka za ovu vrstu razvodnika je:



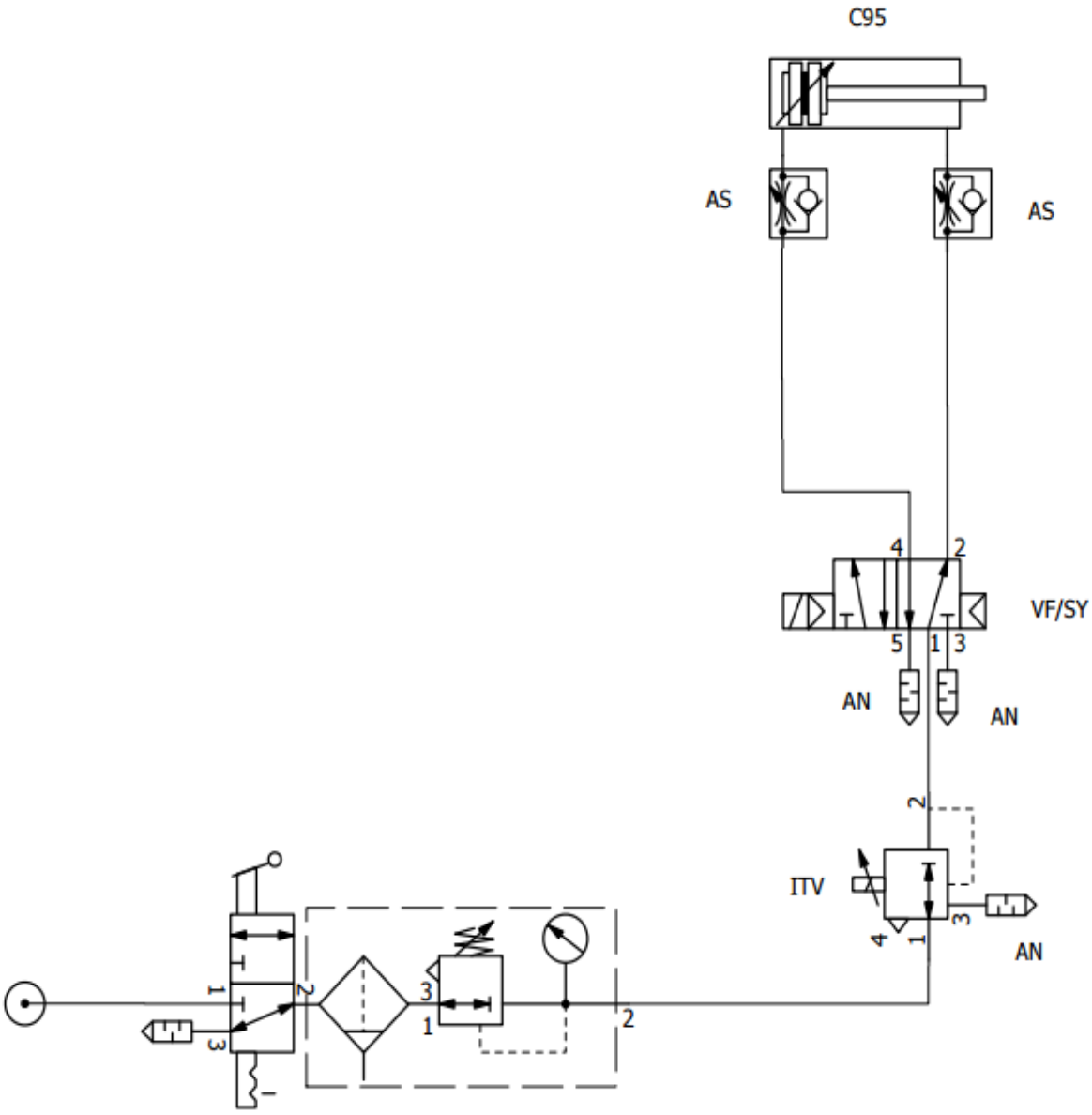
Slika 22: Oznaka razvodnika u pneumatskoj shemi

Slika 23: Monostabilni razvodnik 5/2

4.4. Pneumatska shema sustava preše

Prikazana shema sastavljena je od standardnih oznaka za pneumatske elemente. Proces započinje od kompresora zraka i završava s cilindrom. Potreban tlak iz kompresora vodovima se prenosi preko proporcionalnog tlačnog regulatora do monostabilnog razvodnika. Kad monostabilni razvodnik odredi smjer strujanja zraka, tlak od 5 bara napunit će gornju komoru cilindra i klip će se izvući. Za slučaj uvlačenja klipa monostabilni razvodnik prebacit će protok zraka u suprotnom smjeru i pomoću prigušnog nepovratnog ventila napuniti desnu komoru cilindra s manjim tlakom i na taj način ostvariti silu u suprotnom smjeru.

C95- pneumatski cilindar
ITV- proporcionalni tlačni regulator
AN- prigušnik buke
AS- prigušni nepovratni ventil
VF/SY- 5/2 monostabilni razvodnik
KP- kompresor zraka



Slika 24: Pneumatska shema

5 REGULACIJA SILE PNEUMATSKE PREŠE

5.1. PLC (Programable logic controler)

Upravljanje pneumatskom prešom riješeno je preko PLC logičkog kontrolera, proizvođača *Siemens*, modela *S7-200*. Kontroler sadrži 14 digitalnih ulaza i 10 digitalnih izlaza, dok se analogni izlazi i ulazi lako implementiraju pomoću ekspanzijskih modula. Osim toga, PLC sadrži EEPROM memoriju, koja se ne briše u slučaju nestanka napajanja ili sličnih situacija.

Slika 25: PLC mikrokontroler

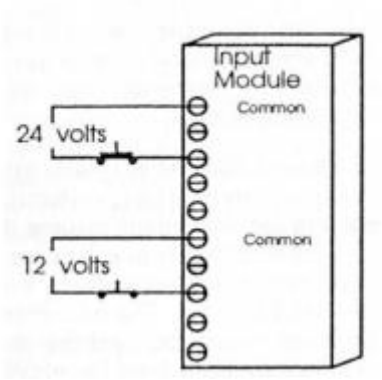
S obzirom da je najčešći problem kod programiranja raznih sustava neka vremenska zadrška ili eventualni broj izvedbi, PLC u sebi sadrži već gotova brojila (countere) i timere kako bi si lakše ostvario potrebni algoritam koji rješava problem sustava pneumatske preše.

5.1.1. Ulazne i izlazne komponente pneumatske preše

Sustav pneumatske preše sadrži 3 elementa koji ulaze u razmatranje upravljanja, senzor, proporcionalni tlačni regulator i monostabilni razvodnik. Ideja regulacije je takva da se za postizanje potrebne sile tlačenja, pošalje određeni napon tlačnom regulatoru i preko njega ostvari određeni tlak koji će se preko cilindra i klipa prenositi kao sila na oprugu ispod koje se nalazi senzor koji ostvaruje povratnu vezu. S obzirom da se radi o dvoradnom cilindru, potrebno je ostvariti tlak i u suprotnom smjeru da bi se klip vratio u prvobitan položaj. Upravljanje je pritom riješeno sa senzorom kao ulazom, te s razvodnikom i tlačnim regulatorom kao izlazima sustava pneumatske preše.

5.1.1.1. Problem implementiranja tlačnog regulatora

Proporcionalni tlačni regulator je strujno upravljan jer se radi o novijem modelu koji je dostupan na tržištu. S obzirom da je PLC zamišljen kao naponski upravljan dolazi do problema u upravljanju. Takav problem je riješen elektroničkom pločicom koja će napon od 12 ili 24 V pretvarati u strujni signal u intervalu od 5-20 mA proporcionalnom tlačnom regulatoru.



Slika 26: Input PLC-a

5.1.1.2. Napajanje sustava pneumatske preše

Napajanje sustava peumatske preše riješit će se s AC/DC pretvornikom koji pretvara napon 220V izmjenične struje iz mreže u 24 V istosmjernog napona. Na ovaj način ostvarit će se napajanje za sve potrebne elemente u sustavu.

Slika 27: Pretvarač napona

5.2. Programiranje PLC-a

Step 7 je programski paket koji podržava Siemensov PLC kontroler, pa će se u tom programu izvršiti upravljanje pneumatskom prešom.

5.2.1. Adresiranje

Na slici 28 prikazani su simboli korišteni prilikom izrade PLC programa za upravljanje pneumatskom prešom. U stupcu *Address* su memorijske lokacije pojedine varijable. Svaka varijabla mora imati definiranu vrstu podatka, stupac *Data type*. Kako bi se olakšalo snalaženje u programu napisani su i jednostavni komentari.

S7 Program(3) (Symbols) -- Zavrsni\SIMATIC 300(1)\CPU 315-2 DP

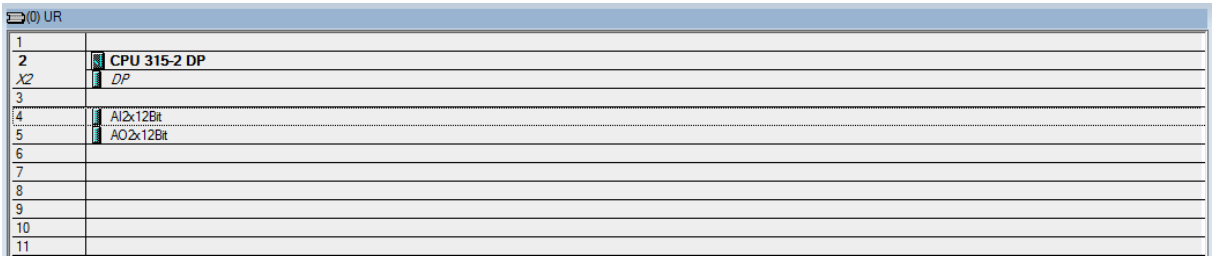
	Statu	Symbol	Address	Data type	Comment
1		always_false	M 0.2	BOOL	uvijek 0
2		always_true	M 0.1	BOOL	uvijek 1
3		error	MW 54	WORD	greska citanja/pisanja
4		Glavni program	OB 1	OB 1	
5		pressure_reference	MD 50	REAL	referenca tlaka
6		process_value_unscaled	MD 56	REAL	masa
7		pv_scaled	MD 60	REAL	skaliran izlaz iz senzora
8		SCALE	FC 105	FC 105	Scaling Values
9		UNSCALE	FC 106	FC 106	Unscaling Values
1					

Slika 28: Tablica simbola

5.2.2. Programiranje u ladder dijagramima

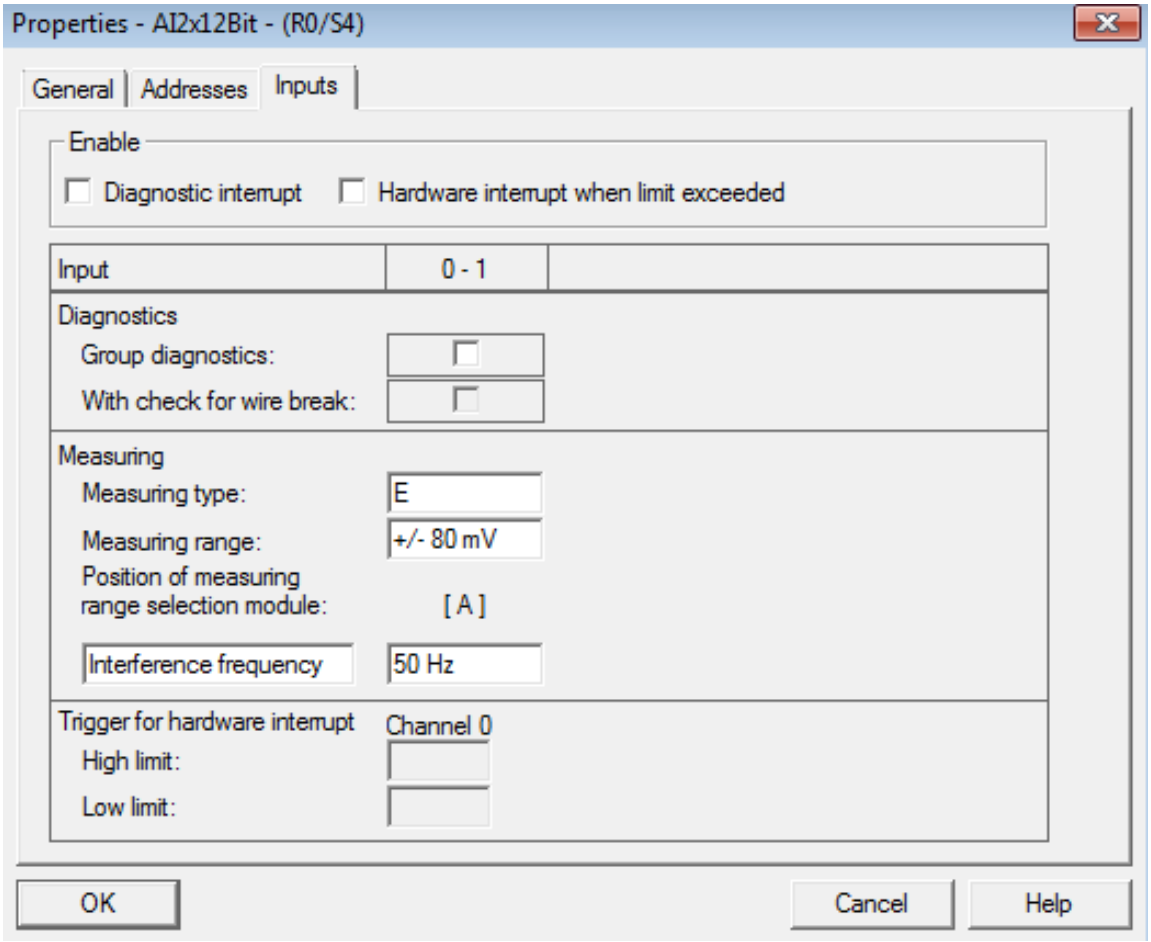
PLC program se sastoji od čitanja analognih ulaza. U završnom radu se koristio senzor sile specificiran u poglavlju 3. Maksimalni napon senzora je 20 mV pri napajanju od 10 VDC, a minimalni je 10mV. Kako bi bilo moguće sa što većom rezolucijom čitati iznos

sile, odnosno mase odabran je analogni modul s opcijom čitanja što manjeg napona. Odabrani *hardware* prikazan je na slici 29.



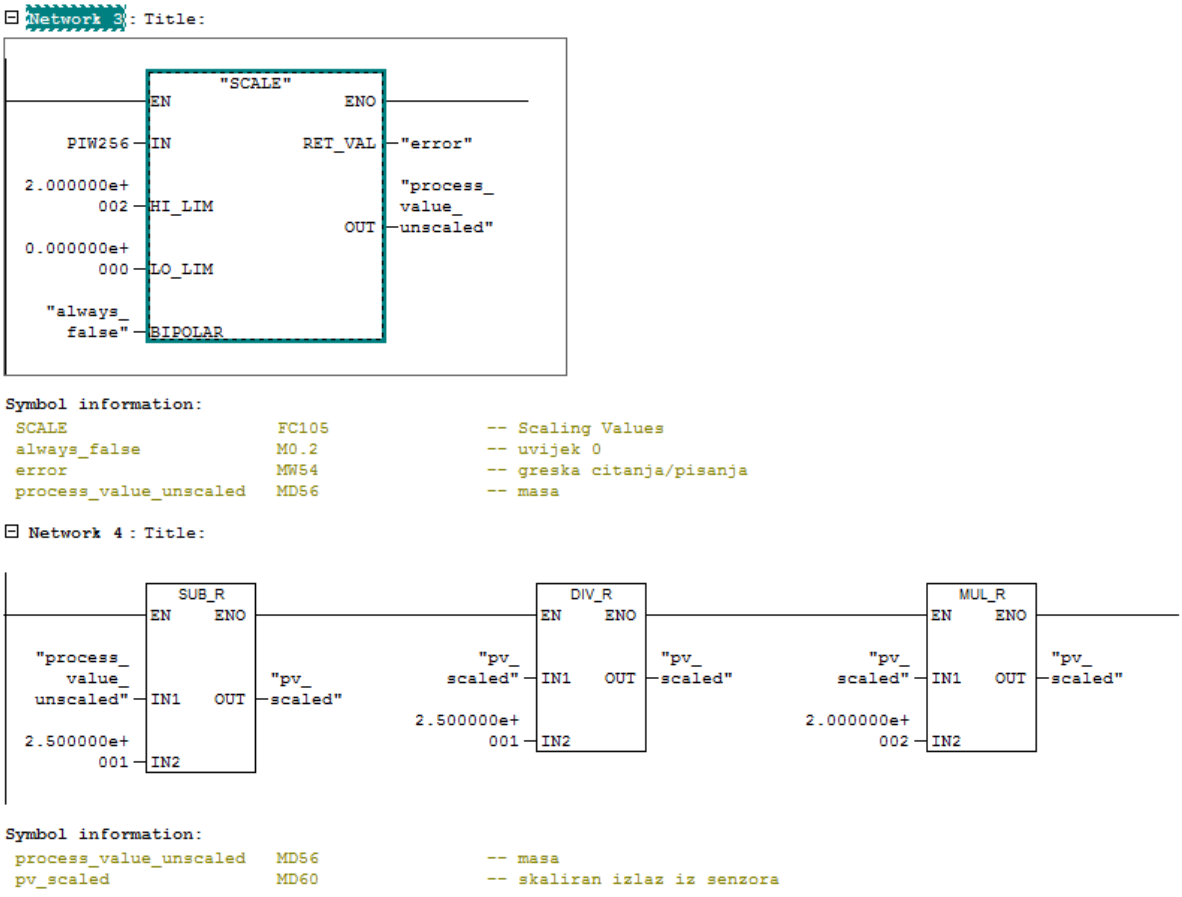
Slika 29: Odabrani *hardware*

Zaključeno je kako odabir analognog ulaza s očitanjem napona u intervalu 0-80mV daje najbolju rezoluciju. Naime zbog nepoklapanja izlaznog intervala senzora s ulaznim naponskim intervalom analognog modula PLC-a u programu će se dobiveni iznos morati dvostruko skalirati. Postavke istog prikazane su na slici 30.



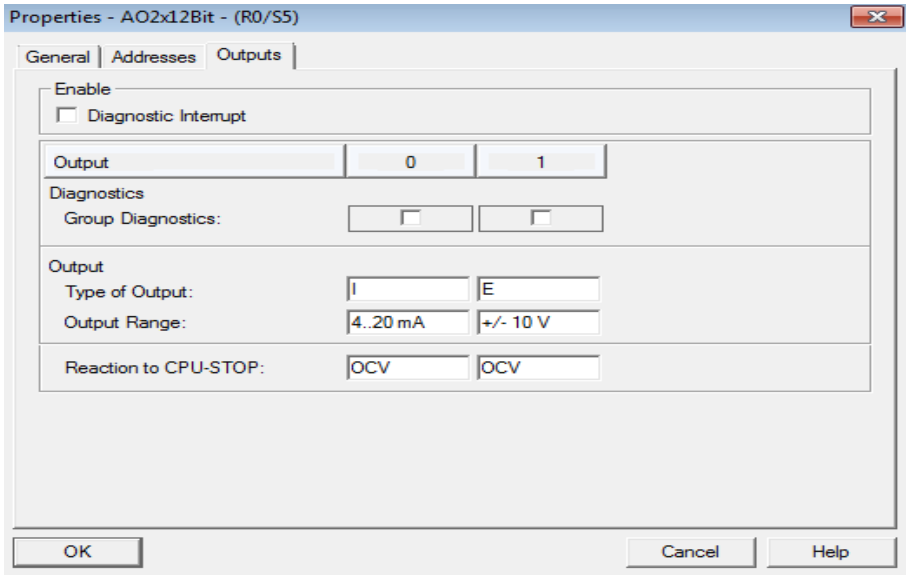
Slika 30: Postavke analognog ulaza

Napon na ulazu u PLC se pretvara u 12-bitni broj s minimalnim iznosom 0 i maksimalnim iznosom 27648. Za minimalni iznos sile prešanja od 0 N senzor daje 10 mV. Taj napon se pretvara u vrijednost 3456 u PIW256 registru. Ugrađena funkcija FC105 skaliranjem na interval 0-200 kg daje 25 kg. U networku 4 napravljeno je dodatno skaliranje, a cijeli postupak prikazan je slikom 31.

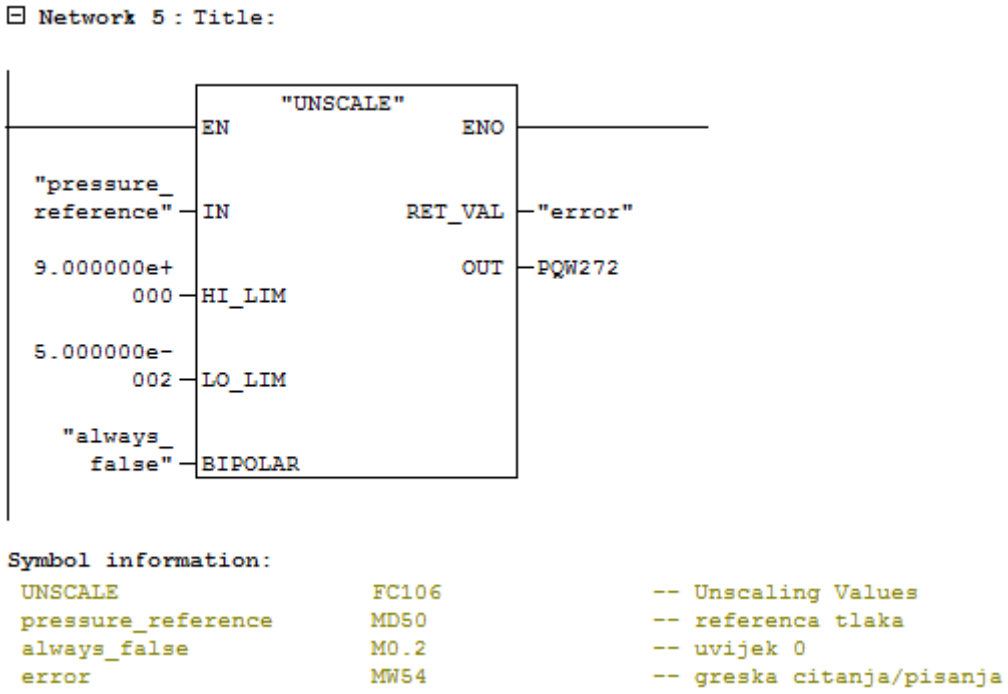


Slika 31: Skaliranje analognog ulaza

Aktuator u procesu upravljanja je proporcionalni tlačni regulator (ventil) koji prima struju 4-20mA. Sukladno tome odabran je analogni izlaz s identičnom izlaznom strujom. Na taj način je elegantno izbjegnut problem skaliranja tlaka na pripadni mu iznos struje. Čitanje analognog ulaza je u *network*-u 5. Opisani proces izveden je ugrađenom funkcijom FC106. Postavke analognog izlaza su na slici 32, a *ladder* dijagram na slici 33.



