UNIVERSITÀ DEGLI STUDI DI TRENTO
DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

TRASMISSIONE IDROSTATICA A CIRCUITO CHIUSO DI UN CARRELLO ELEVATORE

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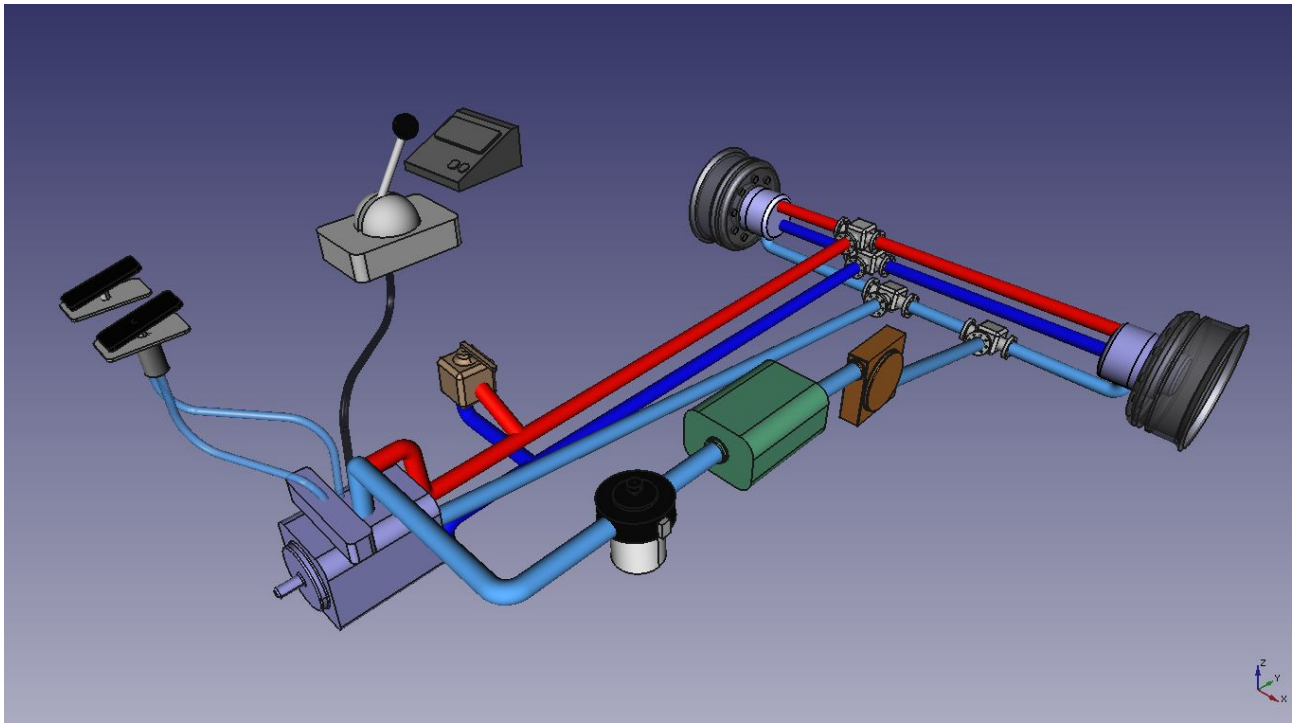
1. INTRODUZIONE



Tubazione rossa/blu: circuito di mandata/ritorno
Tubazione azzurra: trafilamenti + circuito ausiliario(secondario) e di controllo della cilindrata
Arancione: scambiatore di calore, Verde: serbatoio, Bianco-Nero: filtro, Viola: valvola a farfalla

Nel settore delle macchine per la movimentazione dei materiali sono richieste delle soluzioni che permettano al veicolo di avere una massima precisione ed affidabilità operativa senza rinunciare alla potenza.
La trasmissione idrostatica a circuito chiuso costituisce il sistema di trazione ideale.
La potenza meccanica del motore elettrico o termico, con i suoi valori di coppia e numero di giri, è trasformata dalla pompa in potenza idraulica per fornire le grandezze di pressione e di portata. Più precisamente, l'olio acquisisce energia di pressione statica per trasferire coppia(momento torcente) all'attuatore rotante.

Con la designazione di circuito chiuso s'intende un particolare tipo di circuito in cui l'olio in circolazione non ritorna al serbatoio ma è aspirato direttamente dalla pompa.

Il circuito chiuso è coadiuvato da un circuito secondario costituito da una pompa(ausiliaria), un serbatoio, un filtro ed uno scambiatore di calore. Inoltre, il circuito secondario alloggia il sistema di controllo della pompa(principale).

Il sistema di controllo, che agisce sui componenti oleodinamici regolabili, permette di controllare il moto rotatorio del motore idraulico e quindi la traslazione nel seguente modo:

- Macchina ferma
- Accelerazione in avanti
- Decelerazione
- Stop
- Accelerazione indietro
- Decelerazione

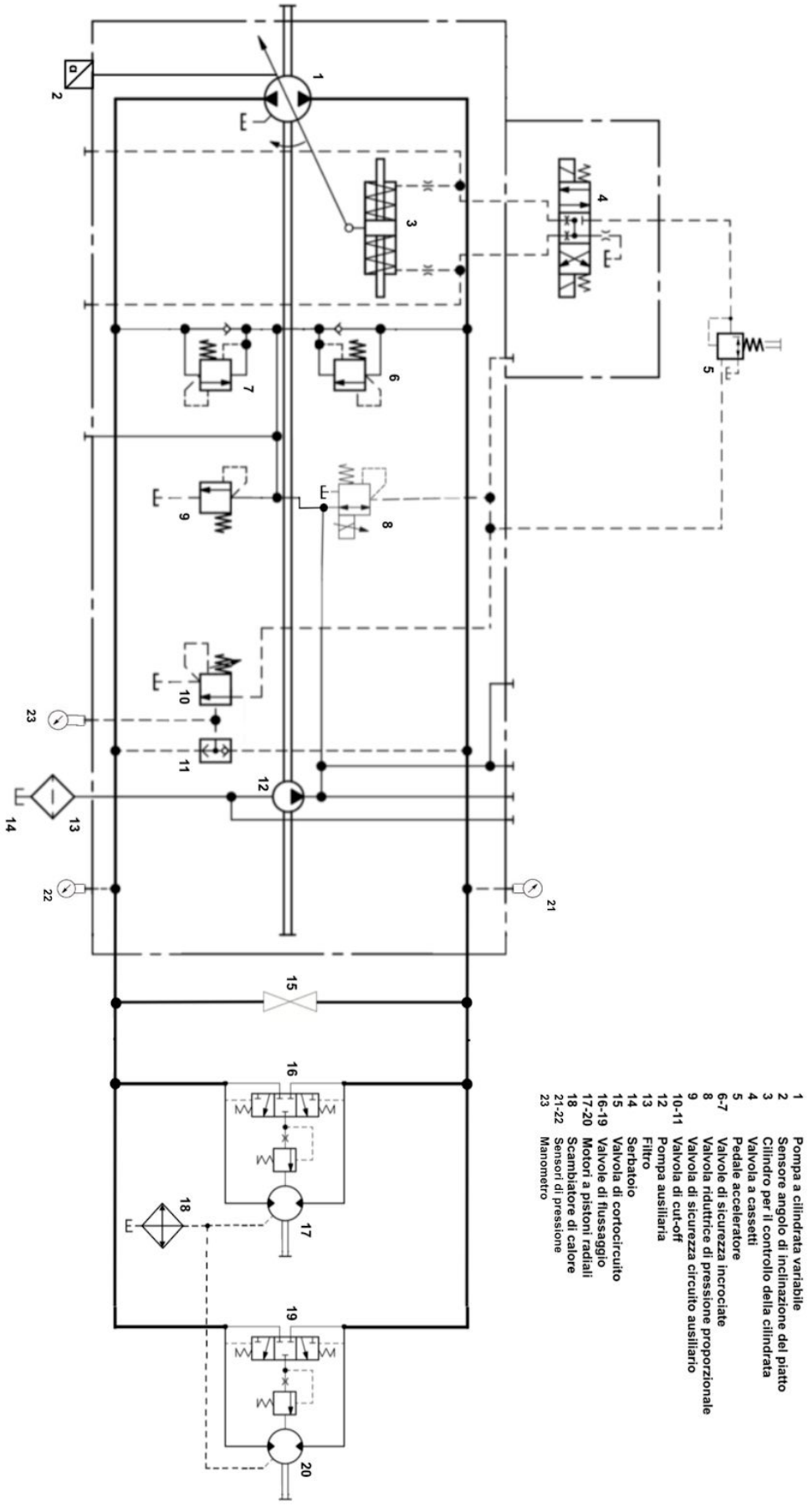
- Stop

Il veicolo da noi progettato è un carrello elevatore che è un mezzo operativo dotato di ruote che viene principalmente utilizzato per il sollevamento e lo spostamento di merci all'interno di depositi, o per il carico e lo scarico delle merci da piattaforme e mezzi di trasporto.