Slika 32: Postavke analognog izlaza



Slika 33: Ladder dijagram za postavljanje analognog izlaza

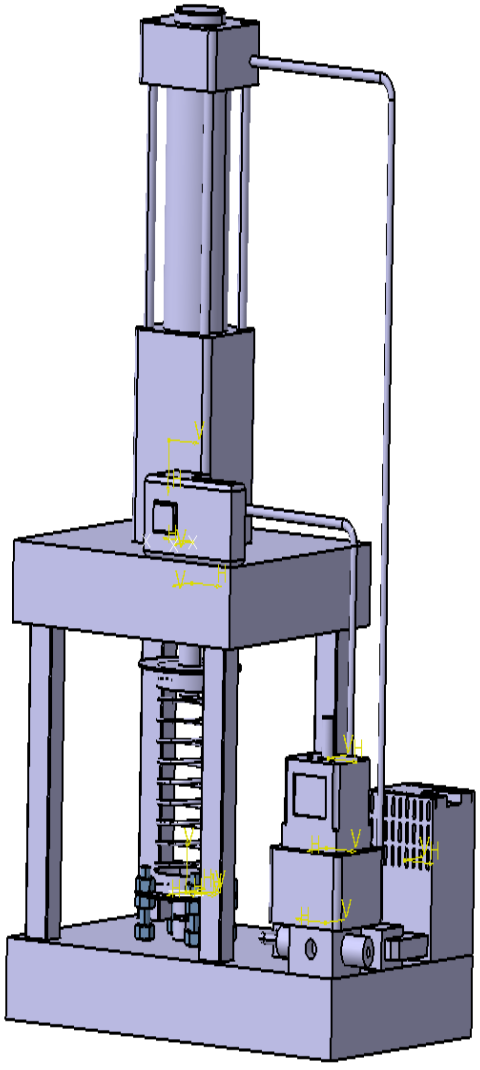
6 Zaključak

U ovom završnom radu se predočava veza između senzora sile, koji je mjerni element, proporcionalnog tlačnog ventila kao izvršnog člana i pneumatskog cilindra kao aktuatora u sustavu pneumatske preše. Cijelim procesom upravlja logički kontroler *PLC*. Način upravljanja riješen je preko analognih ulaza i izlaza, u svrhu regulacije sile koristeći senzor pomoću kojeg se ostvaruje povratna veza.

Za daljne razvijanje upravljanja pneumatskom prešom bi bilo zanimljivo razmatrati upravljanje hodom pneumatskog cilindra. Hod pneumatskog cilindra se također može prikazati preko programiranih funkcija gibanja, radi postizanja istovremene regulacije sile i hoda cilindra.

Ova nastavna maketa pneumatske preše objedinjuje sva znanja stečena kroz studij, a najveći naglasak daje na upravljanje elektropneumatskim sustavima. Sustavi ove vrste se razvijaju vrlo brzo i u skoroj budućnosti ćemo zasigurno svjedočiti mnogim inovacijama iz ove inženjerske discipline. Kao što nam i sama izvedba pokazuje, pneumatska preša koja je razmatrana u kontekstu ovog završnog rada, nema neku konkretnu namjenu, ali je izvrstan primjer kako se kroz jednostavne nastavne makete mogu zorno prikazati problemi kojima se bavi automatika.

Laboratij za automatiku i robotiku, Fakulteta strojarstva i brodogradnje, sadržava velik broj sličnih pneumatskih sustava koje su izradili studenti u sklopu svojih završnih radova, jedan od tih će biti i pneumatska preša koja je obrađena u ovom završnom radu.



Slika 34: Pneumatska preša

Literatura:

[1] Željko Šitum: Regulacija hidrauličkih i pneumatskih sustava, Fakultet strojarstva i brodogradnje, Zagreb, 2015.

[2] Davor Zorc: Mikroprocesorsko upravljanje, , Fakultet strojarstva i brodogradnje, Zagreb, 2015.

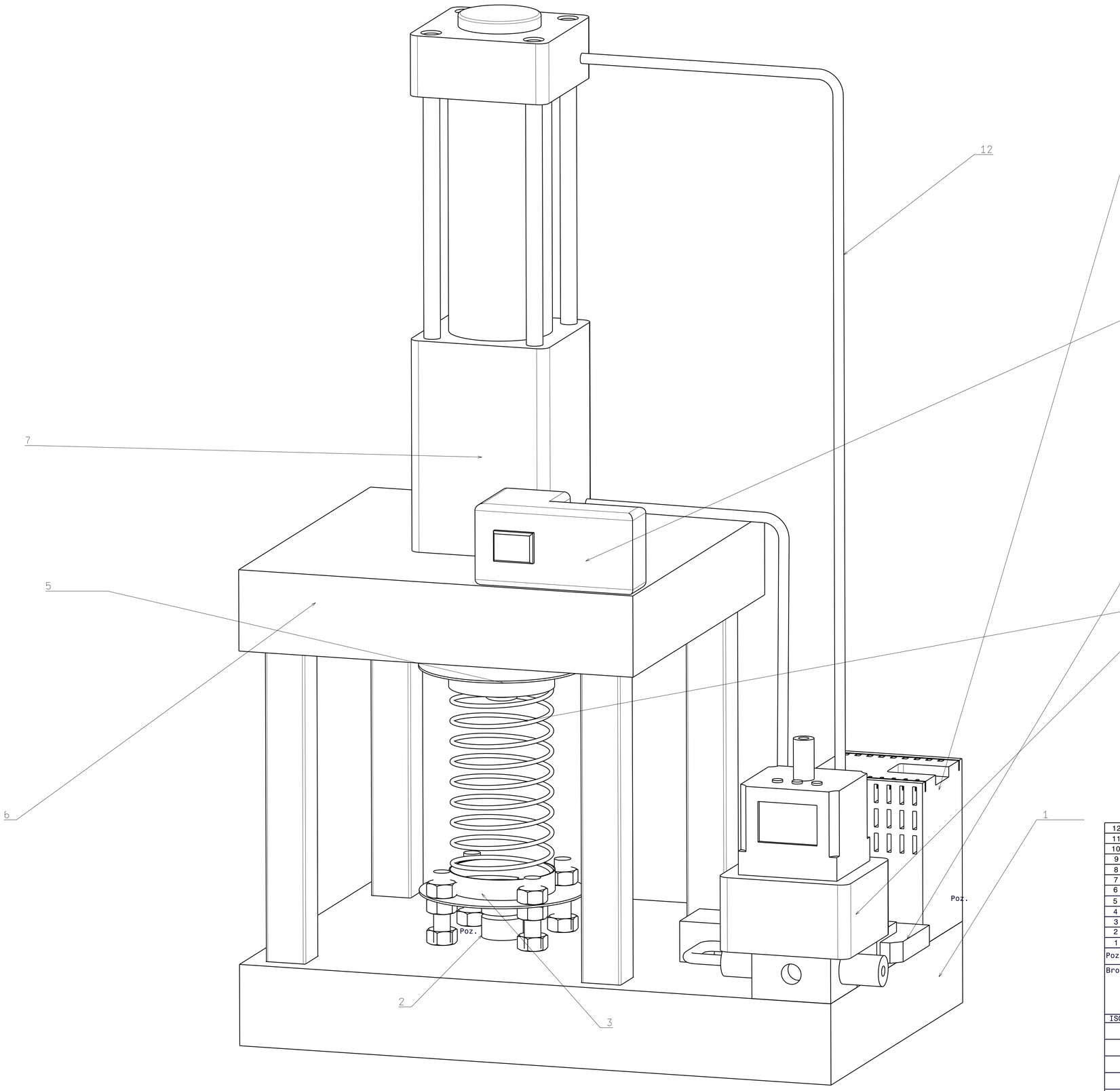
[3] Nenad Kranjčević: Elementi strojeva, Fakultet strojarstva i brodogradnje, Zagreb, 2012.

[4] Bojan Kraut: Strojarski priručnik

Prilozi:

Tehnička dokumentacija:

1. Pneumatski cilindar
2. Proporcionalni tlačni regulator
3. Crteži



Isometric view
Scale: 1:1

Poz.	Naziv dijela	Kom.	Crtež broj / Norma	Materijal	Sirove dimenzije / Proizvođač	Masa
12	Pneumatski vodovi					
11	PLC					
10	Monostabilni razvodnik					
9	Proporcionalni tlacni regulator					
8	AC/DC Konverter					
7	Pneumatski cilindar					
6	Gornja ploca			Drvo		
5	Gornji prihvat opruge			Celik		
4	Opruga			Celik		
3	Donji prihvat opruge			Celik		
2	Senzor					
1	Donja Ploca			Drvo		

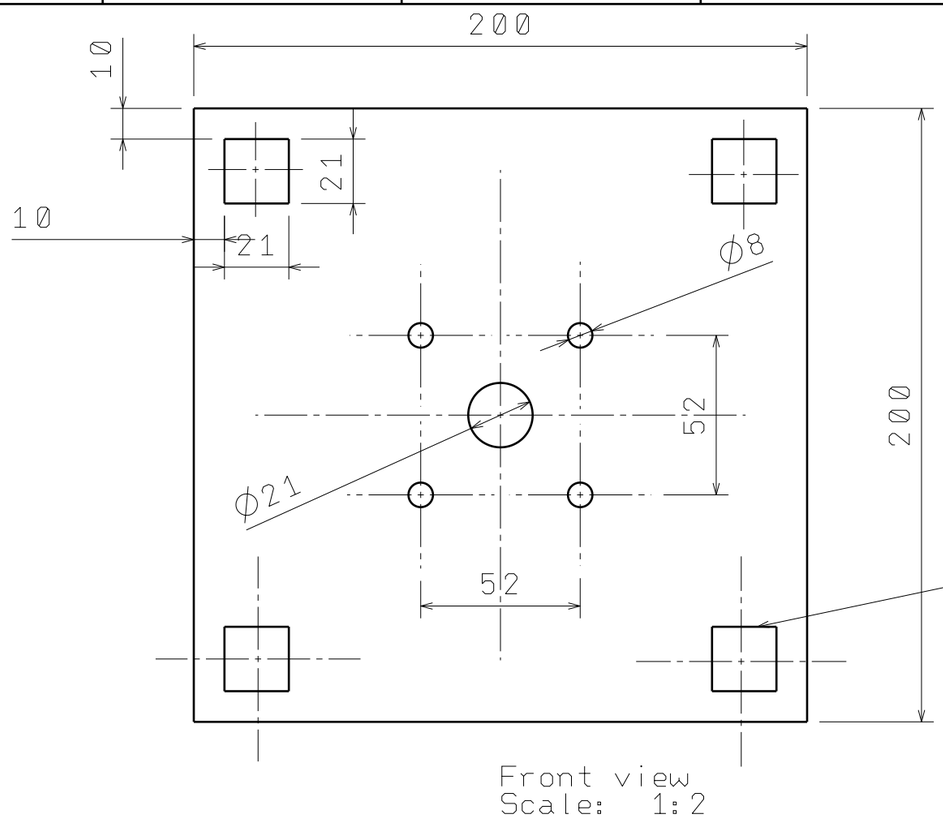
Broj naziva - code		Datum	Ime i prezime	Potpis
	Projektirao		Nikola Rajcic	
	Razradio		Nikola Rajcic	
	Crtao		Nikola Rajcic	
	Pregledao		Željko Šitum	
	Voditelj rada		Željko Šitum	

FSB Zagreb

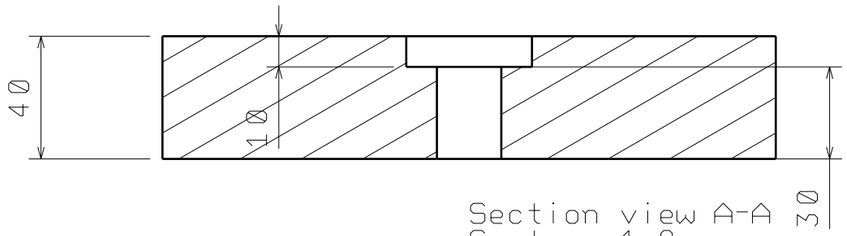
ISO - tolerancije	Objekt:	Objekt broj:
		R. N. broj:
	Napomena:	Mehatronika i robotika / Kopija
	Materijal:	Masa: / ZAVRŠNI RAD
Mjerilo originala 1:1	Naziv: Pneumatska presa	Pozicija: / Format: A1
	Crtež broj:	List: 1

0 10 20 30 40 50 60 70 80 90 100

Design by CADLab

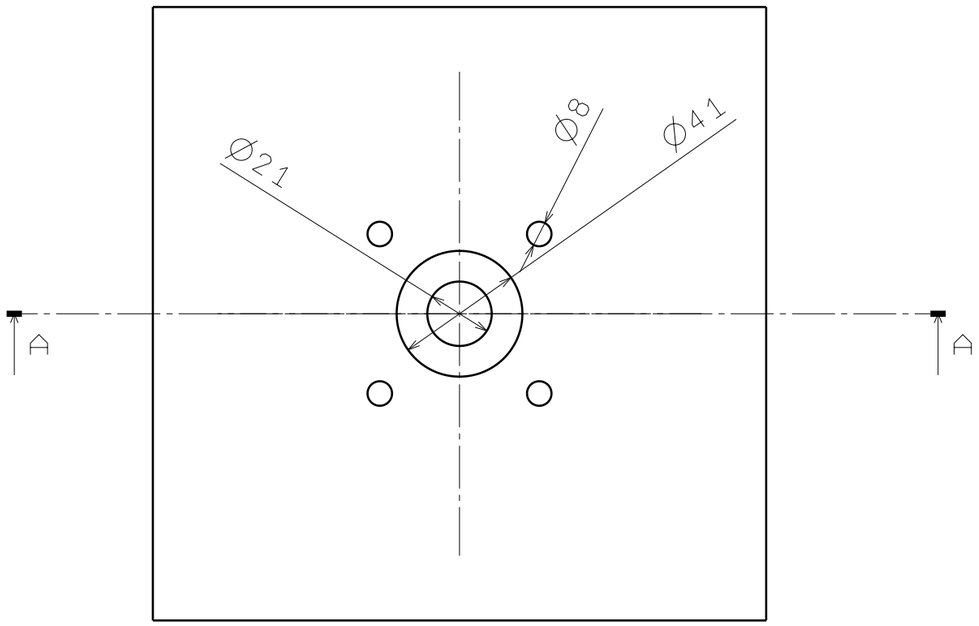


Front view
Scale: 1:2



Section view A-A
Scale: 1:2

Dubina sva 4 uvrta 20 mm (cca do pola ploče)



Front view
Scale: 1:2

Poz.	Naziv dijela	Kom.	Crtež broj	Materijal	Dimenzije	Masa

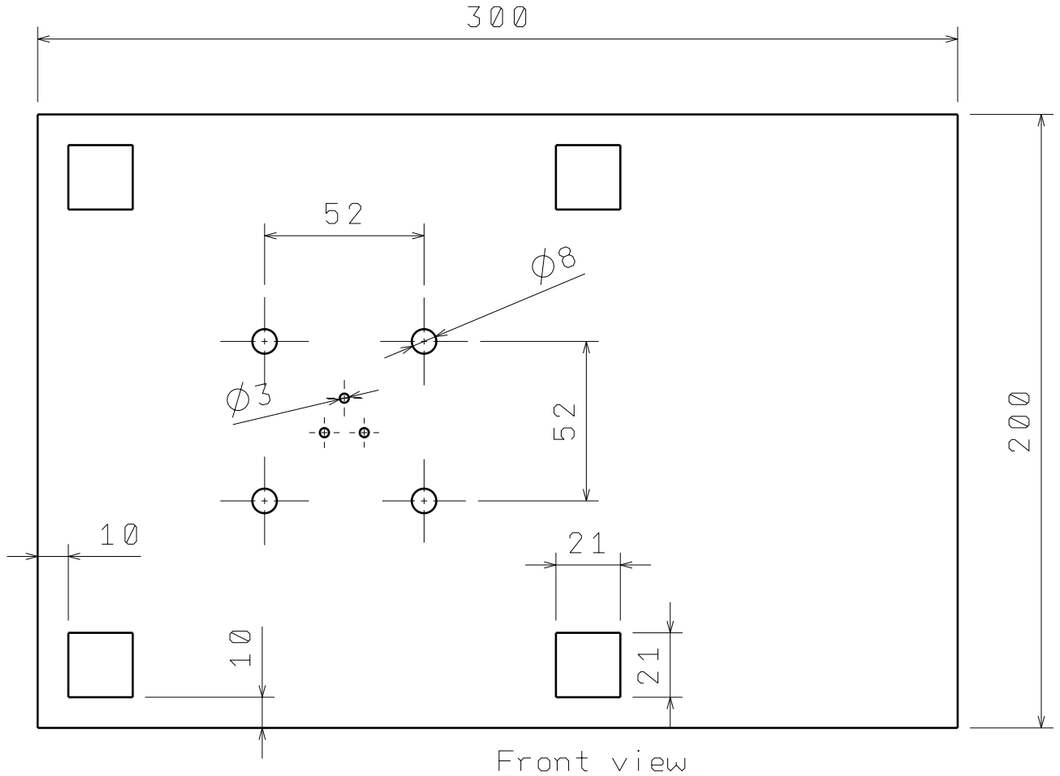
Broj naziva - code		07.02.2017	Potpis
	Projektirao	07.02.2017	Nikola Rajčić
	Razradio	07.02.2017	Nikola Rajčić
	Crtao	07.02.2017	Nikola Rajčić
	Pregledao	07.02.2017	Nikola Rajčić
			Nikola Rajčić

FSB Zagreb

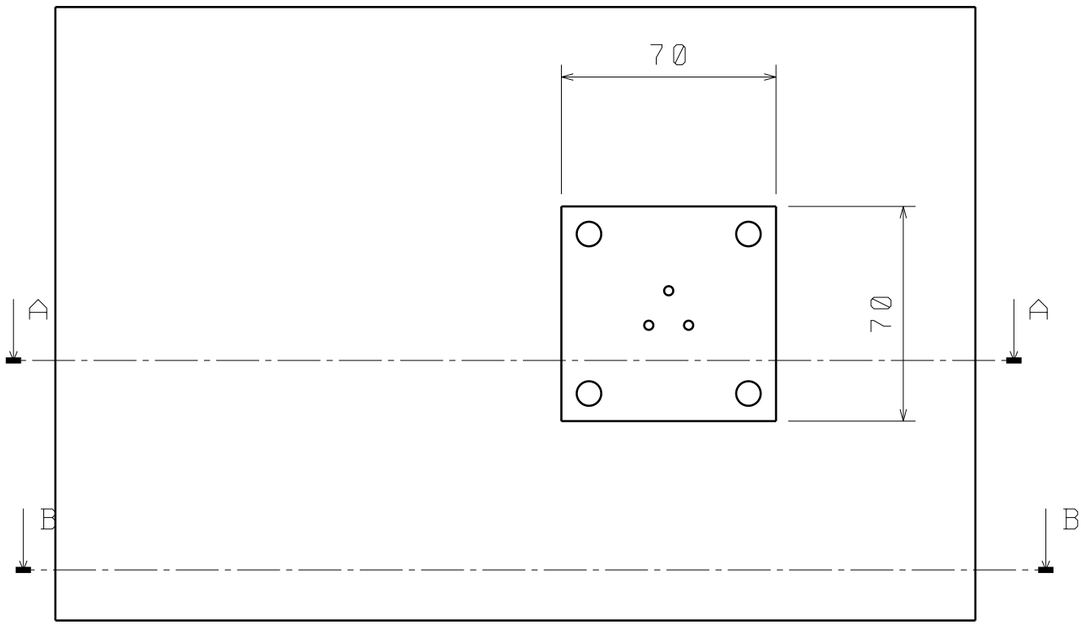
ISO - tolerancije	Pneumatska presa		Objekt broj:
			R. N. broj:
	Napomena:		Kopija
	Materijal:	Masa:	
	Naziv: Gornja ploca		Pozicija:
	Mjerilo originala 1 : 2		Format: A3
			Listova:
	Crtež broj:		List:

Design by CADLab

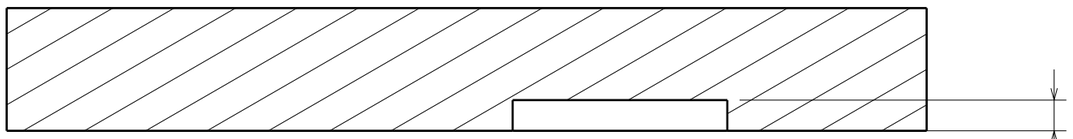
0 10 20 30 40 50 60 70 80 90 100



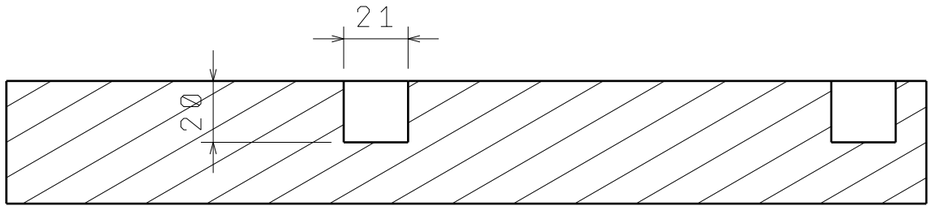
Front view
Scale: 1:2



Front view
Scale: 1:2



Section view A-A
Scale: 1:2



Section view B-B
Scale: 1:2

Poz.	Naziv dijela	Kom.	Crtež broj	Materijal	Dimenzije	Masa
1						

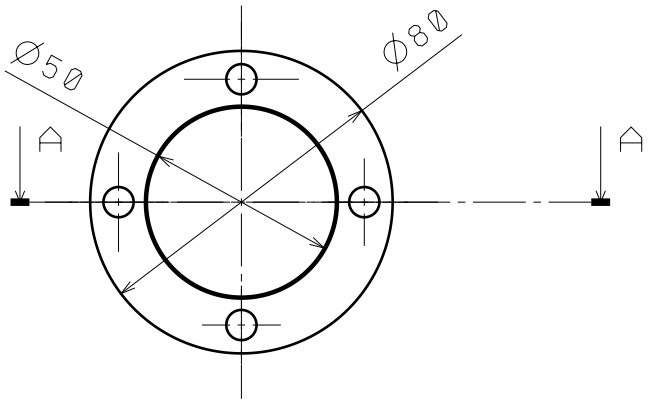
Broj naziva - code		07.02.2017		Potpis
	Projektirao	07.02.2017	Nikola Rajčić	
	Razradio	07.02.2017	Nikola Rajčić	
	Crtao	07.02.2017	Nikola Rajčić	
	Pregledao	07.02.2017	Nikola Rajčić	
			Nikola Rajčić	

FSB Zagreb

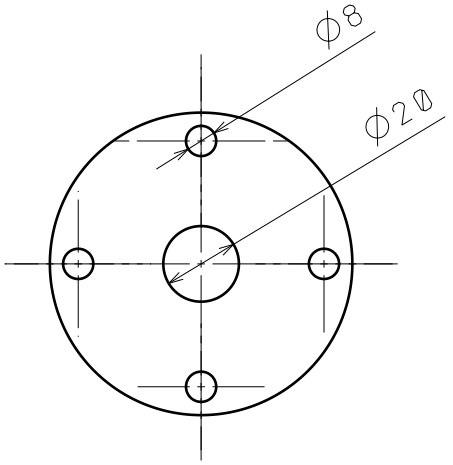
ISO - tolerancije	Pneumatska presa	Objekt broj:	
		R. N. broj:	
	Napomena:		Kopija
	Materijal:	Masa:	
	Naziv: Donja ploca	Pozicija:	Format: A3
	Mjerilo originala 1 : 2		Listova:
	Crtež broj:		List:

0 10 20 30 40 50 60 70 80 90 100

Design by CADLab



Front view
Scale: 1:2



Front view
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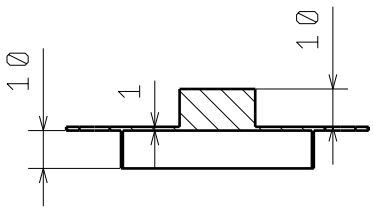

Section view A-A
Scale: 1:2

Broj naziva - code		Datum	Ime i prezime	Potpis
	Projektirao		Nikola Rajčić	
			Nikola Rajčić	
	Razradio		Nikola Rajčić	
	Crtao			
	Pregledao			
ISO - tolerancije	Objekt:		Objekt broj:	
			R. N. broj:	
	Napomena:			Kopija
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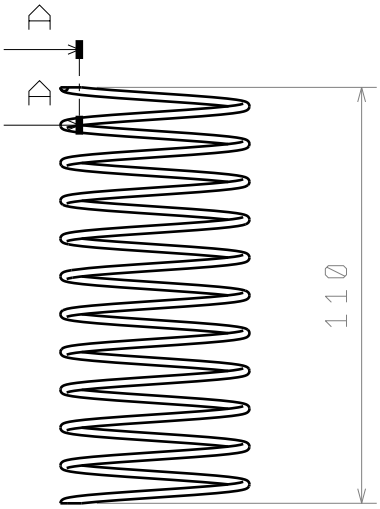
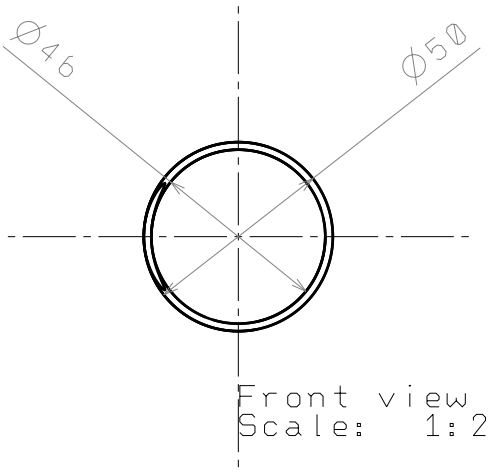
Design by CADLab



Front view
Scale: 1:2

Section view A-A
Scale: 1:2



Front view
Scale: 1:2

Broj naziva - code		Datum	Ime i prezime	Potpis
	Projektirao		Nikola Rajčić	
	Razradio		Nikola Rajčić	
	Crtao		Nikola Rajčić	
	Pregledao			
ISO - tolerancije	Objekt:		Objekt broj:	
			R. N. broj:	
	Napomena:			Kopija
	Materijal:	Masa:		
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		Crtež broj:		List:

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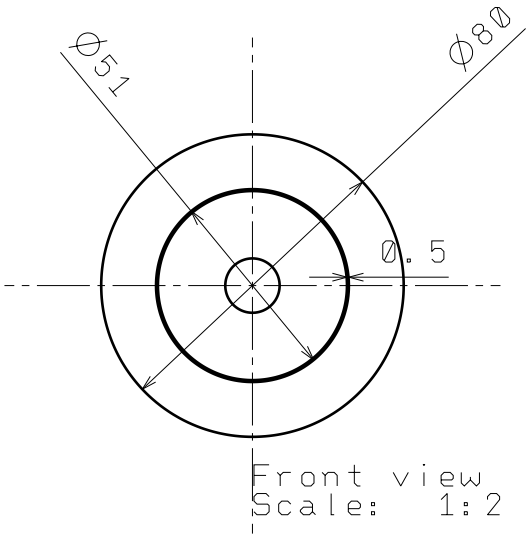
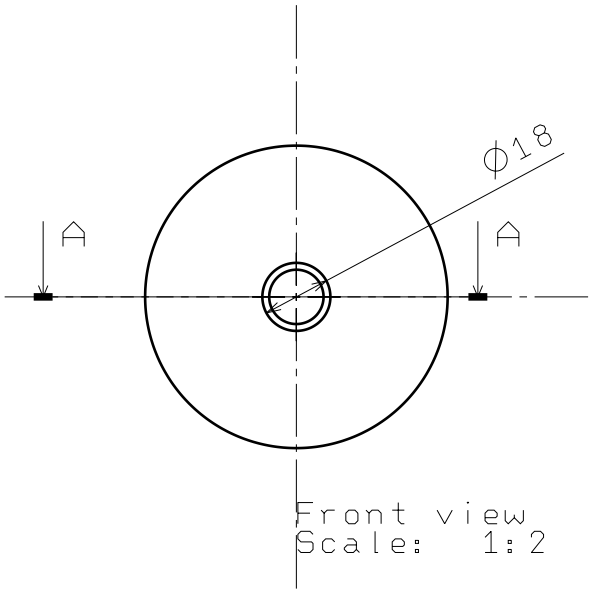
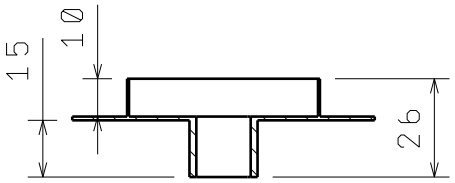
Design by CADLab



Front view
Scale: 1:2



Front view
Scale: 1:2



Section view A-A
Scale: 1:2

Broj naziva - code		Datum	Ime i prezime	Potpis
	Projektirao		Nikola Rajčić	
	Razradio		Nikola Rajčić	
	Crtao		Nikola Rajčić	
	Pregledao			

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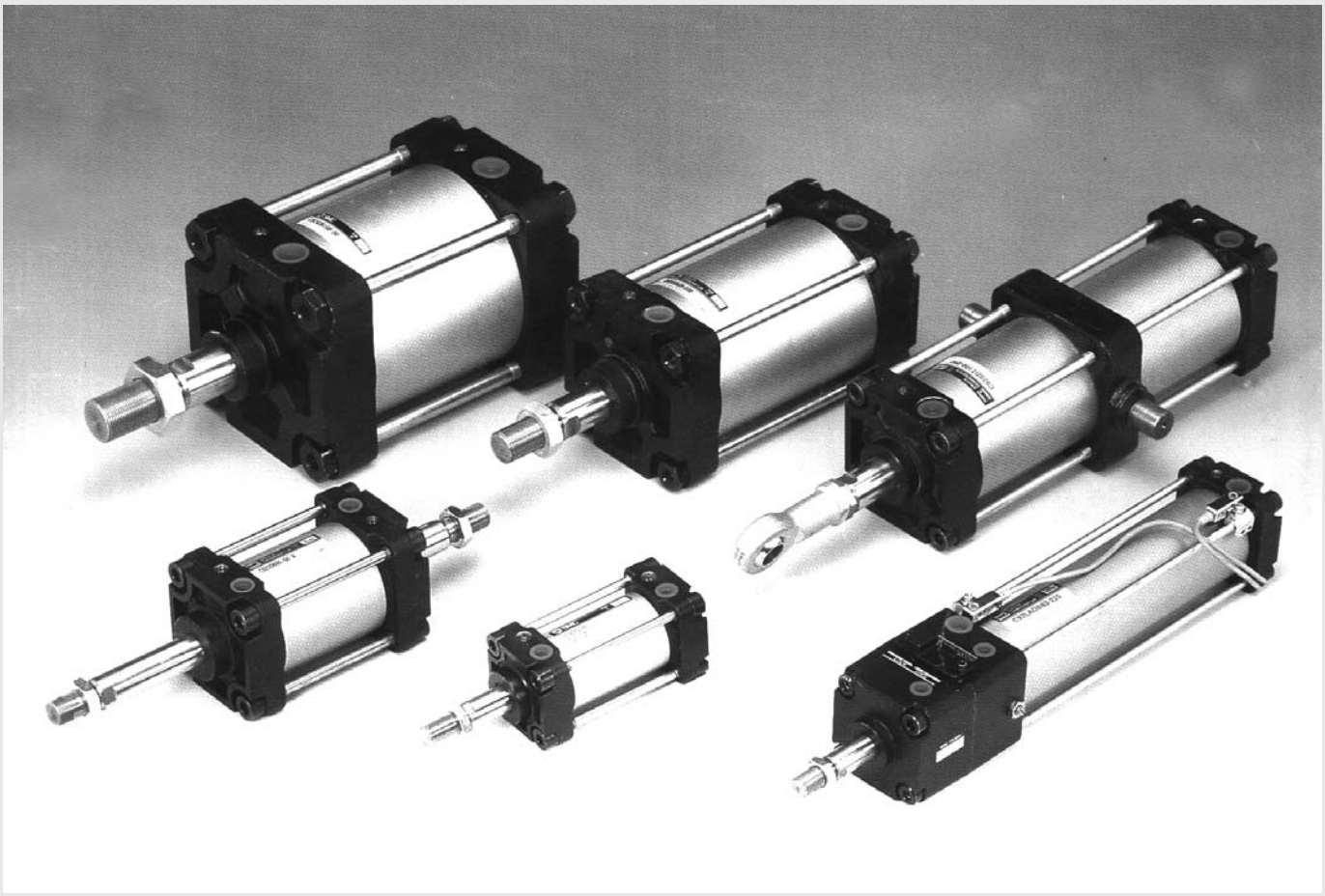
ISO - tolerancije	Objekt:	Objekt broj:	
		R. N. broj:	
	Napomena:		Kopija
	Materijal:	Masa:	
	Mjerilo orginala 1:2	Naziv: Gornji prihvat opruge	Pozicija:
		Crtež broj:	Format:
			Listova:
			List:

Design by CADLab

ISO Cylinder
Series C92

ø32, ø40, ø50, ø63, ø80, ø100, ø125, ø160

Dimensions conform to ISO 6431, CETOP RP43P up to ø100, CETOP RP53P for ø125 and ø160



Variations

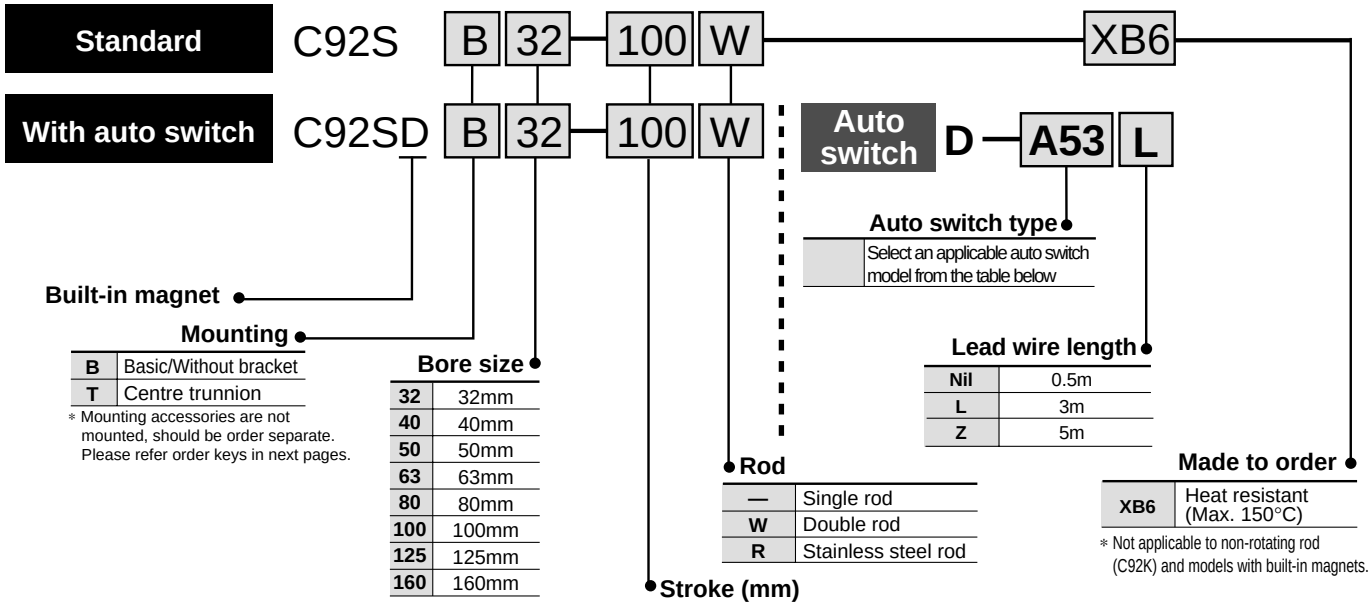
Series	Action	Style		Basic	Standard variations: Buit-in magnet	Standard variations: Stainless steel rod	Made to Order: Heat resist.	Bore (mm)	Page
Standard Series C92 	Double acting	Single rod	Non-lube	●	●	●	●	32, 40, 50, 63, 80, 100, 125, 160	1.12-2
		Double rod	Non-lube	●	●	●	●		
Non-rotating rod Series C92K 	Double acting	Single rod	Non-lube	●	●	●		32, 40, 50, 63	1.12-10
		Double rod	Non-lube	●	●	●			

ISO Cylinder/Standard: Double Acting

Series C92

ø32, ø40, ø50, ø63, ø80, ø100, ø125, ø160

How to Order



Applicable Auto Switches/Tie rod mounting

Style	Special function	Electrical entry	Indicator	Load voltage: Wiring (Output)	DC		AC	Auto switch model	Lead wire (m)∗: 0.5 (—)	3 (L)	5 (Z)	Applicable load	
Reed switch	—	Grommet	Yes	3 wire (Equiv. to NPN)	—	5V	—	**A56**	●	●	—	IC	—
				2 wire	24V	12V	—	**A53**	●	●	●	—	Relay PLC
						5V,12V	100V,200V	**A54**	●	●	●		
			No			5V,12V	—	**A67**	●	●	—	IC	
						12V	200V or less	**A64**	●	●	—		
	Diagnosis indication (2 colour)		Yes			—	—	**A59W**	●	●	—	—	
Solid state switch	—	Grommet	Yes	3 wire (NPN)	24V	5V,12V	—	**F59**	●	●	○	IC	Relay PLC
				3 wire (PNP)				**F5P**	●	●	○		
				2 wire	—	—	100V,200V	**J51**	●	●	○	—	
					24V	12V	—	**J59**	●	●	○		
	Diagnosis indication (2 colour)			3 wire (NPN)		5V,12V		**F59W**	●	●	○	IC	
				3 wire (PNP)				**F5PW**	●	●	○		
				2 wire		12V		**J59W**	●	●	○	—	
	Water resistant (2 colour)							**F5BA**	—	●	○		
	With timer			3 wire (NPN)		5V,12V		**F5NT**	—	●	○	IC	
	Diagnosis output (2 colour)			4 wire (NPN)				**F59F**	●	●	○		
	Latch diagnosis output (2 colour)					—		**F5LF**	●	●	○	—	

∗ Lead wire length 0.5m····· — (Example: A53)
3m····· L (Example: A53L)
5m····· Z (Example: A53Z)

○: Manufactured upon receipt of order.

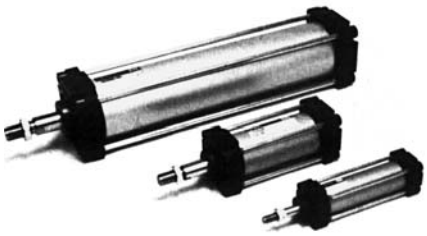
Auto Switch Mounting Bracket Part No.

Bore size	Mounting bracket
ø32	BT-03
ø40	BT-03
ø50	BT-04
ø63	BT-04
ø80	BT-06
ø100	BT-06
ø125	BT-08
ø160	BT-16

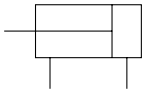
Mounting Bracket Part No.

Bore size	ø32	ø40	ø50	ø63	ø80	ø100	ø125	ø160
Foot(1)	L32	L40	L50	L63	L80	L100	L125	L160
Flange	F32	F40	F50	F63	F80	F100	F125	F160
Single rear clevis	C32	C40	C50	C63	C80	C100	C125	C160
Double rear clevis	D32	D40	D50	D63	D80	D100	D125	D160

Note 1) Two foot brackets required for one cylinder.



JIS Symbol
Double acting



Minimum Strokes for Auto Switch Mounting

Refer to p.1.12-12 for "Minimum Strokes for Auto Switch Mounting".

Specifications

Bore size	ø32	ø40	ø50	ø63	ø80	ø100	ø125	ø160
Action	Double acting							
Fluid	Air							
Proof pressure	1.5MPa							
Max. operating pressure	1.0MPa							
Min. operating pressure	0.05MPa							
Ambient and fluid temperature	Without magnet –10 to 70°C (No freezing)							
	With magnet –10 to 60°C (No freezing)							
Lubrication	Not required (Non-lube)							
Operating piston speed	50 to 500 mm/s							
Allowable stroke tolerance	to 250: $^{+1.0}_{0}$, 251 to 1000: $^{+1.4}_{0}$,1001 to 1500: $^{+1.8}_{0}$							
Cushion	Both ends (Air cushion)							
Thread tolerance	JIS class 2							
Port size	G1/8	G1/4	G1/4	G3/8	G3/8	G1/2	G1/2	G3/4
Mounting	Basic, axial foot, front flange, rear flange, single rear clevis, double rear clevis, centre trunnion							

Standard Stroke

Bore size (mm)	Standard stroke (mm)	Max. * stroke
32	25, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500	1900
40	25, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500	1900
50	25, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500	1900
63	25, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500	1900
80	25, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500	1900
100	25, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500	1900
125	25, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500	2900
160	25, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500	2900

Intermediate strokes are available.
* Consult SMC for longer strokes.

Applicable Auto Switches

Style	Auto switch model	Electrical entry (function)
Reed switch	**D-A5□/A6□**	Grommet
	D-A59W	Grommet (2 colour indication)
Solid state switch	**D-F5□/J5□**	Grommet
	D-F5□W/J59W□	Grommet (2 colour indication)
	D-F5BA	Grommet (2 colour, Water resistant)
	D-F5□F	Grommet (2 colour, diagnosis output)
	D-F5NT	Grommet (Timer)

Accessories

Mounting		Basic	Foot	Front flange	Rear flange	Single rear clevis	Double rear clevis	Center trunnion
Standard	Rod end nut	●	●	●	●	●	●	●
	Clevis pin	—	—	—	—	—	●	—
Option	Single rod clevis	●	●	●	●	●	●	●
	Double rod clevis (with pin)	●	●	●	●	●	●	●
	Rod boot	●	●	●	●	●	●	●

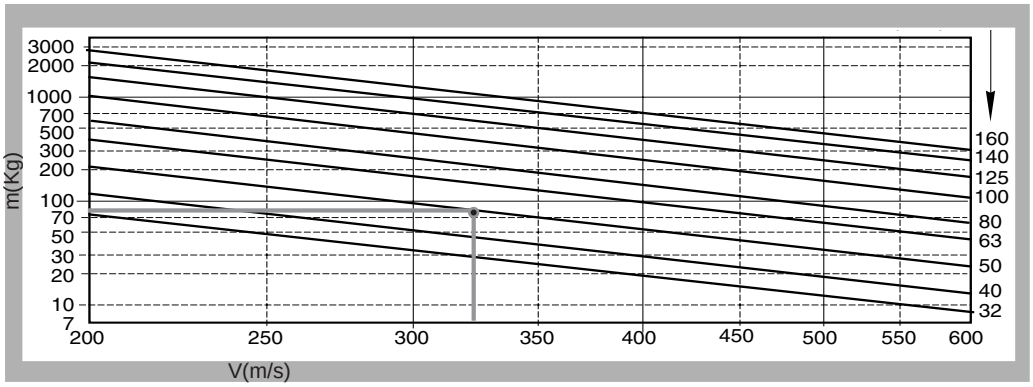
Theoretical Force

(Unit : N) OUT IN

Bore size (mm)	Rod diameter (mm)	Operating direction	Piston area (mm^2)	Operating pressure (MPa)								
				0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
32	12	OUT	804	161	241	322	402	483	563	643	724	804
		IN	691	138	207	276	346	415	484	553	622	691
40	16	OUT	1257	251	377	503	628	754	880	1005	1131	1257
		IN	1056	211	317	422	528	633	739	844	950	1056
50	20	OUT	1963	393	589	785	982	1178	1374	1570	1767	1963
		IN	1649	330	495	660	825	989	1154	1319	1484	1649
63	20	OUT	3117	623	935	1247	1559	1870	2182	2494	2805	3117
		IN	2803	561	841	1121	1402	1682	1962	2242	2523	2803
80	25	OUT	5027	1005	1508	2011	2514	3016	3519	4022	4524	5027
		IN	4536	907	1361	1814	2268	2722	3175	3629	4082	4536
100	30	OUT	7853	1571	2356	3142	3927	4712	5498	6283	7068	7854
		IN	7147	1429	2144	2859	3574	4288	5003	5718	6432	7147
125	32	OUT	12270	2450	3680	4910	6150	7360	8590	9820	11040	12270
		IN	11250	2250	3380	4500	5630	6750	7880	9000	10130	11250
160	40	OUT	20100	4020	6030	8040	10050	12060	14070	16080	18100	20110
		IN	18850	3770	5650	7540	9420	11310	13190	15080	16960	18850

Note) Theoretical force(N) = Pressure (MPa) X Piston area (mm^2)

Allowable Kinetic Energy



Example: Load limit at rod end when air cylinder ø50 is actuated with max. actuating speed 325mm/s. See the intersection of lateral axis 325mm/s and ø50 line, and extend the intersection to left.
Thus the allowable load is 85kg.

Weight Table

(kg)

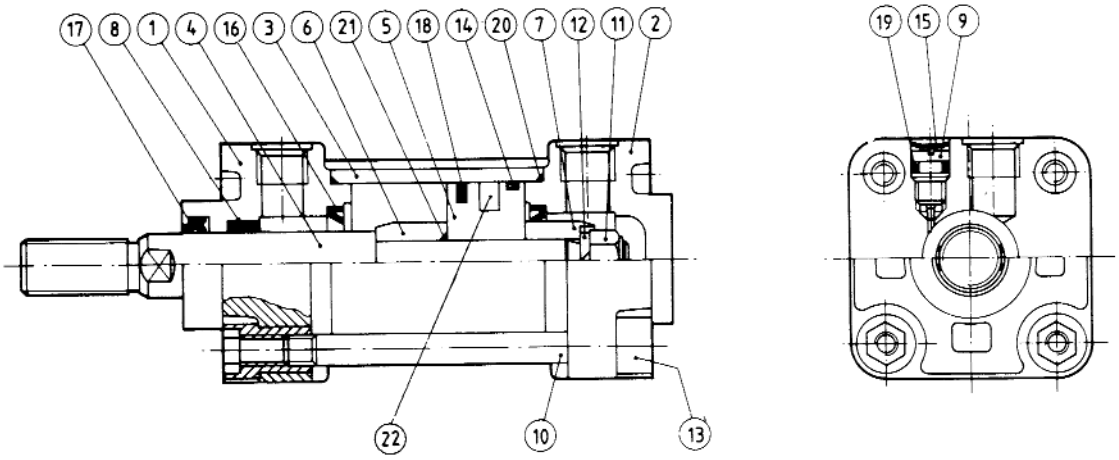
Bore size (mm)		**32**	**40**	**50**	**63**	**80**	**100**	**125**	**160**
Basic weight	Basic	0.47	0.90	1.32	2.07	3.52	5.09	9.06	16.83
	Foot	0.15	0.17	0.20	0.30	0.80	0.94	2.30	5.10
	Flange	0.24	0.40	0.60	0.96	1.84	2.32	4.10	6.90
	Single clevis	0.25	0.27	0.45	0.76	0.93	2.31	3.40	5.90
	Double clevis	0.24	0.26	0.43	0.78	1.38	2.33	4.18	7.30
	Trunnion	0.62	1.50	2.07	3.42	5.86	8.62	12.46	22.43
Additional weight per 50 stroke	All mounting brackets	0.14	0.22	0.28	0.36	0.52	0.64	0.71	0.95

Calculation example: C92SD40-100

- Basic weight ····· 0.90 (Basic, ø40)
- Mounting ····· 0.26 (Double clevis)
- Additional weight ··· 0.22/50 stroke
- Cylinder stroke ····· 100 stroke

0.90+0.22 X 100/50+0.26=1.6kg

Construction



Component Parts

No.	Description	Material	Note
①	**Rod cover**	Aluminum alloy	
②	**Head cover**	Aluminum alloy	
③	**Cylinder tube**	Aluminum alloy	
④	**Piston rod**	C45 hard chrome	
⑤	**Piston**	Aluminum alloy	
⑥	**Cushion ring**	Rolled steel	
⑦	**Cushion ring**	Rolled steel	
⑧	**Bushing**	Lead bronze casting	
⑨	**Cushion adjustment screw**	Steel	(Zinc chromate plated)
⑩	**Tie rod**	Steel	(Zinc chromate plated)
⑪	**Piston nut**	Rolled steel	
⑫	**Spring seat**	Steel wire	(Zinc chromate plated)
⑬	**Tie rod nut**	Steel	(Zinc chromate plated)

No.	Description	Material	Note
⑭	**Wearing**	PRC compound	
⑮	**Serrated washer**	Steel	(Zinc chromate plated)
⑯	**Cushion seal**	NBR	
⑰	**Rod seal/Gasket**	NBR	
⑱	**Piston seal**	NBR	
⑲	**Cushion screw seal**	NBR	
⑳	**Cylinder tube gasket**	NBR	
㉑	**Piston gasket**	NBR	
㉒	**Magnet ring**		

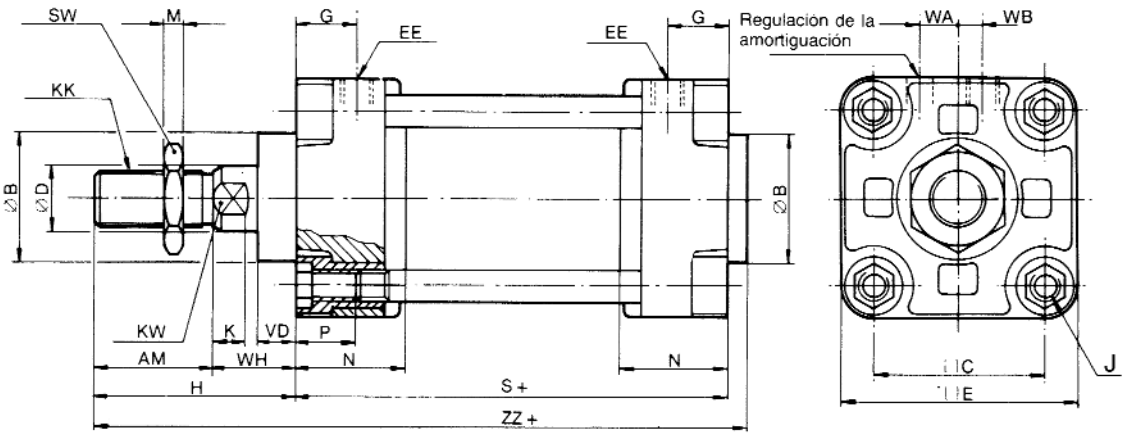
Seal Kits

Bore size (mm)	Kit No.	Contents
32	CS92-32	Kits include items 16 to 21
40	CS92-40	
50	CS92-50	
63	CS92-63	
80	CS92-80	
100	CS92-100	
125	CS92-125	
160	CS92-160	

∗ Seal kits consist of items 16 to 21

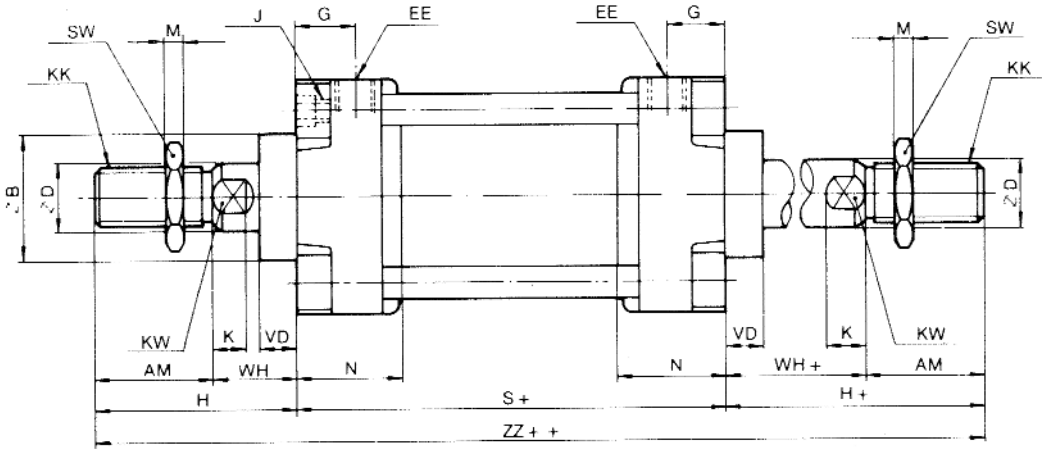
Without Mounting Bracket

C92S□Bø-Stroke



Bore (mm)	AM	øB	C	ØD	E	EE	G	KK	H	J	K	KW	M	N	P	S	SW	VD	WA	WB	WH	ZZ
32	22	30	33	12	46	G1/8	13,5	M10 X 1.25	58	M6	6	10	5	23	11	74	17	10	7	6	36	136
40	24	32	44	16	60	G1/4	15,5	M12 X 1.25	64,5	M6	6	14	7	27	11	84	19	10	10	6	40,5	153,5
50	32	40	52	20	70	G1/4	17	M16 X 1.5	77	M8	7	18	8	30	14	90	24	10	11	10	45	173
63	32	40	64	20	85	G3/8	17	M16 X 1.5	80,5	M8	7	18	8	31	14	98	24	10	11	10	48,5	184,5
80	40	52	78	25	103	G3/8	22	M20 X 1.5	92	M10	11	22	10	37	19	116	30	14	11	16	52	215
100	40	52	92	30	116	G1/2	19,5	M20 X 1.5	97	M10	11	26	10	40	19	126	30	14	12	20	57	231
125	54	60	110	32	140	G1/2	25	M27 X 2	119	M12	15	27	13	45	42	160	41	26	20	15	65	287
160	72	65	140	40	180	G3/4	30	M36 X 2	152	M16	17	36	16	55	52	180	55	31	25	15	80	340

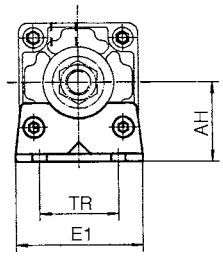
C92S□Bø-Stroke W

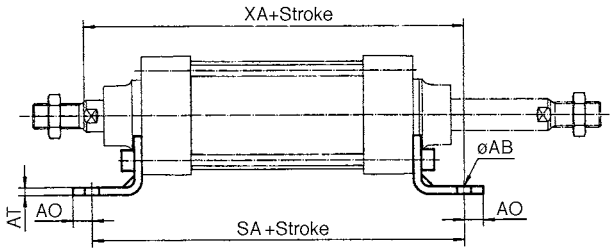


Bore (mm)	AM	øB	øD	EE	G	H	J	KK	K	KW	M	N	S	SW	VD	WH	ZZ
32	22	30	12	G1/8	13,5	58	M6	M10 X 1.25	6	10	5	23	74	17	10	36	190
40	24	32	16	G1/4	15,5	64,5	M6	M12 X 1.25	6	14	7	27	84	19	10	40,5	213
50	32	40	20	G1/4	17	77	M8	M16 X 1.5	7	18	8	30	90	24	10	45	244
63	32	40	20	G3/8	17	80,5	M8	M16 X 1.5	7	18	8	31	98	24	10	48,5	259
80	40	52	25	G3/8	22	92	M10	M20 X 1.5	11	22	10	37	116	30	14	52	300
100	40	52	30	G1/2	19,5	97	M10	M20 X 1.5	11	26	10	40	126	30	14	57	320
125	54	60	32	G1/2	25	119	M12	M27 X 2	15	27	13	45	160	41	26	65	398
160	72	65	40	G3/4	30	152	M16	M36 X 2	17	36	16	55	180	55	31	80	484

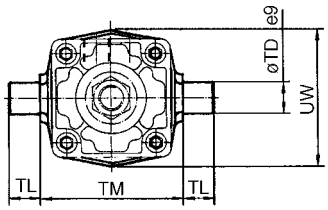
With Mounting Bracket

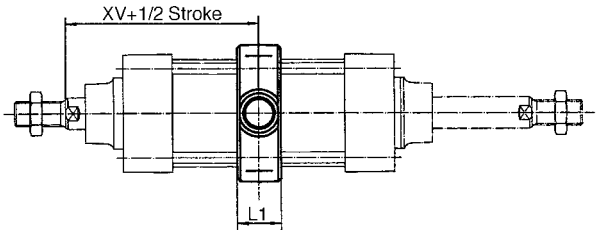
Foot L



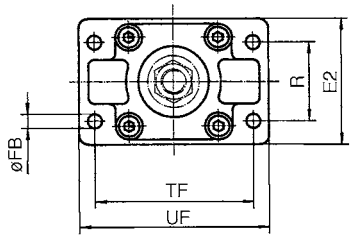


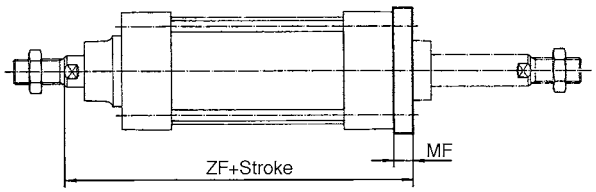
Centre trunnion T

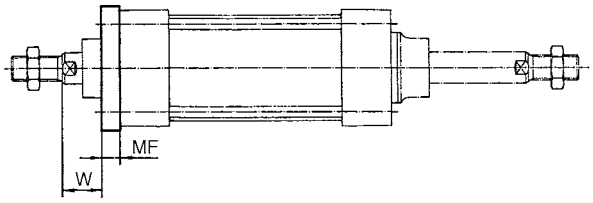




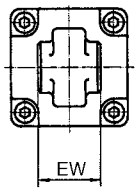
Flange F



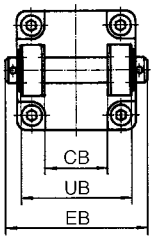


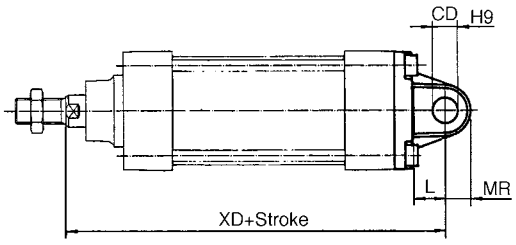


Rear single clevis C



Rear double clevis D

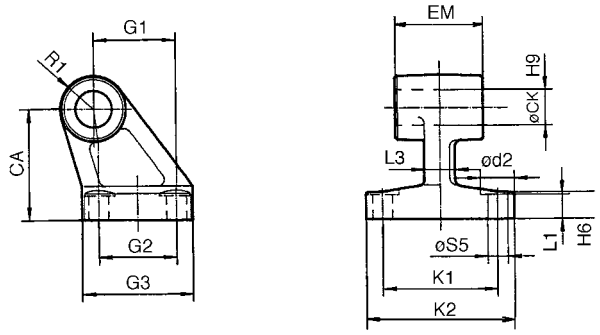




Bore (mm)	E1	R	W	MF	ZF	øFB	CD	EB	L	XD	UB	CB	EW	MR	TR	AO	AT	XA	SA	AH	øAB	L1	XV	TL	øTD	TM	UW	TF	UF	E2
32	46	32	16	12,5	130	7	10	65	15	142	45	26	26	9	32	10	3,2	144	142	32	7	18	73	12	12	50	47	64	78	46
40	60	36	20	12	145	9	12	75	18	160	52	28	28	12	36	11	3,2	163	161	36	9	22	82.5	16	15	85	62	72	90	58
50	70	45	25	15	155	9	12	80	18	170	60	32	32	12	45	12	3,2	175	170	45	9	22	90	16	15	95	74	90	110	68
63	85	50	25	16	170	9	16	90	23	190	70	40	40	16	50	13	3,2	190	185	50	9	28	97.5	19	18	110	90	100	120	89
80	102	63	30	20,5	190	12	16	110	23	210	90	50	50	16	63	15	4,5	215	210	63	12	34	110	26	25	140	110	126	154	100
100	116	75	35	20,5	205	14	20	140	28	230	110	60	60	20	75	18	6	230	220	71	14	40	120	26	25	162	130	150	180	114
125	140	90	45	20	245	16	25	164	30	275	130	70	69,5	25	90	15	9	270	250	90	16	44	145	25	25	160	154	180	210	140
160	180	115	60	20	280	18	30	204	35	315	170	90	89,5	30	115	20	11	320	300	115	18	49	170	32	32	200	194	230	265	180

Accessories

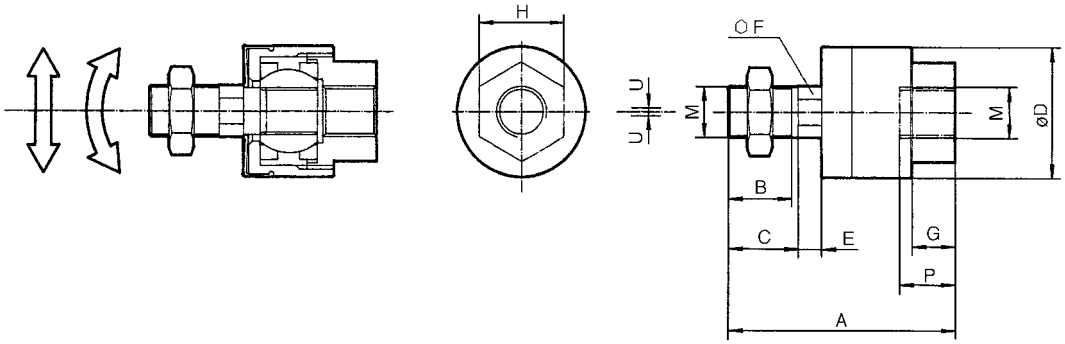
Counter pivot E



Bore (mm)	ød2	øCK	øS5	K1	K2	L3	G1	L1	G2	EM	G3	CA	H6	R1
32	10	10	5,5	38	51	10	21	4	18	26	31	32	8	10
40	10	12	5,5	41	54	10	24	4	22	28	35	36	10	11
50	11	12	6,6	50	65	14	33	6	30	32	45	45	12	13
63	11	16	6,6	52	67	14	37	6	35	40	50	50	12	15
80	15	16	9	66	86	18	47	6	40	50	60	63	14	15
100	15	20	9	76	96	20	55	6	50	60	70	71	15	18
125	18	25	11	94	124	28	70	18	60	70	90	90	20	22,5
160	20	32	14	118	156	34	97	23	88	90	126	115	25	31

Accessories

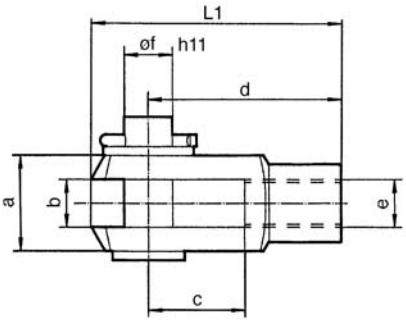
Floating joint JA
Steel, zinc chromate plated



Bore (mm)	Ref.	M	A	B	C	øD	E	F	G	H	P	U	Load (kn)	Weight (g)
32	JA30-10-125	M10 X 1.25	49.5	19.5	22	24	5	8	8	17	9	0.5	2.5	70
40	JA40-12-125	M12 X 1.25	60	20	24	31	6	11	11	22	13	0.75	4.4	160
50/63	JA50-16-150	M16 X 1.5	71.5	22	25	41	7.5	14	13.5	27	15	1.0	11	300
80/100	JAH50-20-150	M20 X 1.5	101	28	30	59,5	11.5	24	16	32	18	2.0	18	1080
125	JA125-27-200	M27 X 2	123	34	38	66	13	27	20	41	24	2.0	28	1500
160	JA160-36-200	M36 X 2	178	51	55	96	16	36	24	55	42	3.0	71	4700

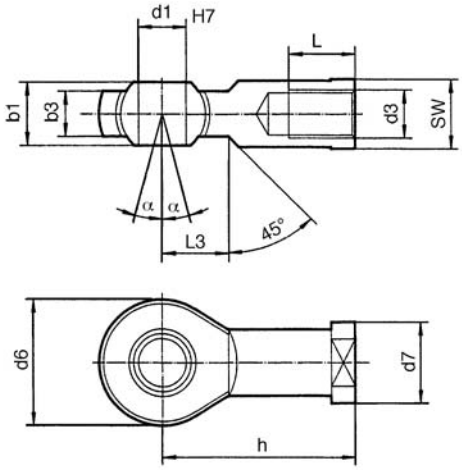
Piston rod clevis GKM (DIN 71752)
Steel, zinc chromate plated

Bore (mm)	Ref.	e	b	d	øf	L1	c	a
32	GKM10-20	M10 X 1.25	10	40	10	52	20	20
40	GKM12-24	M12 X 1.25	12	48	12	62	24	24
50/63	GKM16-32	M16 X 1.5	16	64	16	83	32	32
80/100	GKM20-40	M20 X 1.5	20	80	20	105	40	40
125	GKM30-54	M27 X 2	30	112	30	156	56	55
160	GKM35-54	M36 X 2	36	144	35	182	72	70



Piston rod ball joint KJ (DIN 648)
Steel, zinc chromate plated

Bore (mm)	Ref.	d3	d1	h	d6	b3	b1	L	d7	α	L3
32	KJ10D	M10 X 1.25	10	43	28	10.5	14	20	19	13°	14
40	KJ12D	M12 X 1.25	12	50	32	12	16	22	22	13°	16
50/63	KJ16D	M16 X 1.5	16	64	42	15	21	28	27	15°	26
80/100	KJ20D	M20 X 1.5	20	77	50	18	25	33	34	15°	26
125	KJ27D	M27 X 2	30	110	70	25	37	51	50	15°	35
160	KJ36D	M36 X 2	35	125	80	28	43	56	58	16°	41



ISO Cylinder/Non-rotating Rod: Double Acting

Series C92K

ø32, ø40, ø50, ø63

How to Order

Standard C92K B 32 — 100 W

With auto switch C92KD B 32 — 100 W

Auto switch D — A53 L

Built-in magnet

Mounting

B	Basic/without bracket
T	Centre trunnion

∗ Mounting accessories are not mounted, should be order separate.Please refer order keys in next pages.