I punti focali del nostro lavoro riguardano il dimensionamento della trasmissione idrostatica con il relativo sistema di controllo della cilindrata, assistito dall'elettronica, la gestione ottimale dell'olio e la sicurezza, prestando attenzione alle performance.

Rispetto alla trazione meccanica i principali vantaggi sono:

- possibilità di controllo continuo e sensibile della velocità di trazione
- inversione diretta e senza strappi del movimento
- semplicità e comfort di manovra
- ripartizione a piacere della potenza sui circuiti di trazione e di lavoro
- assenza di sovraccarichi sul motore diesel
- sfruttamento ottimale della potenza disponibile
- totale libertà di layout nel progetto del veicolo, grazie alla possibilità di montare gli attuatori in posizioni indipendenti dal motore primo: in questo modo si eliminano i vincoli cinematici fra motore primo e utenze creati ad esempio da alberi cardanici e da frizioni.


1 Pompa a cilindrata variabile
2 Sensore angolo di inclinazione del piatto
3 Cilindro per il controllo della cilindrata
4 Valvola a cassetti
5 Pedale acceleratore
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18 Scambiatore di calore
21-22 Sensori di pressione
23 Manometro

2. CARATTERISTICHE TECNICHE PRINCIPALI DEL VEICOLO

-Le specifiche del mezzo sono prese dal catalogo di carrelli elevatori Toyota-

Generali			
Alimentazione		Diesel	
Tipo di guida		Seduto	
Capacità/portata nominale	C	3500	kg
Accelerazione a pieno carico	a	0.35	m/s^2
Velocità di marcia con/senza carico	v	19 / 19.5	km/h
Pendenza superabile con/senza carico (in percentuale)	ϑ	11 (19%) / 19.5%	°C
Pesi			
Peso del carrello	M	4920	kg
Reazione sugli assali a carico ant./post.		7290/1130	kg
Reazione sugli assali a vuoto ant./post.		1730/3190	kg
Ruote			
Diametro ruota anteriore	d	762	mm
Numero di ruote ant./post. (x=ruote di trazione)		2x/2	
Dimensioni			
Lunghezza totale		3850	mm
Larghezza totale		1290	mm
Motore Diesel			
Costruttore		TOYOTA 3Z	
Potenza motore ISO1585		42	kW

3. PRESTAZIONI RICHIESTE

Sforzo necessario per vincere la pendenza massima:

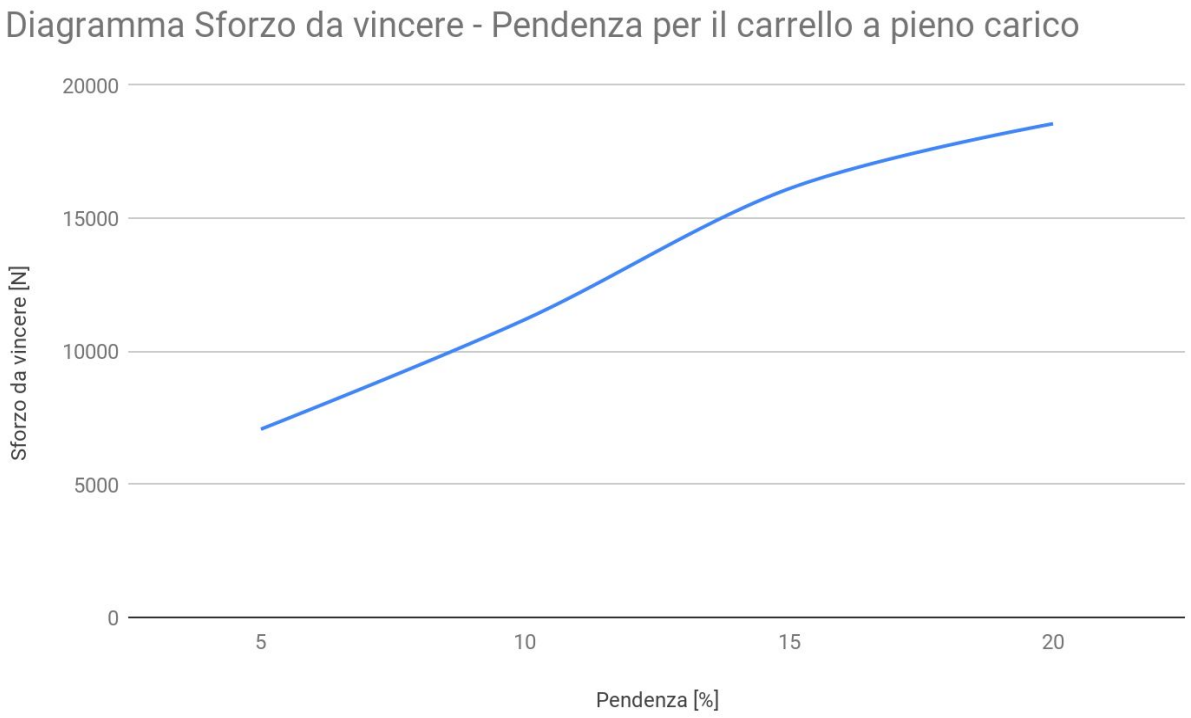
$$S = (M + C) \cdot 9.81 \cdot sin(\vartheta) \sim 15600\ N$$

Sforzo necessario per vincere l'inerzia:

$$I = (M + C) \cdot a \sim 2950\ N$$

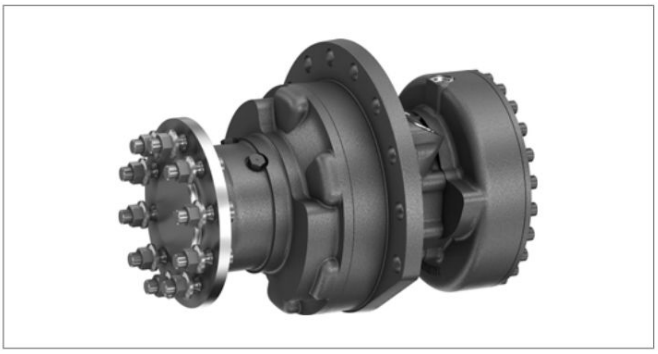
Sforzo massimo:

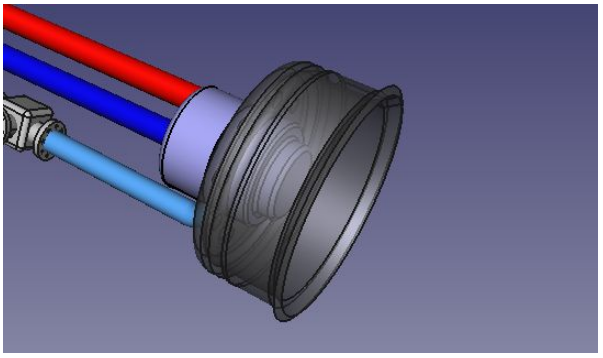
$$S_{tot} = (S + I) \sim 18550\ N$$



Curva: $S_{tot} = (M + C) \cdot 9.81 \cdot sin(\vartheta) + I = (4920 \cdot 3500) \cdot 9.81 \cdot sin(\vartheta) + I$

4. SCELTA DEL MOTORE





-Bosch Rexroth MCR-F-

La tipologia di motore scelto è a pistoni radiali poiché è in grado di fornire una grande coppia ed un'ottima regolarità di rotazione anche a bassi regimi senza il bisogno di utilizzare un riduttore.

Per eliminare le perdite di energia dovute ai tradizionali alberi di trasmissione e al differenziale, e per minimizzare l'ingombro della struttura, è stata scelta la tipologia di motore adatto ad essere montato direttamente sui mozzi delle ruote.

Dimensionamento:

È stato scelto come valore massimo del salto di pressione $\Delta p = 350\ bar$ per evitare che le valvole inserite nel circuito vengano danneggiate.