Bore size

32	32mm
40	40mm
50	50mm
63	63mm

Rod

—	Single rod
W	Double rod

Stroke (mm)
Refer to standard stroke table on p.1.12-12.

Lead wire length

Nil	0.5m
L	3m
Z	5m

Auto switch type

	Select an applicable auto switch model from the table below

Applicable Auto Switches/Tie rod mounting

Style	Special function	Electrical entry	Indicator	Load voltage: Wiring (Output)	Load voltage: DC		Load voltage: AC	Auto switch model	Lead wire (m)∗: 0.5 (—)	3 (L)	5 (Z)	Applicable load	
Reed switch	—	Grommet	Yes	3 wire (Equiv. to NPN)	—	5V	—	**A56**	●	●	—	IC	—
			Yes	2 wire	24V	12V	—	**A53**	●	●	●	—	Relay PLC
						5V,12V	100V,200V	**A54**	●	●	●		
			No			5V,12V	—	**A67**	●	●	—	IC	
						12V	200V or less	**A64**	●	●	—		
	Diagnosis indication (2 colour)		Yes			—	—	**A59W**	●	●	—	—	
Solid state switch	—	Grommet	Yes	3 wire (NPN)	24V	5V,12V	—	**F59**	●	●	○	IC	Relay PLC
				3 wire (PNP)				**F5P**	●	●	○		
				2 wire	—	—	100V,200V	**J51**	●	●	○	—	
	Diagnosis indication (2 colour)				24V	12V	—	**J59**	●	●	○		
				3 wire (NPN)		5V,12V		**F59W**	●	●	○	IC	
				3 wire (PNP)				**F5PW**	●	●	○		
				2 wire		12V		**J59W**	●	●	○	—	
	Water resistant (2 colour)							**F5BA**	—	●	○		
	With timer			3 wire (NPN)		5V,12V		**F5NT**	—	●	○	IC	
	Diagnosis output (2 colour)			4 wire (NPN)				**F59F**	●	●	○		
	Latch diagnosis output (2 colour)					—		**F5LF**	●	●	○	—	

∗ Lead wire length 0.5m····· — (Example: A53)
3m····· L (Example: A53L)
5m····· Z (Example: A53Z)

○: Manufactured upon receipt of order.

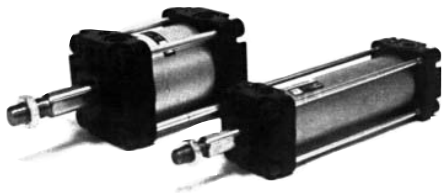
Auto Switch Mounting Bracket Part No.

Bore size	ø32, ø40	ø50, ø63
Mounting bracket	BT-03	BT-04

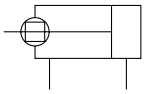
Mounting Bracket Part No.

Bore size	ø32	ø40	ø50	ø63
Foot(1)	L32	L40	L50	L63
Flange	F32	F40	F50	F63
Single rear clevis	C32	C40	C50	C63
Double rear clevis	D32	D40	D50	D63

Note 1) Two foot brackets required for one cylinder.



JIS Symbol
Double acting



Specifications

Bore size	ø32	ø40	ø50	ø63
Action	Double acting			
Fluid	Air			
Proof pressure	1.5MPa			
Max. operating pressure	1.0MPa			
Min. operating pressure	0.05MPa			
Ambient and fluid temperature	Without magnet –10 to 70°C (No freezing)			
	With magnet –10 to 60°C (No freezing)			
Lubrication	Not required (Non-lube)			
Operating piston speed	50 to 500 mm/s			
Allowable stroke tolerance	to 250: $^{+1.0}_{0}$, 251 to 1000: $^{+1.4}_{0}$,1001 to 1500: $^{+1.8}_{0}$			
Cushion	Both ends (Air cushion)(1)			
Thread tolerance	JIS class 2			
Port size	G1/8	G1/4	G1/4	G3/8
Mounting	Basic, axial direction foot, front flange, rear flange, single rear clevis, double rear clevis, centre trunnion			
Non-rotating accuracy	±0.8°	±0.5°	±0.5°	±0.5°

Accessories

Mounting		Basic	Foot	Front flange	Rear flange	Single rear clevis	Double rear clevis	Centre trunnion
Standard	Rod end nut	●	●	●	●	●	●	●
	Clevis pin	—	—	—	—	—	●	—
Option	Single rod clevis	●	●	●	●	●	●	●
	Double rod clevis (with pin)	●	●	●	●	●	●	●
	Rod boot	●	●	●	●	●	●	●

Weight

(kg)

Bore size (mm)		32	40	50	63
Basic weight	Basic	0.47	0.90	1.32	2.07
	Axial foot	0.15	0.17	0.20	0.30
	Flange	0.24	0.40	0.60	0.96
	Single clevis	0.25	0.27	0.45	0.76
	Double clevis	0.24	0.26	0.43	0.78
	Centre trunnion	0.62	1.50	2.07	3.42
Additional weight per 50 stroke	All mounting brackets	0.14	0.22	0.28	0.36

Calculation example: C92KD40-100
- Basic weight ····· 0.90 (Basic)
- Additional weight ··· 0.22/50 stroke
- Cylinder stroke ····· 100 stroke
- Mounting ····· 0.26 (Double clevis)

0.90+0.22 X 100/50+0.26=1.6kg

CJ1
CJP
CJ2
CM2
C85
C76
CG1
MB
MB1
CP95
C95
C92
CA1
CS1

Standard Stroke

Bore size (mm)	Standard stroke (mm)
32	25, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500
40	25, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500
50	25, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500, 600
63	25, 50, 80, 100, 125, 160, 200, 250, 320, 400, 500, 600

Intermediate strokes are available.

Minimum Strokes for Auto Switch Mounting

Refer to p.1.12-14 on "Minimum Strokes for Auto Switch Mounting".

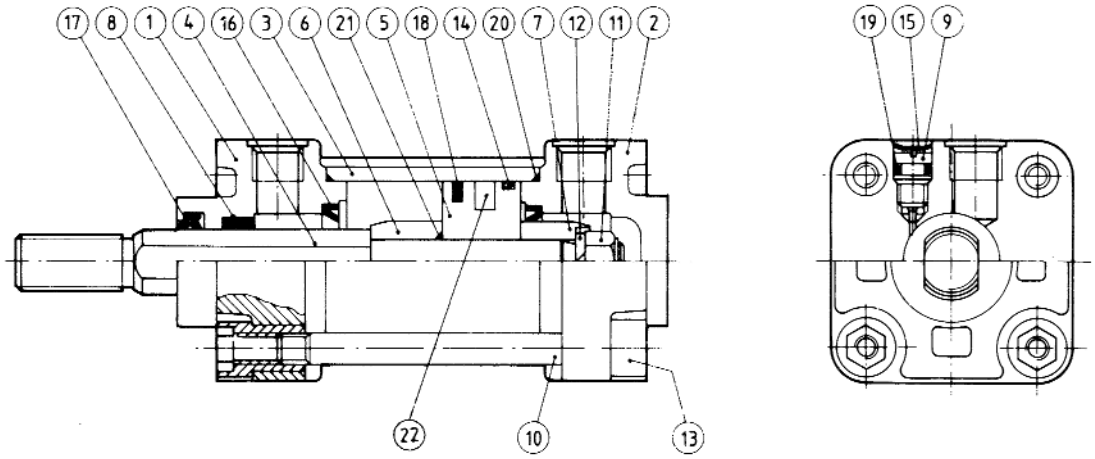
Theoretical Force

OUT side is identical to double acting single rod. Refer to table below for IN side.

Bore size (mm)	Rod diameter (mm^2)
32	675
40	1082
50	1651
63	2804

Theoretical force (N) =
Pressure (MPa) X Piston area (mm^2)

Construction



Component Parts

No.	Description	Material	Note
①	**Rod cover**	Aluminum alloy	
②	**Head cover**	Aluminum alloy	
③	**Cylinder tube**	Aluminum alloy	
④	**Piston rod**	1.4301stainless steel	
⑤	**Piston**	Aluminum alloy	
⑥	**Cushion ring**	Rolled steel	
⑦	**Cushion ring**	Rolled steel	
⑧	**Bushing**	Lead bronze casting	
⑨	**Cushion adjustment screw**	Steel	(Zinc chromate plated)
⑩	**Tie rod**	Steel	(Zinc chromate plated)
⑪	**Piston nut**	Steel	(Zinc chromate plated)
⑫	**Spring seat**	Steel wire	(Zinc chromate plated)
⑬	**Tie rod nut**	Steel	(Zinc chromate plated)

No.	Description	Material	Note
⑭	**Wearing**	PRC compound	
⑮	**Serrated washer**	Steel	(Zinc chromate plated)
⑯	**Cushion seal**	NBR	
⑰	**Rod seal/Gasket**	NBR	
⑱	**Piston seal**	NBR	
⑲	**Cushion screw seal**	NBR	
⑳	**Cylinder tube gasket**	NBR	
㉑	**Piston gasket**	NBR	
㉒	**Magnet ring**		

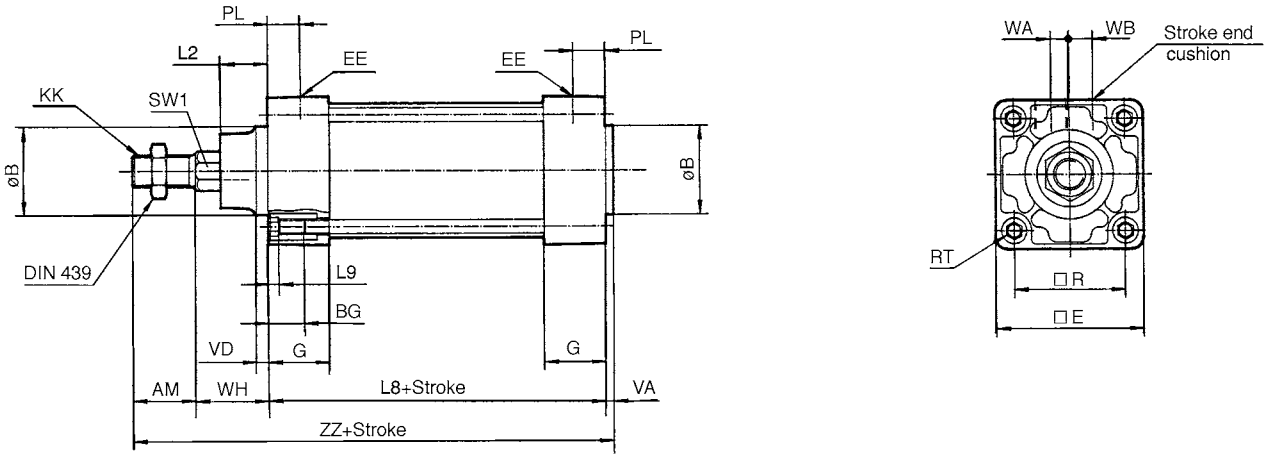
Seal Kits

Bore size (mm)	Kit No.	Contents
32	CK92-32	Kits include items 16 to 21
40	CK92-40	
50	CK92-50	
63	CK92-63	

∗ Seal kits consist of items 16 to 21

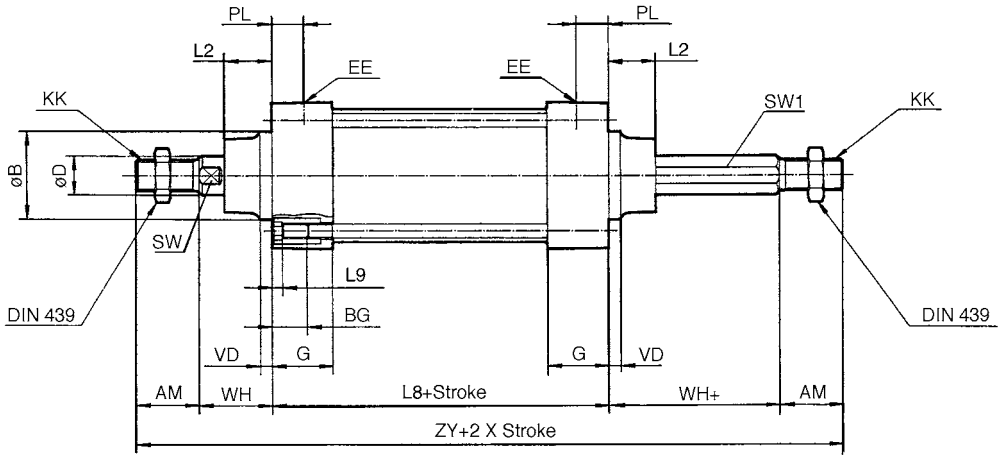
Without Mounting Bracket

C92KBø-Stroke



Bore size (mm)	AM	øB	□C	ØD	□E	EE	KK	G	H	J	K	M	N	P	S	SW	VD	WA	WB	WH	ZZ
32	22	30	33	12	46	G1/8	M10 X 1.25	13,5	58	M6	10	5	23	11	74	17	10	7	6	36	136
40	24	32	44	16	60	G1/4	M12 X 1.25	15,5	64,5	M6	14	7	27	11	84	19	10	10	6	40.5	153,5
50	32	40	52	20	70	G1/4	M16 X 1.5	17	77	M8	18	8	30	14	90	24	10	11	10	45	173
63	32	40	64	20	85	G3/8	M16 X 1.5	17	80,5	M8	18	8	31	14	98	24	10	11	10	48.5	184,5

C92KBø-Stroke W



Bore size (mm)	AM	øB	øD	EE	G	H	KK	J	K	KW	M	N	S	SW	VD	WH	ZZ
32	22	30	12	G1/8	13.5	58	M10 X 1.25	M6	6	10	5	23	74	17	10	36	190
40	24	32	16	G1/4	15.5	64.5	M12 X 1.25	M6	6	14	7	27	84	19	10	40.5	213
50	32	40	20	G1/4	17	77	M16 X 1.5	M8	7	18	8	30	90	24	10	45	244
63	32	40	20	G3/8	17	80.5	M16 X 1.5	M8	7	18	8	31	98	24	10	48.5	259

∗ Refer to p.1.12-7 through 1.12-9 for dimensions with mounting bracket and accessories.

Series C92
Auto Switch Specifications

Refer to P.5.3-17, 27, 37, 46, 54, 58 and 61 for details on auto switches.

Applicable Auto Switch

Style	Auto switch model	Electrical entry (function)
Reed switch	**D-A5□/A6□**	Grommet
	D-A59W	Grommet (2 colour indication)
Solid state switch	**D-F5□/J5□**	Grommet
	D-F5□W/J59W	Grommet (2 colour indication)
	D-F5BAL	Grommet (2 colour indication, Water resistant)
	D-F5□F	Grommet (2 colour indication, diagnostic output)
	D-F5NTL	Grommet (Timer)

Minimum Strokes for Auto Switch Mounting

Style	Auto switch model	No. of auto switches	Support bracket except centre trunnion						Centre trunnion					
			ø32	**ø40**	**ø50**	**ø63**	**ø80**	**ø100**	**ø32**	**ø40**	**ø50**	**ø63**	**ø80**	**ø100**
Reed switch	**D-A5, D-A6**	2 (On different faces or same face)	15				20		60		80	105	110	115
		1												
	D-A59W	2 (On different faces or same face)	20				25		60	70	85	110	115	120
		1	15											
Solid state switch	**D-F5/J5**	2 (On different faces or same face)	15				25		60	70	85	110	115	120
		1	10											
	D-F5NTL	2 (On different faces or same face)	15				25		70	75	95	120	125	130
		1	10											
	D-F5□W D-J59W D-F5BAL D-F5□F D-F5LF	2 (On different faces or same face)	15				25		70	75	90	120	125	130
		1	10											

New

Electro-Pneumatic Regulator
Electronic Vacuum Regulator

[Option]

LISTED

RoHS IP65

- Stepless control of air pressure proportional to an electrical signal
- Added Fieldbus compliant specifications to Series ITV1000/2000/3000!

New

Reduced wiring

Applicable Fieldbus protocols

CC-Link DeviceNet PROFIBUS

Built-in communication board, so no converter needed.

Added RS-232C specification to serial communications!

Compact/lightweight (Integrated communicatioin parts)

Weight: 350 g Note 1) **(ITV1000)**

Power consumption: 4 W Note 1) **or less**

Note 1) Value for communications type. (PROFIBUS DP)

Note 2) ITV1000. Dimensions in parentheses ( ) are for the CC-Link or PROFIBUS DP.

▼ Electro-Pneumatic Regulators

Series ITV0000

Maximum flow rate
6 ℓ/min (ANR)
Set pressure: 0.6 MPa
Supply pressure: 1.0 MPa

Series ITV1000

Maximum flow rate
200 ℓ/min (ANR)
Set pressure: 0.6 MPa
Supply pressure: 1.0 MPa
Grease-free specification (wetted parts)

Series ITV2000

Maximum flow rate
1500 ℓ/min (ANR)
Set pressure: 0.6 MPa
Supply pressure: 1.0 MPa

Series ITV3000

Maximum flow rate
4000 ℓ/min (ANR)
Set pressure: 0.6 MPa
Supply pressure: 1.0 MPa

▼ Electronic Vacuum Regulators

Series ITV009□

Series ITV209□

Series ITV

SMC

CAT.ES60-15F

Compact Electro-Pneumatic Regulator

Series ITV0000

CE [Option] RoHS

How to Order

For single unit and single unit for manifold

ITV00 1 0 – 3 □ □ □ N – □

Pressure range

1	0.1 MPa
3	0.5 MPa
5	0.9 MPa

Power supply voltage

0	24 VDC ±10%
1	12 to 15 VDC

Input signal

0	Current type 4 to 20 mA DC
1	Current type 0 to 20 mA DC
2	Voltage type 0 to 5 VDC
3	Voltage type 0 to 10 VDC

Built-in One-touch fittings type

For single unit

Symbol		SUP 1	OUT 2	EXH 3
Nil	Metric size (Light gray)	ø4		
U	Inch size (Orange)	ø5/32"		

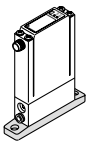
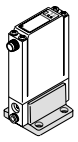
For manifold

Symbol		SUP 1	OUT 2	EXH 3
Nil	Metric size (Light gray)	ø6	ø4	ø6
U	Inch size (Orange)	ø1/4"	ø5/32"	ø1/4"

Base type

Nil	For single unit
M	For manifolds

Bracket/Option for single unit only

Nil	Without bracket
B	Flat Bracket 
C	L-bracket 

Cable connector (Option)

N	Without cable connector
S	Straight type 3 m
L	Right angle type 2 m

CE compliant

Nil	—
Q	CE compliant

∗ For detailed information on models for CE, refer to SMC's website.

Manifold

IITV00 – 02 □ – n

Stations

02	2 stations
03	3 stations
⋮	⋮
10	10 stations

Option

If a DIN rail longer than the specified stations is required, specify the applicable stations in two digits.
(Maximum 10 stations)
Example) **IITV00-05-07**

One-touch fitting size for supply/exhaust parts (End plate)

Nil	ø6 (Light gray)
U	ø1/4" (Orange)

Note) A DIN rail with the length specified by the number of stations is attached to the manifold. For dimensions of the DIN rail, refer to the external dimensions.

How to Order Manifold Assembly (Example)

Indicate the part numbers of electro-pneumatic regulators and options to be mounted below the manifold part number.

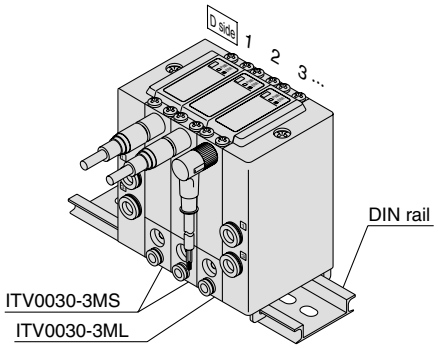
Example)
Due to the common supply/exhaust feature, note that different pressure range combinations are not available.

IITV00-03·····1 set (Manifold part no.)
∗**ITV0030-3MS·····2 sets (Electro-pneumatic regulator part no. (1, 2 stations))**
∗**ITV0030-3ML·····1 set (Electro-pneumatic regulator part no. (3 stations))**

Indicate part numbers in order starting from the first station on the D side.

Note) Combination with having different pressure ranges is not available due to common supply/exhaust features.

The asterisk (∗) specifies mounting. Add an asterisk (∗) at the beginning of electro-pneumatic regulator part numbers to be mounted.



SMC

Electro-Pneumatic Regulator

Series ITV1000/2000/3000

How to Order

[Option]

ITV 3 0 1 0 – 0 1 □ 2 □ S □ – □□ – □

Model

1	1000 type
2	2000 type
3	3000 type

Pressure range

1	0.1 MPa
3	0.5 MPa
5	0.9 MPa

Power supply voltage

0	24 VDC
1	12 to 15 VDC

Note) Communication models (CC, DN PR, RC) are available only for 24 VDC.

Input signal/ Communication model

0	Current type 4 to 20 mA DC (Sink type)
1	Current type 0 to 20 mA DC (Sink type)
2	Voltage type 0 to 5 VDC
3	Voltage type 0 to 10 VDC
40	Preset input
CC	CC-Link
DN	DeviceNet™
PR	PROFIBUS DP
RC	RS-232C communication

Monitor output

1	Analog output 1 to 5 VDC
2	Switch output/NPN output
3	Switch output/PNP output
4	Analog output 4 to 20 mA DC (Sink type)
Nil	None

Thread type

Nil	Rc
N	NPT
T	NPTF
F	G

Port size

1	1/8 (1000 type)
2	1/4 (1000, 2000, 3000 type)
3	3/8 (2000, 3000 type)
4	1/2 (3000 type)

Bracket

Nil	Without bracket
B	Flat bracket
C	L-bracket

Cable connector type

S	Straight type 3 m
L	Right angle type 3 m
N	Without cable connector

Note) Order communication cable (other than RS-232C) separately. See below.

Pressure display unit

Nil	MPa
2 Note)	kgf/cm²
3	bar
4 Note)	psi
5	kPa

Note) Under Japan's new Measurement Act, this is only for overseas sales (SI units are to be used inside Japan). For the communication models, CC, DN, PR and RC, only "Nil" is available as it does not have a pressure display.

Made to Order Specifications

Refer to pages 11, 25, and 26 for details.

CE compliant

Nil	—
Q	CE compliant

Note) Refer to pages 11, 25, and 26 for information on CE compliant made to order products.

∗ For detailed information on models for CE, refer to SMC's website.

For communication cables, use the parts listed below
(refer to the catalog [M8/M12 Connector] CAT.ES100-73 for details)
or order the product certified for the respective protocol (with M12 connector) separately.

Application	Communication cable part number	Remarks
CC-Link compatibility	PCA-1567720 (Socket type)	Dedicated Bus adapter supplied with the product.
	PCA-1567717 (Plug type)	
DeviceNet™ compatibility	PCA-1557633 (Socket type)	T-branch connector not supplied.
	PCA-1557646 (Plug type)	
PROFIBUS DP compatibility	PCA-1557688 (Socket type)	T-branch connector not supplied.
	PCA-1557691 (Plug type)	

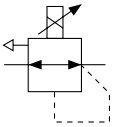
ITV1000

ITV2000

ITV3000

Fieldbus-compatible model

JIS Symbol



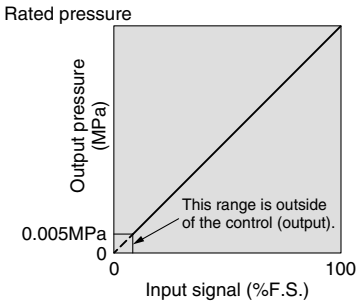


Figure 1. Input/output characteristics chart

Standard Specifications

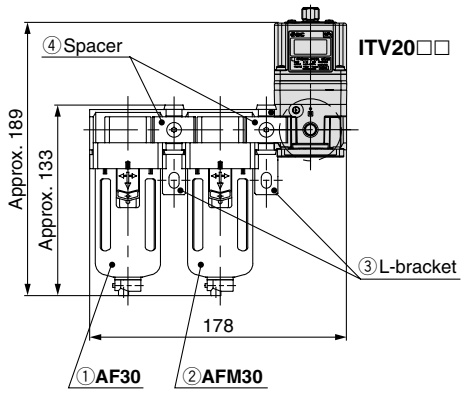
Model		ITV101□ Note 10)	ITV103□ Note 10)	ITV105□ Note 10)
		ITV201□	ITV203□	ITV205□
		ITV301□	ITV303□	ITV305□
Minimum supply pressure		Set pressure +0.1 MPa		
Maximum supply pressure		0.2 MPa	1.0 MPa	
Set pressure range Note 1)		0.005 to 0.1 MPa	0.005 to 0.5 MPa	0.005 to 0.9 MPa
Power supply	Voltage	24 VDC ± 10%, 12 to 15 VDC		
	Current consumption	Power supply voltage 24 VDC type: 0.12 A or less Power supply voltage 12 to 15 VDC type: 0.18 A or less		
Input signal	Current type Note 2)	4 to 20 mA DC, 0 to 20 mA DC (Sink type)		
	Voltage type	0 to 5 VDC, 0 to 10 VDC		
	Preset input	4 points (Negative common)		
Input impedance	Current type	250 Ω or less Note 6)		
	Voltage type	Approx. 6.5 kΩ		
	Preset input	Power supply voltage 24 VDC type: Approx. 4.7 kΩ Power supply voltage 12 VDC type: Approx. 2.0 kΩ		
Output signal (monitor output) Note 3)	Analog output	1 to 5 VDC (Load impedance: 1 kΩ or more) 4 to 20 mA DC (Sink type) (Load impedance: 250 Ω or less) Output accuracy within ±6% (Full span)		
	Switch output	NPN open collector output: Max. 30 V, 80 mA PNP open collector output: Max. 80 mA		
Linearity		Within ±1% (Full span)		
Hysteresis		Within 0.5% (Full span)		
Repeatability		Within ±0.5% (Full span)		
Sensitivity		Within 0.2% (Full span)		
Temperature characteristics		Within ±0.12% (Full span)/°C		
Output pressure display Note 4)	Accuracy	±2%F.S. ± 1 digit		
	Minimum unit	MPa: 0.001, kgf/cm²: 0.01, bar: 0.01, psi: 0.1 Note 5) , kPa: 1		
Ambient and fluid temperature		0 to 50°C (No condensation)		
Enclosure		IP65		
Weight Note 9)	ITV10□□	Approx. 250 g (without options)		
	ITV20□□	Approx. 350 g (without options)		
	ITV30□□	Approx. 645 g (without options)		

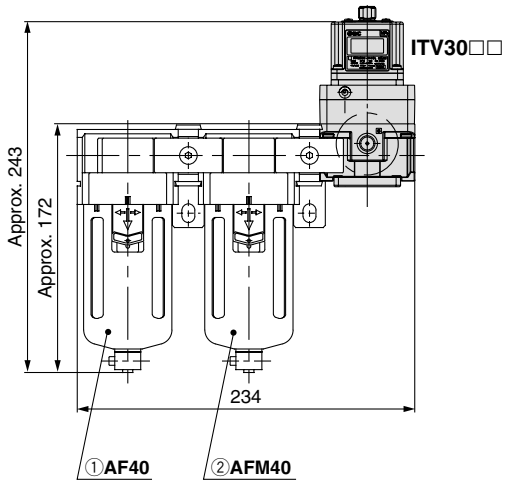
Note 1) Please refer to Figure 1 for the relationship between set pressure and input. Because the maximum set pressure differs for each pressure display, refer to back page 6.
Note 2) 2-wire type 4 to 20 mA DC is not available. Power supply voltage (24 VDC or 12 to 15 VDC) is required.
Note 3) Select either analog output or switch output.
Further, when switch output is selected, select either NPN output or PNP output.
Note 4) Adjustment of numerical values such as the zero/span adjustment or preset input type is set based on the minimum units for output pressure display (e.g. 0.01 to 0.50 MPa). Note that the unit cannot be changed.
Note 5) The minimum unit for 0.9 MPa (130 psi) types is 1 psi.
Note 6) Value for the state with no over current circuit included. If an allowance is provided for an over current circuit, the input impedance varies depending on the input current. This is 350 Ω or less for an input current of 20 mA DC.
Note 7) The above characteristics are confined to the static state. When air is consumed on the output side, the pressure may fluctuate.
Note 8) For communication models, the maximum current consumption is 0.16 A or less.
Note 9) For communication models, add roughly 80 g to the weight (100 g for the PROFIBUS DP).
Note 10) The ITV1000 series is a Grease-free specification (Wetted parts).

Communication Specifications (CC, DN, PR, RC)

Model	ITV□0□0-CC	ITV□0□0-DN	ITV□0□0-PR	ITV□0□0-RC
Protocol	CC-Link	DeviceNet™	PROFIBUS DP	RS-232C
Version Note 1)	Ver 1.10	Release2.0	DP-V0	—
Communication speed	156 k/625 k 2.5 M/5 M/10 M bps	125 k/250 k/500 k bps	9.6 k/19.2 k/45.45 k 93.75 k/187.5 k/500 k 1.5 M/3 M/6 M/12 M bps	9.6 kbps
Configulation file Note 2)	—	EDS	GSD	—
I/O occupation area (input/output data)	4 word/4 word, 32 bit/32 bit (per station, remote device station)	16 bit/16 bit	16 bit/16 bit	—
Communication data resolution	12 bit (4096 resolution)	12 bit (4096 resolution)	12 bit (4096 resolution)	10 bit (1024 resolution)
Fail safe	HOLD Note 3)/CLEAR (Switch setting)	HOLD/CLEAR (Switch setting)	CLEAR	HOLD
Electric insulation Note 4)	No	No	Yes	No
Terminating resistor	—		Built into the product (Switch setting)	—

Note 1) Note that version information is subject to change.
Note 2) Configulation files can be downloaded from the SMC's website: http://www.smcworld.com
Note 3) The output HOLD value when a CC-Link communications error occurs can be set based on the bit area data.
Note 4) The insulation between the electrical signal of the communication system and ITV power supply.





Combinations

◎ Standard specifications ○ Combination possible ▭ Combination not possible

∗ ITV10□□ models are not applicable.

Specifications		Symbol	Applicable model	
			ITV20□□	ITV30□□
Standard specifications	Set pressure max. 0.1 MPa	1	◎	◎
	Set pressure max. 0.5 MPa	3	◎	◎
	Set pressure max. 0.9 MPa	5	◎	◎
	Connection Rc 1/4	02	◎	◎
	Connection Rc 3/8	03	◎	◎
	Connection Rc 1/2	04		◎
Acces-sories	Bracket	B	○	○
	Bracket	C	○	○
Optional specifications	Connection NPT1/4	N02	○	○
	Connection NPT3/8	N03	○	○
	Connection NPT1/2	N04		○
	Connection G 1/4	F02	○	○
	Connection G 3/8	F03	○	○
	Connection G 1/2	F04		○

Modular Products and Accessory Combinations

∗ ITV10□□ models are not applicable.

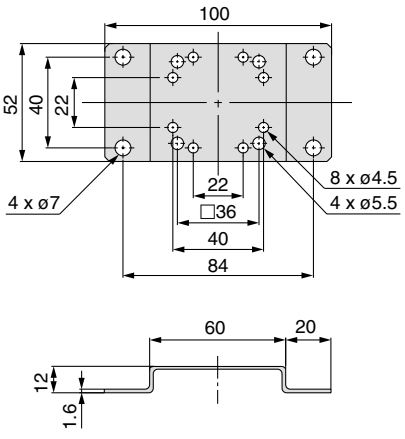
Applicable products and accessories	Applicable model	
	ITV20□□	ITV30□□
① Air filter	AF30	AF40
② Mist separator	AFM30	AFM40
③ L-bracket	B310L	B410L
④ Spacer	Y30	Y40
⑤ Spacer with L-bracket (③ + ④)	Y30L	Y40L
⑥ Spacer with T-bracket	—	Y40T

Accessories (Option)/Part No.

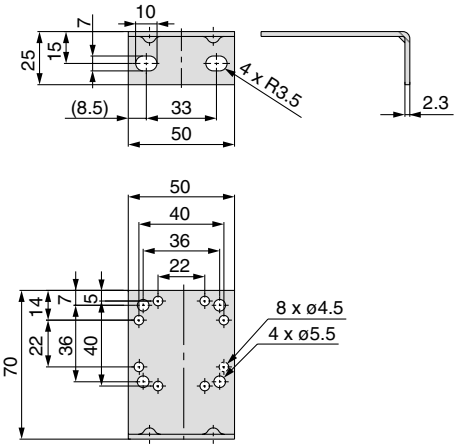
Description		Part No.		
		ITV10□□	ITV20□□	ITV30□□
Flat bracket assembly (including mounting screws)		KT-ITV-F1	KT-ITV-F2	
L-bracket assembly (including mounting screws)		KT-ITV-L1	KT-ITV-L2	
Power cable connector	Straight type 3 m	P398020-500-3 (P398020-504-3 for DeviceNet™)		
	Right angle type 3 m	P398020-501-3 (P398020-505-3 for DeviceNet™)		
Bus adapter (CC-Link model only)		EX9-ACY00-MJ		

Dimensions

Flat bracket



L-bracket



Order Made **Made to Order**
(Refer to pages 25 and 26 for details.)

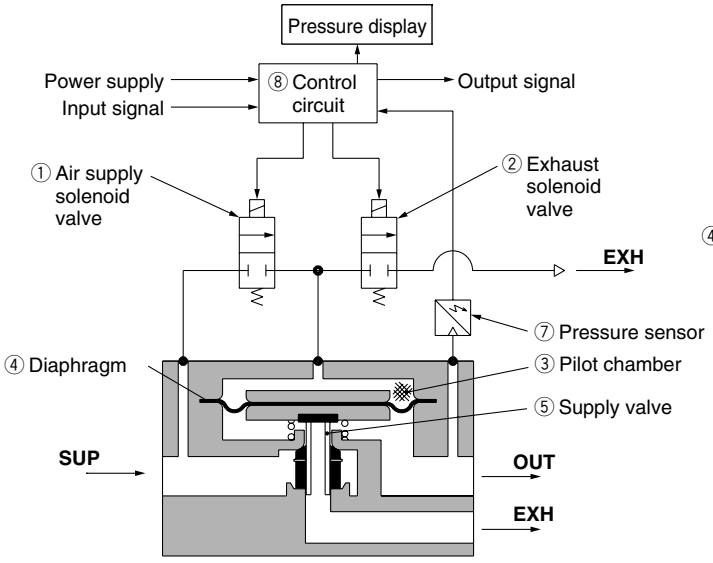
Symbol	CE-compliant	Specifications
X81	Not compliant	16 points preset input type
X156	Compliant	
X93	Not compliant	Digital input type
X157	Compliant	
X102	Not compliant	Reverse type
X321	Compliant	
X224	Not compliant	High pressure type (SUP 1.2 MPa, OUT 1.0 MPa)
X322	Compliant	
X25	Not compliant	Set pressure range 1 to 100 kPa (Except Series ITV3000)
X323	Compliant	
X88	Not compliant	High speed response type (Except Series ITV3000)
X154	Compliant	
X26	Not compliant	For manifold mounting (Except Series ITV3000)
X153	Compliant	

Note 1) Manifolds are compatible with 2 to 8 stations. Consult with SMC for 9 stations or more.
Note 2) Products without symbols are also compatible. Consult with SMC separately.

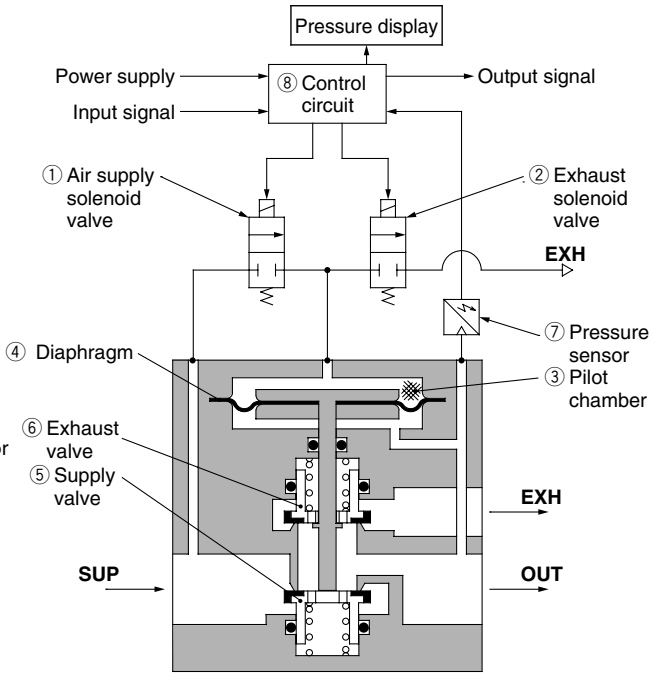
Working Principles

When the input signal rises, the air supply solenoid valve ① turns ON, and the exhaust solenoid valve ② turns OFF. Therefore, supply pressure passes through the air supply solenoid valve ① and is applied to the pilot chamber ③. The pressure in the pilot chamber ③ increases and operates on the upper surface of the diaphragm ④.
As a result, the air supply valve ⑤ linked to the diaphragm ④ opens, and a portion of the supply pressure becomes output pressure.
This output pressure feeds back to the control circuit ⑧ via the pressure sensor ⑦. Here, a correct operation functions until the output pressure is proportional to the input signal, making it possible to always obtain output pressure proportional to the input signal.

Working Principle Diagram

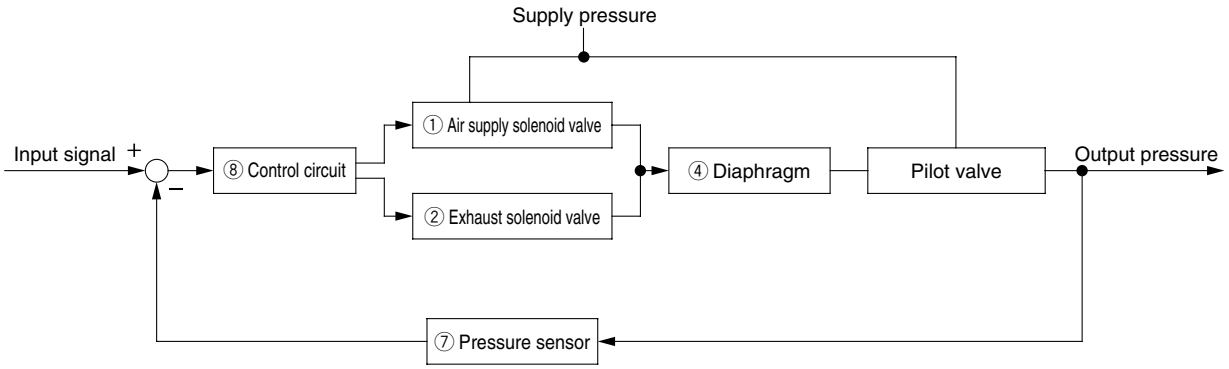


ITV1000



ITV2000, 3000

Block diagram



Series ITV1000/2000/3000
Made to Order Specifications 2

Please contact SMC for detailed dimensions, specifications and lead times.

6 High-Speed Response Time Type

Pressure response with no load is approx. 0.1 sec.

ITV 2 0 1 0 – 0 1 □ 2 □ S □ – X88

Model

1	1000 type
2	2000 type

Pressure range

1	0.1 MPa
3	0.5 MPa
5	0.9 MPa

Power supply voltage

0	24 VDC
1	12 to 15 VDC

Input signal

0	Current type 4 to 20 mA DC (Sink type)
1	Current type 0 to 20 mA DC (Sink type)
2	Voltage type 0 to 5 VDC
3	Voltage type 0 to 10 VDC

Monitor output

1	Analog output 1 to 5 VDC

Thread type

Nil	Rc
N	NPT
T	NPTF
F	G

Port size

1	1/8 (1000 type)
2	1/4 (1000, 2000 type)
3	3/8 (2000 type)

Bracket

Nil	Without bracket
B	Flat bracket
C	L-bracket

Cable connector type

S	Straight type 3 m
L	Right angle type 3 m
N	Without cable connector

Pressure display unit

Nil	MPa
2 *	kgf/cm²
3	bar
4 *	psi
5	kPa

* Under Japan's new Measurement Act, this is only for overseas sales (SI units are to be used inside Japan).

High-speed response time specifications

Symbol	CE-compliant
X88	Not compliant
X154	Compliant

7 Manifold Specifications (Except Series ITV3000)

2 through 8 station manifold.