Raggio ruote:

$$r = \frac{d}{2} = 0.381\ mm$$

Momento torcente massimo:

$$T = S_{tot} \cdot r \sim 7000\ Nm$$

Momento torcente per motore:

$$T' = \frac{T}{2} \sim 3500\ Nm$$

Cilindrata necessaria:

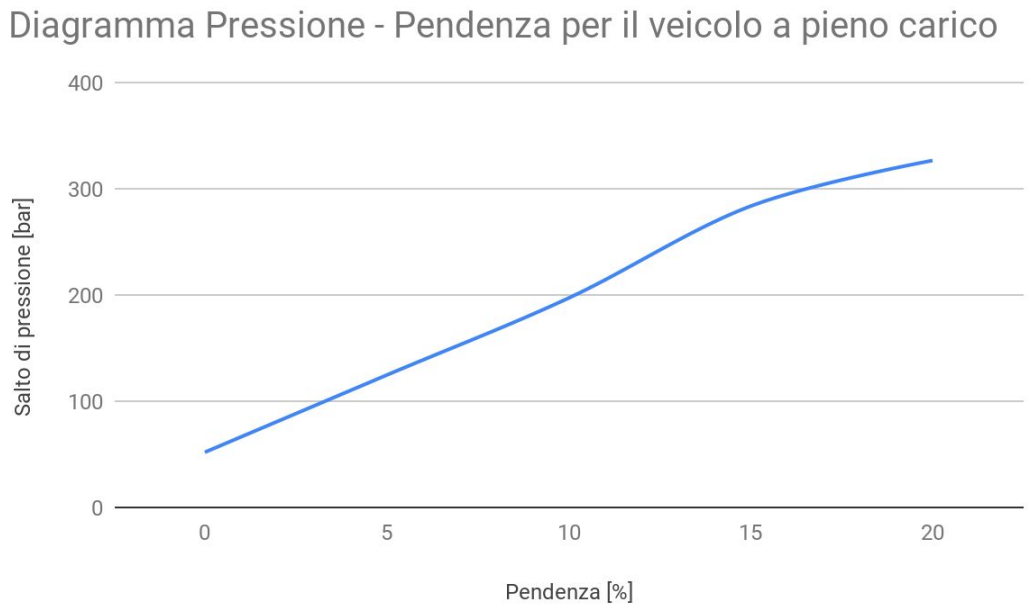
$$V_{motore} = \frac{(T' \cdot 20 \cdot \pi)}{\Delta p} \sim 615\ cm^3$$

CARATTERISTICHE:	
Produttore	Bosch Rexroth
Modello	MCR-F
Tipologia	Pistoni radiali
Codice prodotto: MCR | 5 | F | 680 | F180 | z | / | 32 | C4L/R | M | 1L | 12 | S | / | F6 | / | / |	

Il salto di pressione massimo raggiunto con il motore scelto è di ~325 bar.

Motor performance MCR5										
Displacement	V_g	cm^3/rev	380	470	520	565	620	680	750	820
Specific torque		Nm/bar	6	7	8	9	10	11	12	13
Maximum torque[5)]	T_{max}	Nm	2722	3366	3724	4047	3947	4329	4775	5220
Minimum speed for smooth running[7)]	n_{min}	rpm	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Maximum speed (1L)[8)9)]	n_{max}	rpm	475	385	350	320	290	265	240	220
Maximum speed (2WL)[8)9)]	n_{max}	rpm	570	465	420	385	350	320	290	265

Analisi di come varia la pressione nel circuito a seconda della pendenza che il veicolo deve affrontare:



Curva: $\Delta p = \frac{20\cdot\pi\cdot[(M+C)\cdot 9.81\cdot sin(\vartheta)+I]\cdot r}{V_{motore}} = \frac{20\cdot\pi\cdot[(4920+3500)\cdot 9.81\cdot sin(\vartheta)+2950]\cdot 0.381}{680}$

I rendimenti che interessano i motori idraulici sono:

- Rendimento volumetrico
- Rendimento idromeccanico
- Rendimento totale

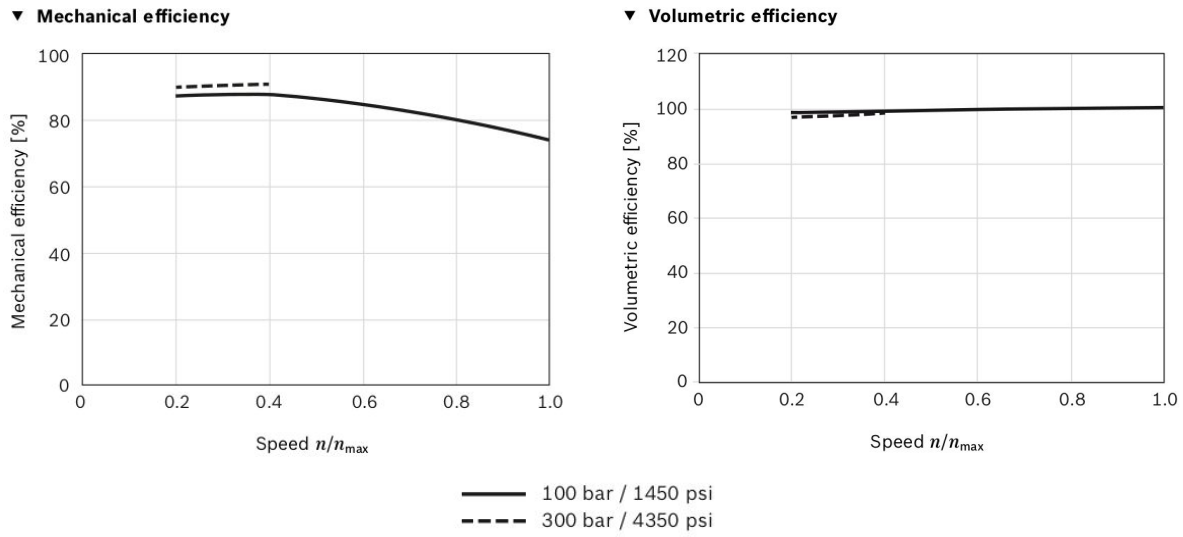
Il rendimento volumetrico del motore è il rapporto fra la portata teorica e la portata effettiva assorbita.

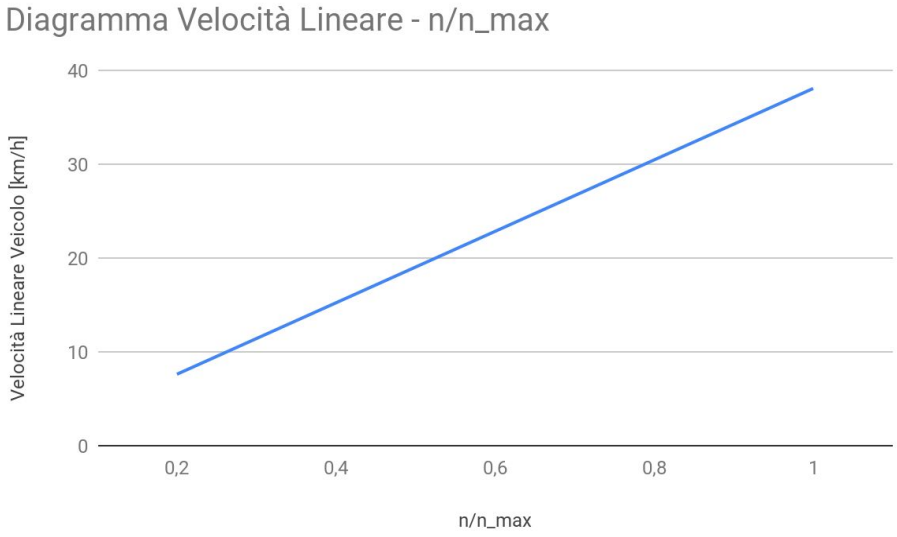
Il rendimento idromeccanico del motore è il rapporto tra la coppia reale e la coppia sviluppabile in assenza di perdite.

Il rendimento totale è il prodotto dei due rendimenti.

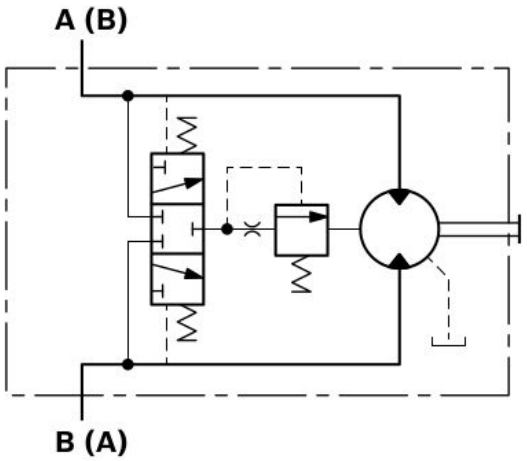
Quindi, in un motore idraulico la potenza meccanica disponibile all'albero è sempre inferiore alla potenza idraulica assorbita dal motore.

Grafici delle performance del motore MCR-F forniti dalla Bosch Rexroth:





Retta: $v = [(\frac{n}{n_{max}}) \cdot n_{max}] \cdot \frac{(2 \cdot \pi) \cdot r \cdot 3.6}{60} = [(\frac{n}{n_{max}}) \cdot 265] \cdot \frac{(2 \cdot \pi) \cdot 0.381 \cdot 3.6}{60}$

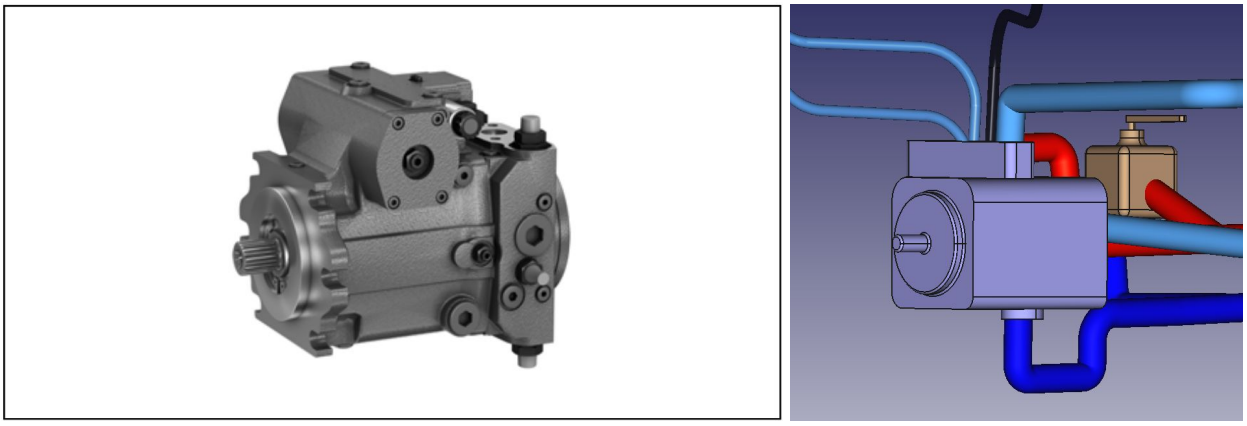


Abbiamo accessoriato i motori con una valvola di flussaggio per mantenere l'olio ad una corretta temperatura. In un circuito chiuso l'olio viene scambiato continuamente tra pompa e motore, questo porta ad un notevole aumento della temperatura dell'olio. La valvola di flussaggio permette di scaricare l'olio caldo, prelevato dal ramo di bassa pressione, nel serbatoio. L'olio passa prima attraverso uno scambiatore di calore che si occupa del suo raffreddamento. Per compensare la perdita d'olio nel circuito, la pompa ausiliaria ne immette di fresco.

Flushing flow rates

Flushing code	Orifice size [mm]	Flow [l/min] at 25 bar[1)]	
		min	max
F1	Ø1	2.2	2.7
F2	Ø1.5	5.0	6.1
F7	Ø1.7	6.4	7.8
F4	Ø2	8.2	10.7
F6	Ø2.3	8.8	11.4

5. SCELTA DELLA POMPA

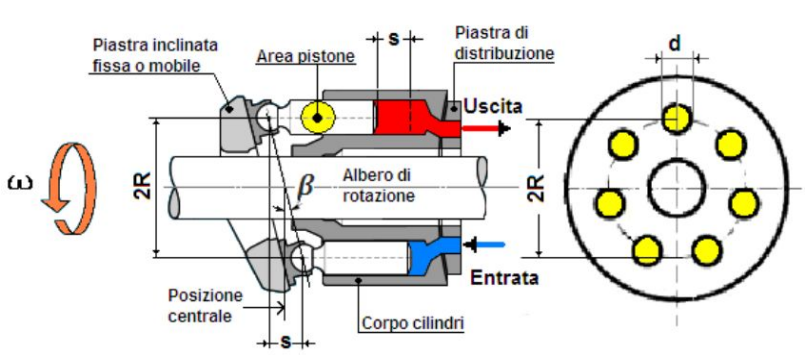


-Bosch Rexroth A4VG-

La pompa scelta è a pistoni assiali a cilindrata variabile a piastra inclinata perché permette una regolazione della portata erogata ai motori e quindi della velocità con cui il veicolo si muove.

La pompa è stata accessoriata con un sensore che misura l'angolo di rotazione del piatto inclinato. Dal valore dell'angolo si ricava il valore della cilindrata della pompa. Questa misura è importante per il sistema di controllo del veicolo.

Il corpo pompa contiene un blocco in lega, munito di cavità cilindriche equidistanti, con assi paralleli o convergenti rispetto all'albero. In ogni alloggiamento è infilato un pistone in acciaio. All'estremità opposta ogni pistone tocca contro un piatto obliquo fisso, il cui angolo rispetto all'albero della pompa è variabile. Quando si mette in rotazione l'albero, esso trascina in rotazione il blocco cilindri, che per effetto dell'inclinazione del piatto genera il movimento alternato dei pistoni nelle sedi, con conseguente effetto di pompaggio. La cilindrata varia con l'angolo di inclinazione secondo la formula:



$$V_g = \frac{\pi \cdot d^2 \cdot R \cdot N \cdot tan(\beta)}{2}$$

dove:

V_g = *cilindrata* [cm^3]

d = *diametro pistoni* [mm]

R = *raggio*

N = *numero pistoni*

β = *angolo di inclinazione* [°]

Quando l'angolo di inclinazione è nullo allora la piastra si trova in posizione neutra ed i pistoni non fanno la corsa. la portata erogata dalla pompa è nulla ed i motori non ruotano.

La variazione della cilindrata viene effettuata da un circuito di controllo.

Dimensionamento:

Regime di rotazione massimo dei motori:

$$\omega_{max} = \frac{v \cdot 60}{r \cdot 3.6 \cdot 2\pi} \sim 134\ rpm$$

Portata massima richiesta:

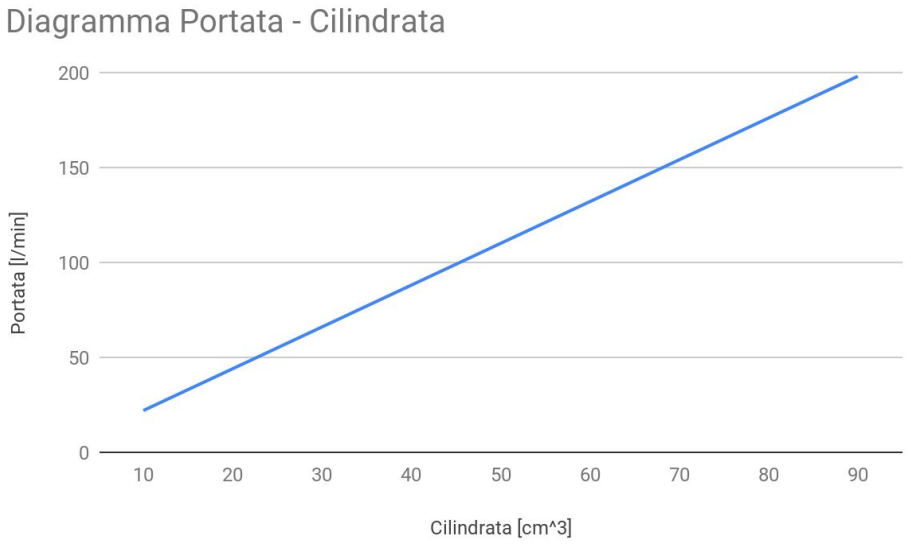
$$Q = \frac{(V_{motore} \cdot \omega_{max} \cdot 2)}{1000} \sim 182\ l/min$$

Il regime di rotazione del motore Diesel è di 2200 rpm per garantire la condizione ottimale del Diesel (approfondimento nel sistema di controllo della cilindrata).