How to Order Manifolds

IITV20 – □ 02 – 5

Stations

2	2 stations
⋮	⋮
8	8 stations

ITV1000, 2000

OUT port size

02	1/4
03	3/8

Connection thread type

Nil	PT
N	NPT
F	PF

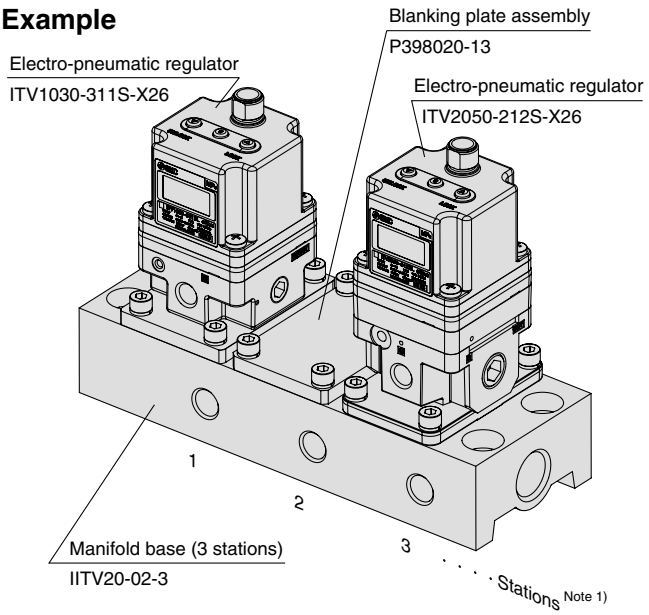
IITV20-02-3 .....1 set (3 station manifold base part no.)
*ITV1030-311S-X26 .....1 set (Electro-pneumatic regulator part no.) Note 2)
*P398020-13 .....1 set (Blanking plate assembly part no.)
*ITV2050-212S-X26 .....1 set (Electro-pneumatic regulator part no.) Note 2)
The * is the symbol for mounting. Add the * symbol at the beginning of part numbers for electro-pneumatic regulators, etc. to be mounted on the base.

Note) Refer to the table below for possible mixed combination.

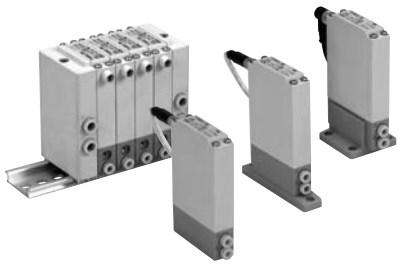
Model	ITV101□	ITV103□	ITV105□	ITV201□	ITV203□	ITV205□
ITV101□	●	—	—	●	—	—
ITV103□	—	●	●	—	●	●
ITV105□	—	●	●	—	●	●
ITV201□	●	—	—	●	—	—
ITV203□	—	●	●	—	●	●
ITV205□	—	●	●	—	●	●

How to Order Manifold Assemblies

Example



Note 1) Electro-pneumatic regulators are counted starting from station 1 on the left side with the OUT ports in front.
Note 2) The port size for mounted electro-pneumatic regulators is Rc 1/8 (ITV1000), Rc 1/4 (ITV2000) only.
Note 3) When there is a large number of stations, use piping with the largest possible inside diameter for the supply side, such as steel piping.
Note 4) The use of the straight type cable connector is recommended. To mount right angle type, be certain to check that no possible interference occurs.
Note 5) When mounting a blanking plate and the regulator with different pressure set, please inform SMC of the order of a manifold station beside a purchase order.



Specifications

Model		ITV009□	
Minimum supply pressure		Set pressure –1 kPa	
Maximum supply pressure		–101 kPa	
Set pressure range		–1 to –100 kPa	
Maximum flow rate		2 ℓ/min (ANR) (Supply pressure: –101 kPa)	
Power supply	**Voltage**	24 VDC ±10%, 12 to 15 VDC	
	Current consumption	Power supply voltage 24 VDC type: 0.12 A or less Power supply voltage 12 to 15 VDC type: 0.18 A or less	
Input signal	**Voltage type**	0 to 5 VDC, 0 to 10 VDC	
	Current type	4 to 20 mA DC, 0 to 20 mA DC	
Input impedance	**Voltage type**	Approximately 10 kΩ	
	Current type	Approximately 250 Ω	
Output signal	**Analog output**	1 to 5 VDC (Load impedance: 1 kΩ or more) Output accuracy: Within ±6% (Full span)	
Linearity		Within ±1% (Full span)	
Hysteresis		Within 0.5% (Full span)	
Repeatability		Within ±0.5% (Full span)	
Sensitivity		Within 0.2% (Full span)	
Temperature characteristics		Within ±0.12% (Full span)/°C	
Operating temperature range		0 to 50°C (No condensation)	
Enclosure		IP65 equivalent *	
Connection type		Built-in One-touch fittings	
Connection size	**For single unit**	Metric size	[1], [2], [3]: ø4
		Inch size	[1], [2], [3]: ø5/32"
	Manifold	Metric size	[1], [3]: ø6, [2]: ø4
		Inch size	[1], [3]: ø1/4", [2]: ø5/32"
Weight Note 1)		100 g or less (without option)	

Note 1) Indicates the weight of a single unit.
For IITV00-n
Total weight (g) ≤ Stations (n) x 100 + 130 (Weight of end block A, B assembly) + Weight (g) of DIN rail

Note 2) When there is a downstream flow consumption, pressure may become unstable depending on piping conditions.

* When using under the conditions equivalent to IP65, connect the fitting or tube to the breathing hole prior to use. (For details, refer to "Specific Product Precautions 1" on back page 2)

Accessories (Option)

Bracket

Flat bracket assembly (including 2 mounting screws)
P39800022

L-bracket assembly (including 2 mounting screws)
P39800023

Tighting torque when assembling is 0.3 N·m.

Cable connector

Straight type
M8-4DSX3MG4

Right angle type
ELWIKA-KV4408 PVC025 2M

5 Port Solenoid Valve

New

RoHS

Reduced power consumption:

0.55 W [With power saving circuit]

1.55 W [Standard]

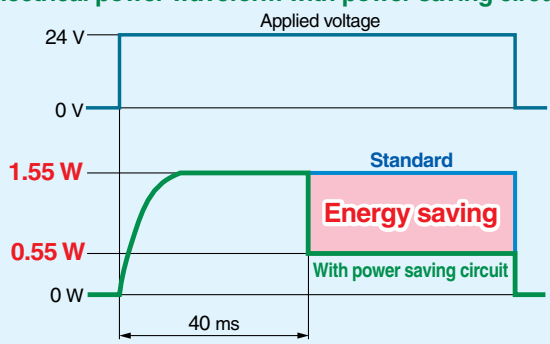
(Conventional: 2.0 W) * With DC light

Series VF3000

Power consumption is reduced by power saving circuit.

Power consumption is decreased by approx. 1/3 by reducing the wattage required to hold the valve in an energized state. (Effective energizing time is over 40 ms at 24 VDC.) Refer to electrical power waveform as shown below.

Electrical power waveform with power saving circuit



Built-in full-wave rectifier (AC)

Noise reduction

Noise is considerably reduced by changing it to DC mode with a full-wave rectifier.

Reduced apparent power

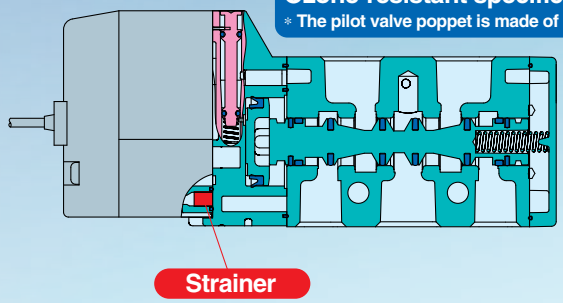
Conventional: 5.6 VA → 1.55 VA

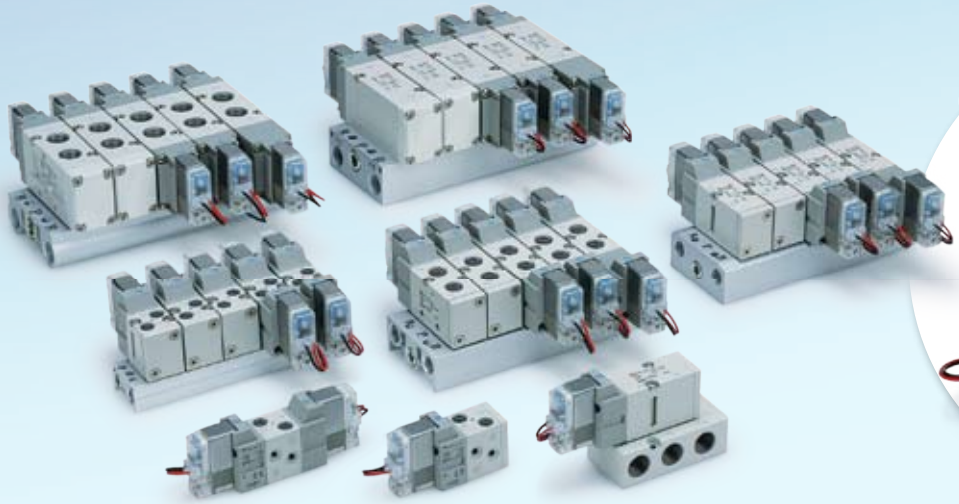
Built-in strainer in the pilot valve

Unexpected troubles due to foreign matter can be prevented.

Note) Be sure to mount an air filter on the inlet side.

Rubber material: HNBR
Ozone-resistant specification
* The pilot valve poppet is made of FKM.





New **Low wattage specification added**

* VF1000/3000

Power consumption **0.35 W** (Without light)

0.4 W (With light)

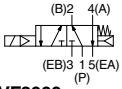
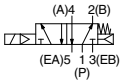
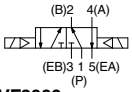
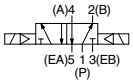
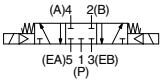
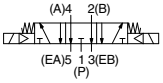
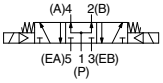
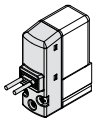
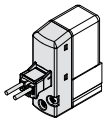
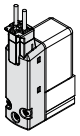
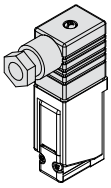
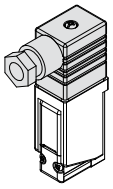
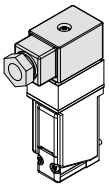
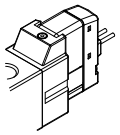
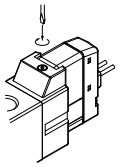
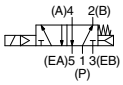
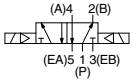
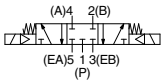
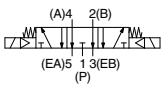
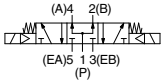
Series VF1000/3000/5000

SMC

CAT.NAS11-99C

Model Selection by Operating Conditions ①

Single Unit

	Series	Sonic conductance C [dm³/(s·bar)]	Type of actuation	Port size	Voltage	Electrical entry	Light/Surge voltage suppressor	Manual override	
Body ported	**VF1000** 	0.76	2-position single **VF1000**  **VF3000** **VF5000**  2-position double **VF1000**  **VF3000** **VF5000**  3-position closed center  3-position exhaust center  3-position pressure center 	M5 x 0.8 1/8	12 VDC 24 VDC 24 VAC 100 VAC 200 VAC 110 VAC 220 VAC 240 VAC	Grommet  L-type plug connector  M-type plug connector  DIN terminal  DIN (EN175301-803) terminal  Conduit terminal 	DC ■ With surge voltage suppressor ■ With light/surge voltage suppressor ■ With surge voltage suppressor (Non-polar) ■ With light/surge voltage suppressor (Non-polar) AC ■ With light/surge voltage suppressor	Non-locking push type  Push-turn locking slotted type 	Page 1
	VF3000 	4.0		1/8 1/4					
	VF5000 	8.8		1/4 3/8					
Base mounted	**VF3000** 	3.1	2-position single  2-position double  3-position closed center  3-position exhaust center  3-position pressure center 	1/4 3/8					Page 15
	VF5000 	9.4		1/4 3/8 1/2					

New Low wattage specification From page 26 Power consumption: 0.35 W (Without light) 0.4 W (With light)

Cylinder Speed Chart ①

Use as a guide for selection.
Please check the actual conditions with SMC Model Selection Program.

Body Ported

0.5 MPa = 73 psi

Series	Average speed (mm/s)	Bore size														
		Series CJ2 Pressure 0.5 MPa Load factor 50% Stroke 60 mm			Series CM2 Pressure 0.5 MPa Load factor 50% Stroke 300 mm				Series MB, CA2 Pressure 0.5 MPa Load factor 50% Stroke 500 mm					Series CS1 Pressure 0.5 MPa Load factor 50% Stroke 1000 mm		
		ø6	ø10	ø16	ø20	ø25	ø32	ø40	ø40	ø50	ø63	ø80	ø100	ø125	ø140	ø160
VF1120-01	1000 800 600 400 200 0															
VF3130-02	1000 800 600 400 200 0															
VF5120-03	1000 800 600 400 200 0														★	★

Perpendicular, upward actuation
Horizontal actuation

∗ With ★: when using steel piping

Base Mounted

0.5 MPa = 73 psi

Series	Average speed (mm/s)	Bore size																
		Series CJ2 Pressure 0.5 MPa Load factor 50% Stroke 60 mm			Series CM2 Pressure 0.5 MPa Load factor 50% Stroke 300 mm				Series MB, CA2 Pressure 0.5 MPa Load factor 50% Stroke 500 mm					Series CS1 Pressure 0.5 MPa Load factor 50% Stroke 1000 mm				
		ø6	ø10	ø16	ø20	ø25	ø32	ø40	ø40	ø50	ø63	ø80	ø100	ø125	ø140	ø160	ø180	ø200
VF3140-03	1000 800 600 400 200 0													★	★			
VF5144-04	1000 800 600 400 200 0														★	★	★	★

Perpendicular, upward actuation
Horizontal actuation

∗ With ★: when using steel piping

Body Ported

Pilot Operated 5 Port Solenoid Valve
Series VF1000/3000/5000
Single Unit

Note) Only DIN and conduit terminal types are available with AC mode. Refer to the electrical entry for details.

RoHS

How to Order Valve

Body ported **VF** **3** **1** **3** **0** □ □ – **5** **G** □ □ **1** – **01** □ – □ – □

Series

1	VF1000
3	VF3000
5	VF5000

Type of actuation

1	2-position single
2	2-position double
3	3-position closed center
4	3-position exhaust center
5	3-position pressure center

∗ Only 1 and 2 are available with the VF1000.

Body model

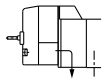
Symbol	VF1000	VF3000	VF5000
2	○	—	○
3	—	○	—

Pressure specifications

Nil	Standard (102 psi (0.7 MPa))
K	High-pressure type (145 psi (1 MPa))

Body option

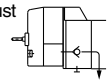
0: Pilot valve individual exhaust



PE port∗ EA/EB port

VF1000	VF3000	VF5000
○	○	○

3: Main/Pilot valve common exhaust



PE port EA/EB port

VF1000	VF3000	VF5000
—	○	○

∗ Refer to "Made to Order" (Page 14) when piping to PE port is required.

Coil specifications

Nil	Standard
T	With power saving circuit (DC only)

Note) Be sure to select the power saving circuit type when it is continuously energized for long periods of time. (Refer to page 51 for details.)

∗ T type is available with DC mode only. When T is selected, only Z type of light/surge voltage suppressor is available. (Note that when the electrical entry of DIN terminal type without connector is selected, only DOS and YOS are available.)

Rated voltage

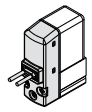
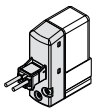
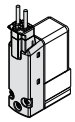
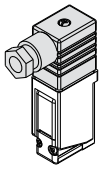
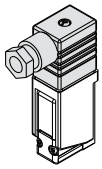
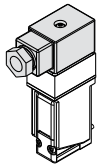
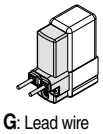
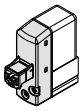
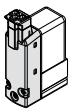
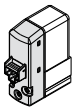
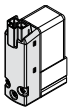
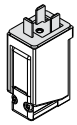
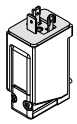
DC

5	24 VDC
6	12 VDC

AC (50/60 Hz)

1	100 VAC
2	200 VAC
3	110 VAC [115 VAC]
4	220 VAC [230 VAC]
7	240 VAC
B	24 VAC

Electrical entry

Grommet	L-type plug connector	M-type plug connector	DIN terminal	DIN (EN175301-803) terminal	Conduit terminal
			[IP65 compatible]	[IP65 compatible]	[IP65 compatible]
					
G: Lead wire length 300 mm **H**: Lead wire length 600 mm	**L**: With lead wire (length 300 mm)	**M**: With lead wire (length 300 mm)	**D**: With connector	**Y**: With connector	**T**: Conduit terminal
					
G: Lead wire length 300 mm **H**: Lead wire length 600 mm DC Without light/ surge voltage suppressor	**LN**: Without lead wire	**MN**: Without lead wire			
					
LO: Without connector	**MO**: Without connector	**DO**: Without connector	**YO**: Without connector		
CE compliant DC	○	○	○	○	○	○
CE compliant AC Note 2)	—	—	—	○	○	○

∗ LN and MN types are with 2 sockets.
∗ Refer to page 49 when different length of lead wire for L/M-type plug connector is required.
∗ Refer to page 50 for details on the DIN (EN175301-803) terminal.
Note 1) When using IP65, select the main/pilot valve common exhaust type. (Except VF1000)
Note 2) With the same specifications as the DC type, all electrical entries for the 24 VAC type are CE marking compliant.

Thread type

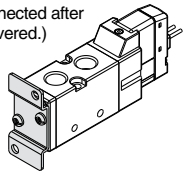
Nil	Rc
F	G
N	NPT
T	NPTF

∗ M5 is available with Nil only.

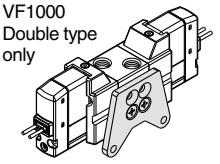
Bracket

Nil	Without bracket
F	With bracket

VF1000/3000 Single type (The bracket cannot be connected after delivered.)



VF1000 Double type only



∗ Not available with the VF5000.

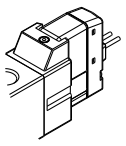
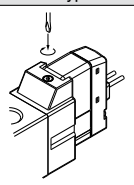
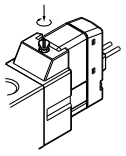
Made to Order

Nil	—
X500	Pilot exhaust port with piping thread (M3) specification (Refer to page 14.)
X600	TRIAC output specification (Refer to page 14.)

A, B port size

Symbol	Port size	VF1000	VF3000	VF5000
M5	M5 x 0.8	○	—	—
01	1/8	○	○	—
02	1/4	—	○	○
03	3/8	—	—	○

Manual override

Nil: Non-locking push type	**D**: Push-turn locking slotted type	**E**: Push-turn locking lever type
		

Light/Surge voltage suppressor

Symbol	Light/Surge voltage suppressor	DC	AC
Nil	Without light/surge voltage suppressor	○	○
S	With surge voltage suppressor	○	—Note)
Z	With light/surge voltage suppressor	○	○
R	With surge voltage suppressor (Non-polar)	○	—
U	With light/surge voltage suppressor (Non-polar)	○	—

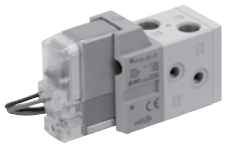
Note) S type is not available with AC mode, since a rectifier prevents surge voltage generation.

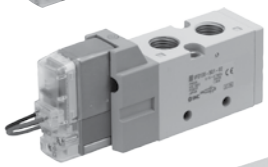
∗ In the DIN terminal type, since a light is installed in the connector, DOZ, DOU, YOZ, YOU are not available.

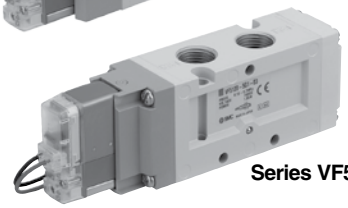
⚠ Caution

When using the surge voltage suppressor type, residual voltage will remain. Refer to page 51 for details.

SMC


Series VF1000


Series VF3000


Series VF5000

Specifications

Model			VF1000	VF3000	VF5000
Fluid			Air		
Operating pressure range	Standard	2-position single/3-position	22 to 102 psi (0.15 to 0.7 MPa)		
		2-position double	15 to 102 psi (0.1 to 0.7 MPa)		
	High-pressure type	2-position single/3-position	22 to 145 psi (0.15 to 1.0 MPa)		
		2-position double	15 to 145 psi (0.1 to 1.0 MPa)		
Ambient and fluid temperature			14 to 122°F (–10 to 50°C) (No freezing)		
Max. operating frequency (Hz)		2-position single/double	10	10	5
		3-position	—	3	3
Manual override			Non-locking push type Push-turn locking slotted type Push-turn locking lever type		
Pilot exhaust type			Individual exhaust, Main/Pilot valve common exhaust (Except VF1000)		
Lubrication			Not required		
Mounting orientation			Unrestricted		
Impact/Vibration resistance (m/s²) Note)			300/50		
Enclosure			Dustproof (IP65* for D, Y, T)		

Note) Impact resistance: No malfunction occurred when it is tested in the axial direction and at the right angles to the main valve and armature in both energized and de-energized states every once for each condition. (Values at the initial period)
Vibration resistance: No malfunction occurred in a one-sweep test between 45 and 2000 Hz. Test was performed at both energized and de-energized states in the axial direction and at the right angles to the main valve and armature. (Values at the initial period)

* Based on IEC 60529. When using IP65, select the main/pilot valve common exhaust type.

Made to Order

Made to Order
(Refer to page 14 for details.)

Symbol	Specification
X500	Pilot exhaust port with piping thread (M3) specification
X600	TRIAC output specification

Solenoid Specifications

Electrical entry			Grommet (G), (H) L-type plug connector (L) M-type plug connector (M)	DIN terminal (D) DIN (EN175301-803) terminal (Y) Conduit terminal (T)
			G, H, L, M	D, Y, T
Coil rated voltage (V)		DC	24, 12	
		AC (50/60 Hz)	24, 100, 110, 200, 220, 240	
Allowable voltage fluctuation			±10% of rated voltage*	
Power consumption (W)	DC	Standard	1.5 (With light: 1.55)	1.5 (With light: 1.75)
		With power saving circuit	0.55 (With light only)	0.75 (With light only)
Apparent power (VA)*	AC	24 V	1.5 (With light: 1.55)	1.5 (With light: 1.75)
		100 V	1.55 (With light: 1.65)	1.55 (With light: 1.7)
		110 V [115 V]		
		200 V		
		220 V [230 V]		
		240 V		
Surge voltage suppressor			Diode (Non-polar type: Varistor)	
Indicator light			LED (Neon light is used for AC mode of D, Y, T.)	