Cilindrata massima:

$$V_{pompa} = \frac{(Q \times 1000)}{\omega_{diesel}} \sim 82\ cm^3$$

CARATTERISTICHE	
Produttore	Bosch Rexroth
Modello	A4VG Series 32
Tipologia	Pistoni assiali
Codice prodotto: A4V | G | 90 | NV | D | / | / | / | 1 | 32 | R | N | S | F | 02 | F | 02 | 1 | S | R | / | / |	



Retta: $Q = \frac{(V_{motore} \cdot \omega_{max} \cdot 2)}{1000}$

I rendimenti che interessano la pompa sono:

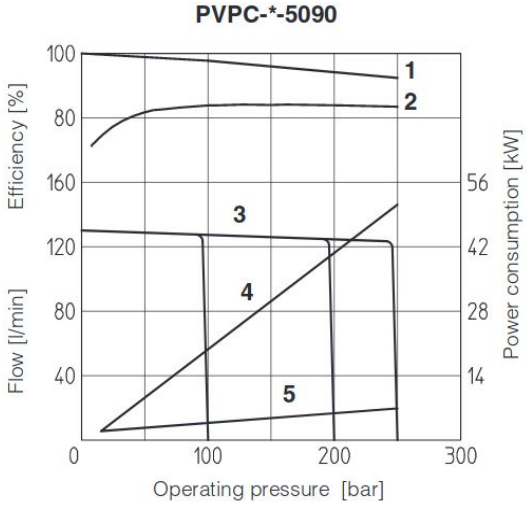
- Rendimento volumetrico
- Rendimento idromeccanico
- Rendimento totale

Il rendimento volumetrico della pompa è definito come il rapporto fra portata effettiva nelle condizioni di pressione e di regime considerate e portata teorica.

Il rendimento idromeccanico della pompa corrisponde al rapporto fra la pressione reale e la pressione sviluppabile in assenza di perdite.

Il rendimento totale è il prodotto dei due rendimenti.

In mancanza di documentazione sulle performance della pompa, abbiamo deciso di riportare un diagramma indicativo dei rendimenti di una pompa a cilindrata variabile. Sul tale grafico si svilupperanno i conti termodinamici.

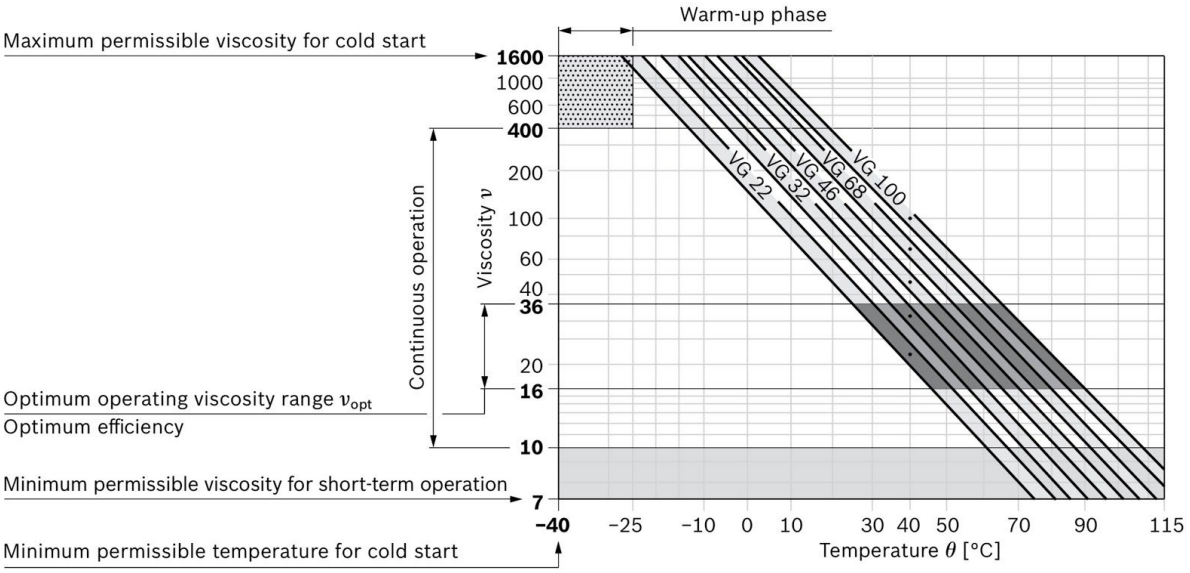


1 = Volumetric efficiency
2 = Overall efficiency
3 = Flow versus pressure curve
4 = Power consumption with full flow
5 = Power consumption at pressure compensation

-Atos PVPC - 5090-

6. OLIO E TUBI

Dai manuali della Bosch Rexroth riguardanti pompa e motore è stato ricavato il seguente grafico per la scelta dell'olio, che tiene in considerazione viscosità ottimale e intervallo di temperatura.



Valutando l'applicazione della trasmissione in un carrello elevatore probabilmente utilizzato in un intervallo di temperatura tra -10 e 35 °C è risultata ottimale la scelta dell'olio VG 32, il quale presenta un intervallo di viscosità ottimale tra 35 e 60 °C. Il riscaldamento risulta agevole visto il limite inferiore della temperatura per avere una buona viscosità. Il raffreddamento necessita di uno scambiatore di calore che riesca a dissipare la potenza termica immessa utilizzando la portata della pompa ausiliaria. Nonostante maggiore sia la temperatura massima per la viscosità ottimale, migliore è il funzionamento dello scambiatore di calore, questa viene limitata dalla tensione di vapore all'interno del ramo di bassa pressione che, nel caso di surriscaldamento o malfunzionamento creerebbe danni ai componenti dovuti a fenomeni cavitativi.

Per questa applicazione sono necessari tubi flessibili, per potersi adattare al meglio all'interno del carrello elevatore. Inoltre i tubi devono reggere alte pressioni, caratteristiche della trasmissione idrostatica.

Il tubo scelto resiste ad una pressione di lavoro di 420 bar, inoltre è stato scelto il diametro di 1" per garantire una corretta portata, considerando le perdite di carico, e per non richiedere particolari adattatori per pompa e motori. I tubi scelti sono consigliati per applicazioni ad alte pressioni e con possibili alti impulsi di pressione come le trasmissioni idrostatiche. I tubi sono costituiti da gomma sintetica, resistente all'olio minerale e sono rinforzati da 6 strati di spirali in acciaio che garantiscono la tenuta.

Tubo flessibile	
Produttore	GATES
Modello	70737
Codice prodotto: 70737 16EFG6KXLL	

PRODUCT DETAILS

Part #	70737	**Product #**	46511399
Description	70737 16EFG6KXLL	**UPC**	072053882193
Max W.P. (psi)	6000	**Hose I.D. (in)**	1
Hose O.D. (in)	1.53	**MBR (in)**	6
Wt. Per ft	1.5		

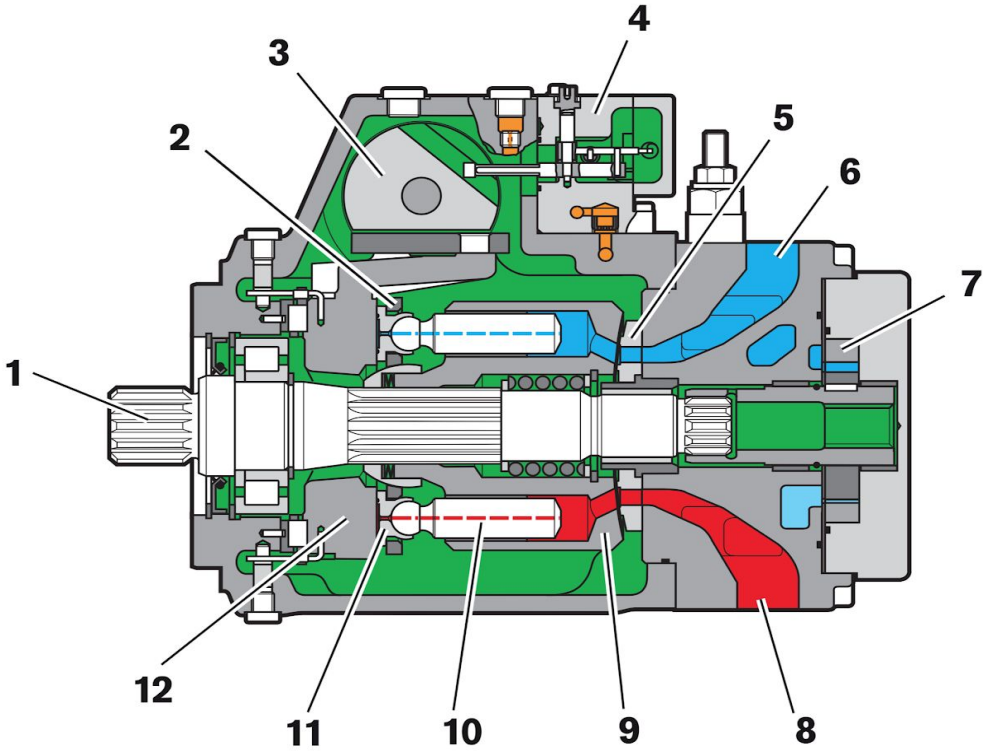
WORKING PRESSURE

Min. Burst Pressure (psi)	24000

Descrizione generale del tubo 70737 16EFG6KXLL

7. POMPA AUSILIARIA

Per evitare fenomeni di cavitazione è prevista l'alimentazione forzata di tutte le condotte che potrebbero fungere da condotto di aspirazione. Tale alimentazione viene realizzata da una pompa ausiliaria che gestisce una portata leggermente superiore a quella di trafilamento del circuito (solitamente 10-15% della portata principale). Le due valvole di ritegno, incluse nelle valvole di sicurezza incrociate, consentono di inviare la portata di sovralimentazione a quello dei due condotti che si trova a pressione minore. Le valvole di flussaggio realizzano l'importante funzione di garantire un opportuno ricambio del fluido. Senza la loro presenza infatti rimarrebbe intrappolata nel circuito sempre la stessa quantità di fluido, con pericolo di surriscaldamento. D'altra parte non risulta conveniente installare uno scambiatore di calore direttamente su una delle condotte principali poiché, data l'elevata pressione del fluido, risulterebbe molto costoso e di difficile tenuta. Oltre a ciò la pompa ausiliaria si occupa di alimentare il circuito di controllo relativo alla pompa principale. Difatti la pompa ausiliaria genera una pressione sufficiente per utilizzare il cilindro a doppio effetto a doppio stelo responsabile della variazione della cilindrata della pompa per mezzo di una piastra inclinata.



Sezione pompa A4VG serie 32

1 Albero di trasmissione
2 Piastra di richiamo
3 Pistone di posizionamento
4 Centralina
5 Piastra di comando
6 Lato bassa pressione
7 Pompa ausiliaria
8 Lato alta pressione
9 Cilindri
10 Pistoni
11 Pattino
12 Culla

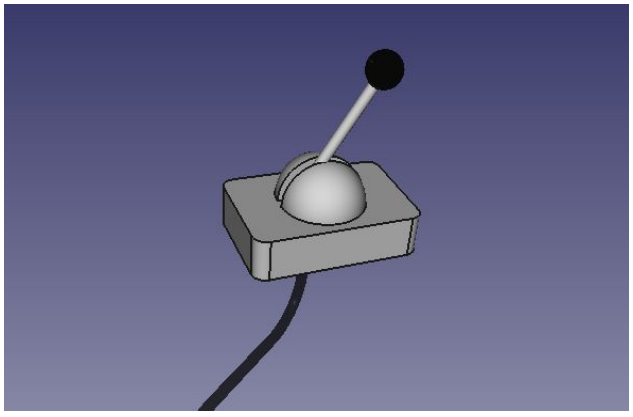
Per ottimizzare la compattezza del sistema è stata scelta la pompa fornita da Rexroth incorporata nella pompa scelta A4VG serie 32 modello 90.
Si tratta di una pompa ad ingranaggi, collegata all'albero di trasmissione dopo la pompa a pistoni assiali, la scelta della pompa ad ingranaggi inclusa nella pompa principale risulta ottimale per ottenere il minor ingombro possibile, vista la modesta portata e pressione richiesta. La pompa ausiliaria scelta è inoltre in grado di alimentare ulteriori possibili utenze.

In seguito sono riportate le specifiche della pompa ausiliaria ad ingranaggi fornita da Rexroth

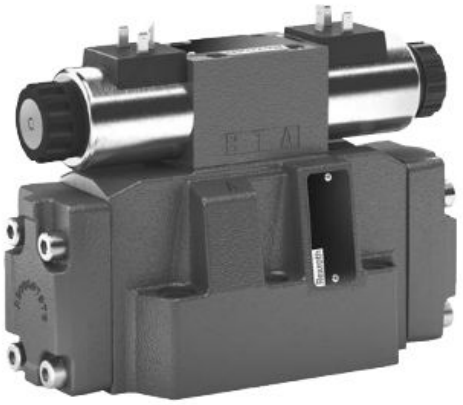
Boost pump	
Nominal pressure $p_{Sp\ nom}$	25 bar
Maximum pressure $p_{Sp\ max}$	40 bar
Pressure at suction port **S** (inlet)	
Continuous $p_{S\ min}$ ($v \leq 30$ mm²/s)	≥ 0.8 bar absolute
Momentary, during cold start ($t < 3$ min)	≥ 0.5 bar absolute
Maximum pressure $p_{S\ max}$	≤ 5 bar absolute

Size		**NG**		**28**	**40**	**56**	**71**	**90**	**125**
Displacement, geometric, per revolution									
	variable pump	$V_{g\ max}$	cm³	28	40	56	71	90	125
	boost pump (at p = 20 bar)	$V_{g\ Sp}$	cm³	6.1	8.6	11.6	19.6	19.6	28.3

8. SISTEMA DI CONTROLLO DELLA DIREZIONE DI AVANZAMENTO

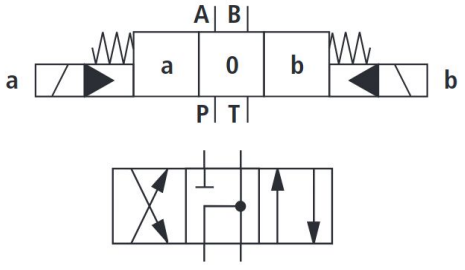


-Cambio-



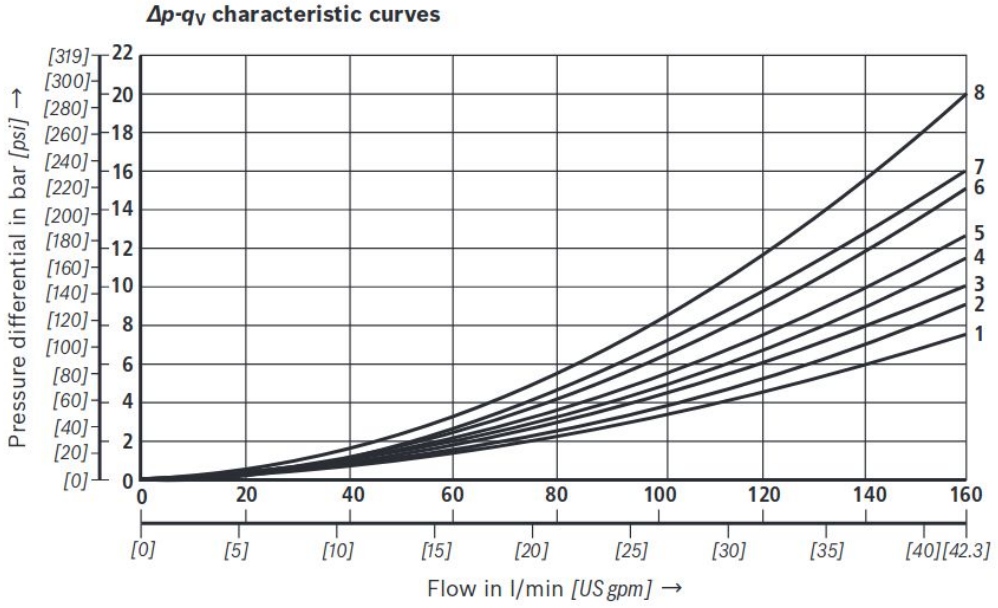
-Directional spool valve, pilot operated-

La pompa scelta è reversibile, cioè permette di invertire il senso di pompaggio dell'olio senza invertire il senso di rotazione. Ad essere invertita è la posizione di componenti costruttivi, in particolare il piatto inclinato, il quale passa attraverso la posizione di cilindrata nulla e si sposta in senso opposto. Durante questa operazione i rami di mandata ed aspirazione si scambiano di compito.
L'inclinazione del piatto è comandata da un cilindro a doppio effetto a doppio stelo con ritorno in posizione di riposo mediante molle, il quale è comandato da una valvola distributrice a cassetti 4/3, comandata elettro-idraulicamente ed azionata da solenoidi.
È stato scelto di far controllare la direzione di marcia del veicolo direttamente dal guidatore attraverso un cambio manuale. La leva del cambio ha tre posizioni possibili che permettono la marcia in avanti, la retromarcia e lo stato di "folle". La leva invia un segnale di tipo elettrico alla valvola distributrice che si muove come richiesto.