* It is in common between 110 VAC and 115 VAC, and between 220 VAC and 230 VAC.
* Allowable voltage fluctuation is –15% to +5% of the rated voltage for 115 VAC or 230 VAC.
* Since voltage drops due to the internal circuit in S, Z, T types (with power saving circuit), the allowable voltage fluctuation should be within the following range.
24 VDC: –7% to +10% 12 VDC: –4% to +10%

Response Time

Series	Type of actuation		Pressure specifications	Operating pressure range psi (MPa)	Response time (ms) (at 73 psi (0.5 MPa))			
					Without light/surge voltage suppressor	With light/surge voltage suppressor		AC
						S, Z type	R, U type	
VF1000	2-position	Single	Standard	22 to 102 (0.15 to 0.7)	20	45	23	45
		Double		15 to 102 (0.1 to 0.7)	12	12	12	12
		Single	High-pressure type	22 to 145 (0.15 to 1.0)	23	48	26	48
		Double		15 to 145 (0.1 to 1.0)	15	15	15	15
VF3000	2-position	Single	Standard	22 to 102 (0.15 to 0.7)	20	45	23	45
		Double		15 to 102 (0.1 to 0.7)	12	12	12	12
	3-position			22 to 102 (0.15 to 0.7)	30	55	33	55
	2-position	Single	High-pressure type	22 to 145 (0.15 to 1.0)	23	48	26	48
		Double		15 to 145 (0.1 to 1.0)	15	15	15	15
	3-position			22 to 145 (0.15 to 1.0)	33	58	36	58
VF5000	2-position	Single	Standard	22 to 102 (0.15 to 0.7)	30	55	33	55
		Double		15 to 102 (0.1 to 0.7)	15	15	15	15
	3-position			22 to 102 (0.15 to 0.7)	50	75	53	75
	2-position	Single	High-pressure type	22 to 145 (0.15 to 1.0)	33	58	36	58
		Double		15 to 145 (0.1 to 1.0)	18	18	18	18
	3-position			22 to 145 (0.15 to 1.0)	53	78	56	78

Note) Based on dynamic performance test, JIS B 8375-1981. (Coil temperature: 68°F (20°C), at rated voltage)

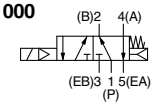
Construction: Body Ported

2-position single

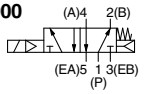
Symbol

2-position single

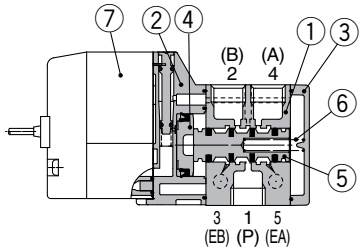
VF1000



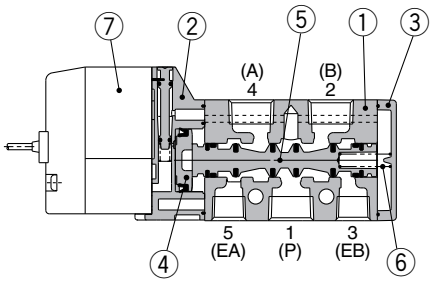
VF3000
VF5000



VF1000



VF3000/5000

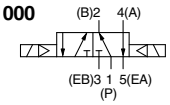


2-position double

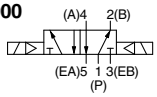
Symbol

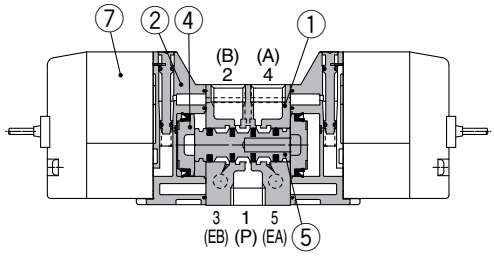
2-position single

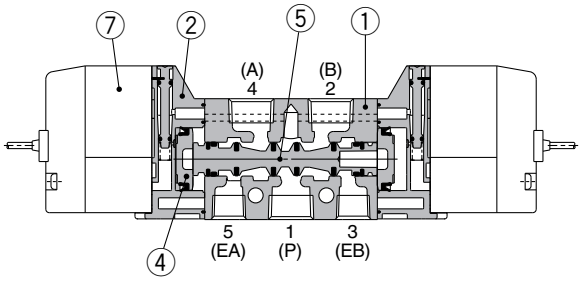
VF1000



VF3000
VF5000



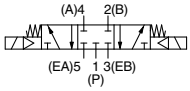




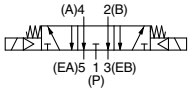
3-position closed center/exhaust center/pressure center

Symbol

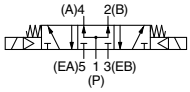
3-position closed center

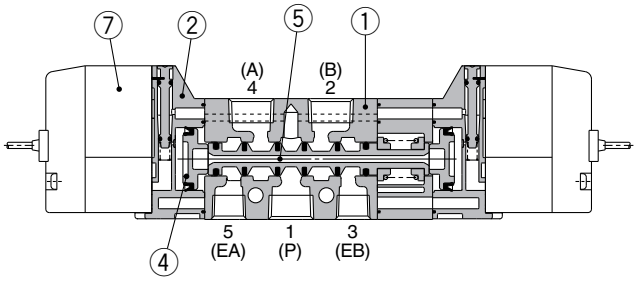


3-position exhaust center



3-position pressure center





(Drawing shows a closed center type.)

Component Parts

No.	Description	Material	Note
1	**Body**	Aluminum die-casted	White
2	**Adapter plate**	Resin	Gray
3	**End plate**	Resin (VF313□-F, VF1120-F: Aluminum die-casted)	White
4	**Piston**	Resin	
5	**Spool valve**	Aluminum, HNBR	
6	**Spring**	Stainless steel	

Replacement Parts

No.	Description	Part no.	Note
7	**Pilot valve assembly**	Refer to “How to Order Pilot Valve Assembly” on page 5.	Built-in strainer

Bracket Assembly Part No.

Description	Part no.
Bracket (for VF1000 double)	DXT144-8-1A (With 2 mounting screws)

How to Order Pilot Valve Assembly (With a gasket and two mounting screws)

⚠ Caution

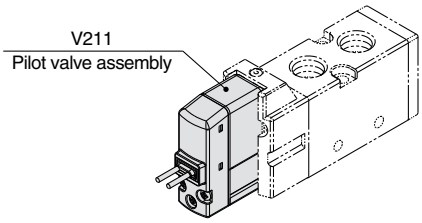
When only the pilot valve assembly is replaced, it is not possible to change from V211 (Grommet or L/M-type) to V212 (DIN or Conduit type), or vice versa.

Valve model: VF□□□□ □ □ – 5 G Z □1 – □□□

∗ Select from the below in accordance with the valve used.

■ Grommet or L/M-type

V 2 1 1 □ □ – 5 G Z



Light/Surge voltage suppressor

		DC	AC
Nil	Without light/surge voltage suppressor	○	○
S	With surge voltage suppressor	○	Note)
Z	With light/surge voltage suppressor	○	○
R	With surge voltage suppressor (Non-polar)	○	—
U	With light/surge voltage suppressor (Non-polar)	○	—

Note) S type is not available with AC mode, since a rectifier prevents surge voltage generation. When T is selected, only Z type of light/surge voltage suppressor is available.

⚠ Caution

When using the surge voltage suppressor type, residual voltage will remain. Refer to page 51 for details.

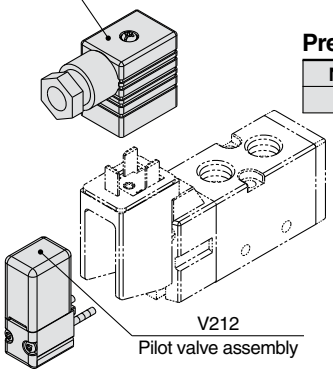
Electrical entry

G	Grommet (Lead wire length 300 mm)	
H	Grommet (Lead wire length 600 mm)	
L	L-type plug connector	With lead wire
LN		Without lead wire
LO		Without connector
M	M-type plug connector	With lead wire
MN		Without lead wire
MO		Without connector

∗ LN and MN types are with 2 sockets.
∗ Refer to page 49 when different length of lead wire for L/M-type plug connector is required.

■ DIN or Conduit type

V 2 1 2 □ □ – 5



Pressure specifications

Nil	Standard (102 psi (0.7 MPa))
K	High-pressure type (145 psi (1 MPa))

Coil specifications

Nil	Standard
T	With power saving circuit (DC only)

∗ T type is available with DC mode only.

Rated voltage

DC

5	24 VDC
6	12 VDC

AC (50/60 Hz)

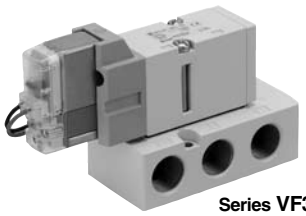
1	100 VAC
2	200 VAC
3	110 VAC [115 VAC]
4	220 VAC [230 VAC]
7	240 VAC
B	24 VAC

⚠ Caution

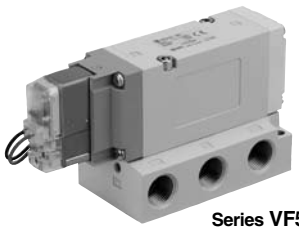
For V212 (DIN or Conduit type), the coil specifications and voltage (including light/surge voltage suppressor) cannot be changed by replacing the pilot valve assembly.

⚠ Caution

Tightening torque of the pilot valve assembly mounting screw
M2.5: 0.24 lbf·ft (0.32 N·m)



Series VF3000



Series VF5000

Made to Order

Made to Order
(Refer to page 14 for details.)

Symbol	Specification
X600	TRIAC output specification

Specifications

Model			VF3000	VF5000
Fluid			Air	
Operating pressure range	**Standard**	**2-position single/3-position**	22 to 102 psi (0.15 to 0.7 MPa)	
		2-position double	15 to 102 psi (0.1 to 0.7 MPa)	
	High-pressure type	**2-position single/3-position**	22 to 145 psi (0.15 to 1.0 MPa)	
		2-position double	15 to 145 psi (0.1 to 1.0 MPa)	
Ambient and fluid temperature			14 to 144°F (–10 to 50°C) (No freezing)	
Max. operating frequency (Hz)		**2-position single/double**	10	5
		3-position	3	3
Manual override			Non-locking push type Push-turn locking slotted type Push-turn locking lever type	
Pilot exhaust type			Individual exhaust, Main/ Pilot valve common exhaust	Pilot valve base exhaust
Lubrication			Not required	
Mounting orientation			Unrestricted	
Impact/Vibration resistance (m/s²) Note)			300/50	
Enclosure			Dustproof (IP65* for D, Y, T)	

Note) Impact resistance: No malfunction occurred when it is tested in the axial direction and at the right angles to the main valve and armature in both energized and de-energized states every once for each condition. (Values at the initial period)
Vibration resistance: No malfunction occurred in a one-sweep test between 45 and 2000 Hz. Test was performed at both energized and de-energized states in the axial direction and at the right angles to the main valve and armature. (Values at the initial period)

* Based on IEC 60529. When using IP65, select the main/pilot valve common exhaust type or pilot valve base exhaust type.

Solenoid Specifications

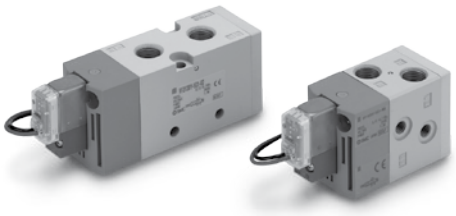
Electrical entry			Grommet (G), (H) L-type plug connector (L) M-type plug connector (M)	DIN terminal (D) DIN (EN175301-803) terminal (Y) Conduit terminal (T)
			G, H, L, M	D, Y, T
Coil rated voltage (V)		**DC**	24, 12	
		AC (50/60 Hz)	24, 100, 110, 200, 220, 240	
Allowable voltage fluctuation			±10% of rated voltage*	
Power consumption (W)	**DC**	**Standard**	1.5 (With light: 1.55)	1.5 (With light: 1.75)
		With power saving circuit	0.55 (With light only)	0.75 (With light only)
Apparent power (VA)*	**AC**	**24 V**	1.5 (With light: 1.55)	1.5 (With light: 1.75)
		100 V	1.55 (With light: 1.65)	1.55 (With light: 1.7)
		110 V [115 V]		
		200 V		
		220 V [230 V]		
		240 V		
Surge voltage suppressor			Diode (Non-polar type: Varistor)	
Indicator light			LED (Neon light is used for AC mode of D, Y, T.)	

* It is in common between 110 VAC and 115 VAC, and between 220 VAC and 230 VAC.
* Allowable voltage fluctuation is –15% to +5% of the rated voltage for 115 VAC or 230 VAC.
* Since voltage drops due to the internal circuit in S, Z, T types (with power saving circuit), the allowable voltage fluctuation should be within the following range.
24 VDC: –7% to +10% 12 VDC: –4% to +10%

Response Time

Series	Type of actuation		Pressure specifications	Operating pressure range psi (MPa)	Response time (ms) (at 73psi (0.5 MPa))			
					Without light/surge voltage suppressor	With light/surge voltage suppressor		AC
						S, Z type	R, U type	
VF1000	2-position	Single	Standard	22 to 102 (0.15 to 0.7)	20	45	23	45
		Double		15 to 102 (0.1 to 0.7)	12	12	12	12
		Single	High-pressure type	22 to 145 (0.15 to 1.0)	23	48	26	48
		Double		15 to 145 (0.1 to 1.0)	15	15	15	15
VF3000	2-position	Single	Standard	22 to 102 (0.15 to 0.7)	20	45	23	45
		Double		15 to 102 (0.1 to 0.7)	12	12	12	12
	3-position			22 to 102 (0.15 to 0.7)	30	55	33	55
	2-position	Single	High-pressure type	22 to 145 (0.15 to 1.0)	23	48	26	48
		Double		15 tp 145 (0.1 to 1.0)	15	15	15	15
	3-position			22 to 145 (0.15 to 1.0)	33	58	36	58
VF5000	2-position	Single	Standard	22 to 102 (0.15 to 0.7)	30	55	33	55
		Double		15 to 102 (0.1 to 0.7)	15	15	15	15
	3-position			22 to 102 (0.15 to 0.7)	50	75	53	75
	2-position	Single	High-pressure type	22 to 145 (0.15 to 1.0)	33	58	36	58
		Double		15 to 145 (0.1 to 1.0)	18	18	18	18
	3-position			22 to 145 (0.15 to 1.0)	53	78	56	78

Note) Based on dynamic performance test, JIS B 8375-1981. (Coil temperature: 68°F (20°C), at rated voltage)



Specifications

Model		VF1000	VF3000
Fluid		Air	
Internal pilot operating pressure range	**2-position single/3-position**	22 to 102 psi (0.15 to 0.7 MPa)	
	2-position double	15 to 102 psi (0.1 to 0.7 MPa)	
Ambient and fluid temperature		14 to 122°F (–10 to 50°C) (No freezing)	
Max. operating frequency (Hz)	**2-position single/double**	5	5
	3-position	3	3
Manual override		Non-locking push type Push-turn locking slotted type Push-turn locking lever type	
Pilot exhaust type		Main/Pilot valve common exhaust	
Lubrication		Not required	
Mounting orientation		Unrestricted	
Impact/Vibration resistance (m/s²) Note)		150/30	
Enclosure		Dustproof (IP65* for DIN terminal)	

* Based on IEC 60529.

Note) Impact resistance: No malfunction occurred when it is tested in the axial direction and at the right angles to the main valve and armature in both energized and de-energized states every once for each condition. (Values at the initial period)

Vibration resistance: No malfunction occurred in a one-sweep test between 45 and 2000 Hz. Test was performed at both energized and de-energized states in the axial direction and at the right angles to the main valve and armature. (Values at the initial period)

Solenoid Specifications

Electrical entry			Grommet (G), (H) L-type plug connector (L) M-type plug connector (M)	DIN terminal (D), (Y)
			G, H, L, M	D, Y
Coil rated voltage (V)	**DC**		24, 12	
	AC (50/60 Hz)		100, 110, 200, 220	
Allowable voltage fluctuation			±10% of rated voltage*	
Power consumption (W)	**DC**	**Standard**	0.35 {With light: 0.4 (With light of DIN terminal: 0.45)}	
Apparent power (VA)*	**AC**	**100 V**	0.78 (With light: 0.81)	0.78 (With light: 0.87)
		110 V [115 V]	0.86 (With light: 0.89) [0.94 (With light: 0.97)]	0.86 (With light: 0.97) [0.94 (With light: 1.07)]
		200 V	1.18 (With light: 1.22)	1.15 (With light: 1.30)
		220 V [230 V]	1.30 (With light: 1.34) [1.42 (With light: 1.46)]	1.27 (With light: 1.46) [1.39 (With light: 1.60)]
Surge voltage suppressor			Diode (DIN terminal, Non-polar type: Varistor)	
Indicator light			LED (Neon light is used for AC mode of DIN terminal.)	

* It is in common between 110 VAC and 115 VAC, and between 220 VAC and 230 VAC.
* Allowable voltage fluctuation is –15% to +5% of the rated voltage for 115 VAC or 230 VAC.
* Since voltage drops due to the internal circuit in S and Z types, the allowable voltage fluctuation should be within the following range.
  24 VDC: –7% to +10%
  12 VDC: –4% to +10%

Response Time

Series	Type of actuation	Response time (ms) (at 73 psi (0.5 MPa))			
		Without light/surge voltage suppressor	With light/surge voltage suppressor		AC
			S, Z type	R, U type	
VF1000	2-position single	45	55	45	45
	2-position double	12	12	12	12
VF3000	2-position single	55	63	55	50
	2-position double	14	14	14	16
	3-position	100	100	90	90

Specific Product Precautions 5

Be sure to read before handling.
Refer to back cover for Safety Instructions, "Handling Precautions for SMC Products" (M-E03-3) for 3/4/5 Port Solenoid Valves Precautions.

One-touch Fittings Precautions

⚠ Caution

When fittings are used, they may interfere with one another depending on their types and sizes. Therefore, the dimensions of the fittings to be used should first be confirmed in their respective catalogs.
Fittings whose compliance with the VF series is already confirmed are stated below. If the fitting within the applicable range is selected, there will not be any interference.

Applicable Fittings: Series KQ2H, KQ2S

Series	Model	Piping port	Port size	Applicable tubing O.D.						
				ø3.2	ø4	ø6	ø8	ø10	ø12	ø16
VF1000	VF1□20-□□1-M5	4(A), 2(B)	M5	●	●					
		5(EA), 3(EB)	M5	●	●	●				
	VF1□20-□□1-01	4(A), 2(B)	1/8	●	●	●	●			
		5(EA), 3(EB)	M5	●	●	●				
	VF1□3□-□□1-M5	4(A), 2(B)	M5	●	●					
	VF1□3□-□□1-01	4(A), 2(B)	1/8	●	●	●	●			
	Type 30 manifold base	1(P), 5/3(R)	1/8	●	●	●	●	●		
	Type 31 manifold base	1(P)	1/8	●	●	●				
		5(EA), 3(EB)	M5	●	●					

Series	Model	Piping port	Port size	Applicable tubing O.D.						
				ø3.2	ø4	ø6	ø8	ø10	ø12	ø16
VF3000	VF3□3□-□□1-01	4(A), 2(B)	1/8	●	●	●	●	●		
		1(P), 5(EA), 3(EB)	1/8	●	●	●	●			
	VF3□3□-□□1-02	4(A), 2(B)	1/4	●	●	●	●	●	●	
		1(P), 5(EA), 3(EB)	P: 1/4, EA, EB: 1/8	●	●	●	●			
	VF3□4□-□□1-02	4(A), 2(B)	1/4	●	●	●	●	●	●	
		1(P), 5(EA), 3(EB)	1/4	●	●	●	●	●	●	
	VF3□4□-□□1-03	4(A), 2(B)	3/8			●	●	●	●	
		1(P), 5(EA), 3(EB)	3/8			●	●	●	●	
	Type 30 manifold base	1(P), 5(R), 3(R)	1/4	●	●	●	●	●	●	
	Type 40 manifold base	4(A), 2(B)	1/4	●	●	●	●	●	●	
		1(P), 5(R), 3(R)	1/4	●	●	●	●	●	●	

Series	Model	Piping port	Port size	Applicable tubing O.D.						
				ø3.2	ø4	ø6	ø8	ø10	ø12	ø16
VF5000	VF5□2□-□□1-02	4(A), 2(B)	1/4	●	●	●	●	●	●	
		1(P), 5(EA), 3(EB)	1/4	●	●	●	●	●	●	
	VF5□2□-□□1-03	4(A), 2(B)	3/8			●	●	●	●	
		1(P), 5(EA), 3(EB)	3/8			●	●	●	●	
	VF5□44-□□1-02	4(A), 2(B)	1/4	●	●	●	●	●	●	
		1(P), 5(EA), 3(EB)	1/4	●	●	●	●	●	●	
	VF5□44-□□1-03	4(A), 2(B)	3/8			●	●	●	●	
		1(P), 5(EA), 3(EB)	3/8			●	●	●	●	●
	VF5□44-□□1-04	4(A), 2(B)	1/2					●	●	●
		1(P), 5(EA), 3(EB)	1/2					●	●	●
	Type 20 manifold base	1(P), 5(R), 3(R)	3/8			●	●	●	●	
	Type 21 manifold base	1(P), 5(R), 3(R)	1/2					●	●	●
	Type 40 manifold base	4(A), 2(B)	1/4	●	●	●	●	●	●	
		1(P), 5(R), 3(R)	3/8			●	●	●	●	