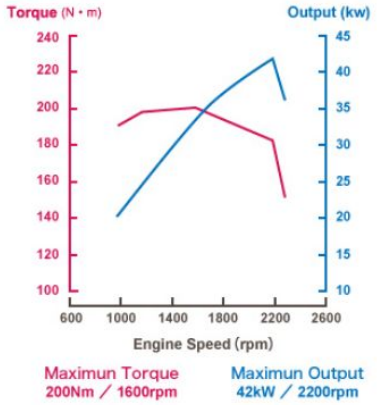
Directional spool valve, pilot operated, with electro-hydraulic actuation	
Produttore	Bosch Rexroth
Modello	WEH
Simbolo	
Codice prodotto: / | 3 | WEH | 10 | / | P | 4X | / | G24 | / | ET | / | / | / | / | 10 | / | / | / | / | / |	
Flow control valve	

Produttore	Bosch Rexroth
Modello	ST-C-06
Simbolo	
Codice prodotto: OD.21.01 | 03 | 56 |	

Curva caratteristica della valvola a cassetti:



9. SISTEMA AUTOMATICO DI REGOLAZIONE DELLA CILINDRATA



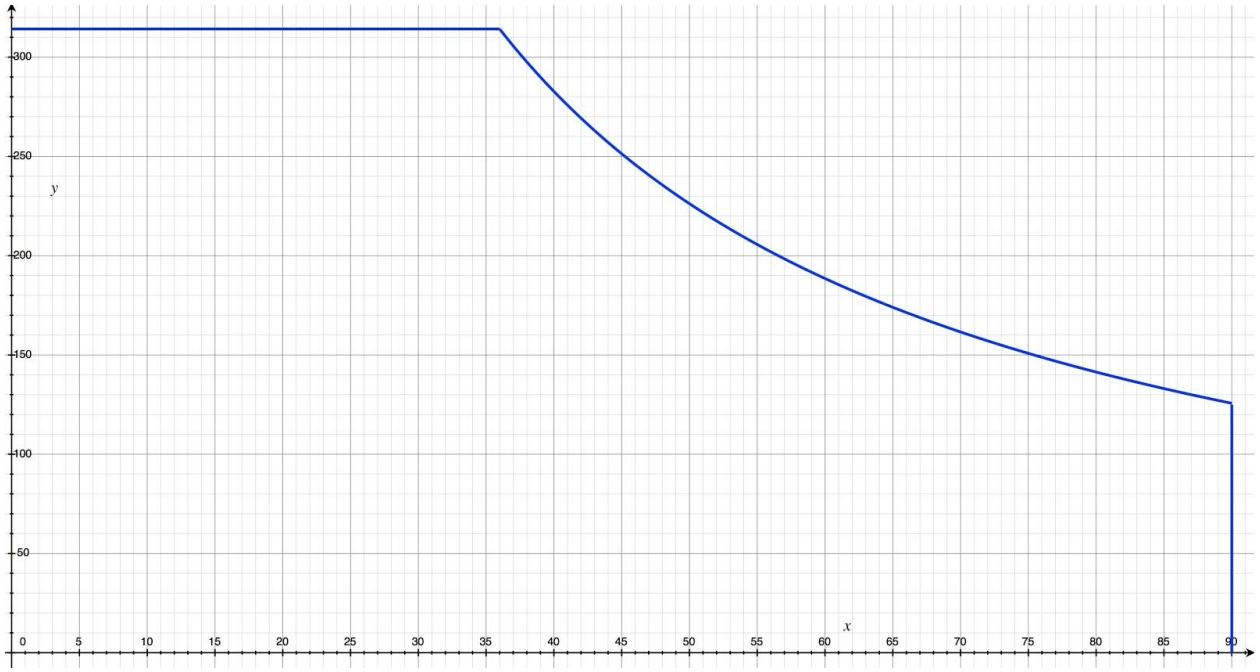
Dal grafico del motore Toyota 3Z, montato sul nostro veicolo, si nota che esso fornisce la potenza massima $P = 42\ kW$ quando si trova a regime di rotazione $\omega = 2200\ rpm$. A questa velocità è in grado di fornire una coppia di $M = 180\ Nm$.

Il nostro sistema di controllo permette al motore Diesel di lavorare continuamente a regime ottimale.
Infatti, questo è stato possibile sfruttando le potenzialità dell'oleodinamica, che si occupa delle fasi di accelerazione e decelerazione.
Il guidatore è responsabile dell'accelerazione e della decelerazione del mezzo. Esso è affiancato da un regolatore di potenza automatico che si occupa di mantenere il sistema nella condizione ottimale quando aumenta la pressione nel circuito. Si verifica un aumento della pressione nelle fasi di accelerazione e avanzamento in salita.
Il regolatore corregge la cilindrata della pompa, impostata dal guidatore, affinché sia rispettata l'equazione:

$$p \cdot V_g = costante = (M \cdot 20 \cdot \pi) \sim 11300\ Nm$$

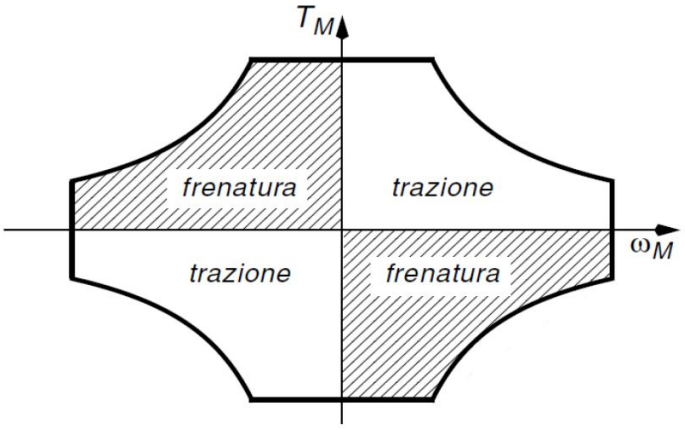
Il regolatore entra in funzione nell'intervallo in cui cui la pompa sfrutta tutta la potenza del Diesel:

- $p_{min} \sim 125\ bar$
- $p_{max} \sim 325\ bar$



Asse delle ascisse: Cilindrata [cm^3], Asse delle ordinate: Pressione [bar]

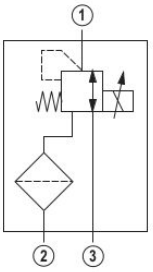
Complessivamente, la regolazione avviene su quattro quadranti come si può vedere dal diagramma Coppia - Velocità di rotazione:



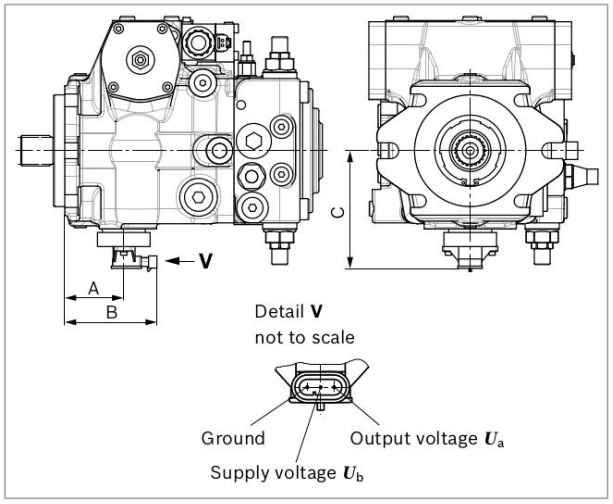
-Formedil Trasmissioni idrostatiche-

Il produttore Bosch Rexroth fornisce già un proprio sistema di regolazione della potenza interno alla pompa. Per mancanza di documentazione fornita dal produttore, insieme alla pompa, abbiamo deciso di assemblare un nostro sistema di controllo affidandoci comunque alla gamma di prodotti Bosch Rexroth.
Il sistema di regolazione scelto è proporzionale per avere la massima rapidità e precisione possibile. Esso è composto da una valvola riduttrice di flusso proporzionale, l'elettronica corrispondente, due sensori di misurazione della pressione ed un sensore di rilevamento della cilindrata incluso nella pompa scelta.
Le misure dei sensori vengono trasformate in segnali di tensione di corrente che vengono elaborati dalla componentistica elettronica che si occupa di regolare la valvola riduttrice di pressione. L'elettronica le invia un segnale di corrente e garantisce che l'equazione sopra descritta sia sempre rispettata.
La valvola riduttrice di pressione regola la pressione di pilotaggio che arriva al cilindro di controllo della cilindrata. Il valore minimo di pressione di pilotaggio stabilito dalla Bosch Rexroth è di circa 20 bar:

Boost pump		
Nominal pressure $p_{Sp\ nom}$	25 bar	
Maximum pressure $p_{Sp\ max}$	40 bar	
Pressure at suction port **S** (inlet)		
Continuous $p_{S\ min}$ ($\nu \leq 30$ mm²/s)	≥ 0.8 bar absolute	
Momentary, during cold start (t < 3 min)	≥ 0.5 bar absolute	
Maximum pressure $p_{S\ max}$	≤ 5 bar absolute	
Control pressure		
Minimum control pressure $p_{St\ min}$		To ensure the function of the control, a minimum control pressure $p_{St\ min}$ at n = 2000 rpm is necessary depending on the rotational speed and working pressure
Controls EP, HD, HW	20 bar above case pressure	
Controls DA, DG, EZ, ET	25 bar above case pressure	

PROPORTIONAL PRESSURE REDUCING VALVE	
Produttore	Bosch Rexroth
Modello	MHDRE 06 SK
Simbolo	
Codice prodotto: MHDRE | 06 | S | K | 3X | / | 30 | A | G24 | K4 | V | / |	
Produttore *Pressure Sensor*	Bosch Rexroth
Modello	PR3
Codice prodotto: BODAS – PR3 | 400 | G | S | 05 | 10 |	

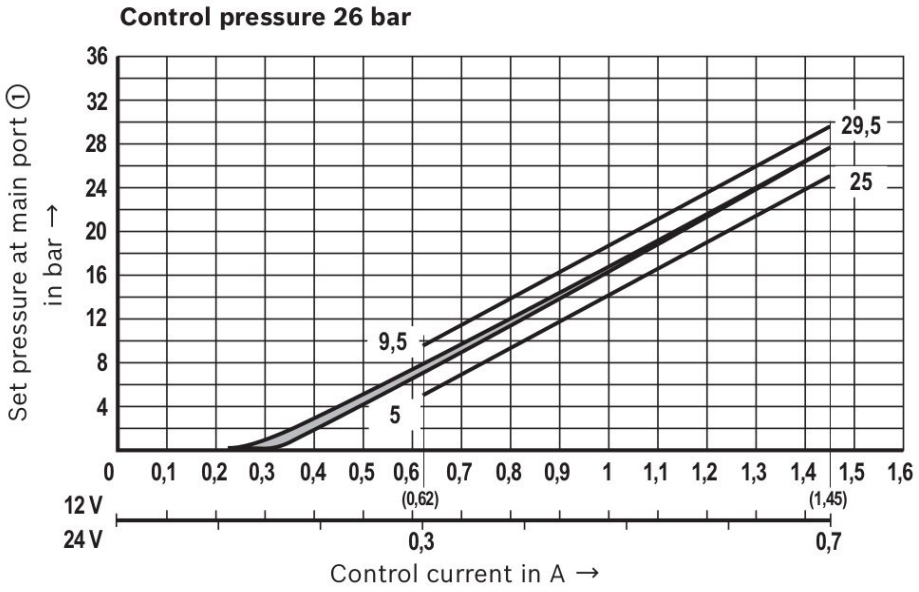
Sensore di misurazione della cilindrata:



Characteristics	
Supply voltage U_b	10 to 30 V DC
Output voltage U_a	0.5 V ($V_{g\,max}$) 2.5 V ($V_{g\,0}$) 4.5 V ($V_{g\,max}$)
Reverse polarity protection	Short-circuit resistant
EMC resistance	Details on request
Operating temperature range	-40 °C to +115 °C
Vibration resistance, sinusoidal vibration EN 60068-2-6	10 g / 5 to 2000 Hz
Shock resistance: continuous shock IEC 68-2-29	25 g
Salt spray resistance (DIN 50 021-SS)	96 h
Type of protection with installed mating connector	IP67 – DIN/EN 60529 IP69K – DIN 40050-9
Housing material	Plastic
Connector version	AMP Super Seal 1.5

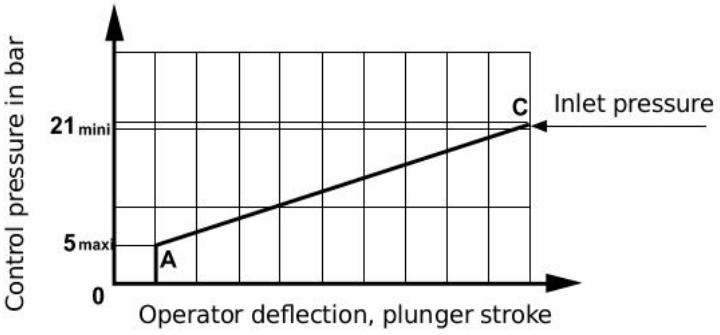
Sensore di misurazione della pressione:

Valvola riduttrice di pressione proporzionale:

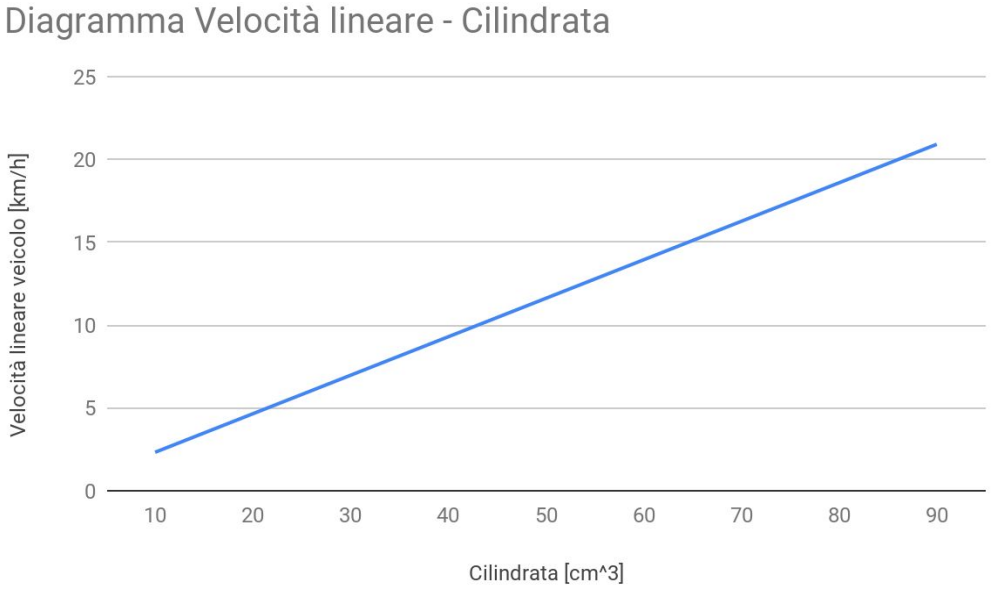

Control pressure 26 bar
Set pressure at main port ① in bar →
36
32
28
24
20
16
12
8
4
29,5
25
9,5
5
0
0,1
0,2
0,3
0,4
0,5
0,6
0,7
0,8
0,9
1
1,1
1,2
1,3
1,4
1,5
1,6
(0,62)
(1,45)
12 V
24 V
0,3
0,7
Control current in A →

10. SISTEMA DI REGOLAZIONE DELLA CILINDRATA PILOTATO DAL GUIDATORE:

Il sistema di accelerazione controllato dal guidatore agisce sulla cilindrata della pompa. La cilindrata è controllata dalla pressione nel cilindro di regolazione, ed è denominata "pressione di pilotaggio". La pressione di pilotaggio è controllata dal guidatore attraverso un pedale connesso ad una valvola regolatrice di pressione. Maggiore è la flessione del pedale, maggiore è la pressione di pilotaggio. Viceversa, se il pedale viene rilasciato, la pressione di pilotaggio scende ad un valore minimo per cui la cilindrata della pompa è nulla.
In questa condizione il circuito assorbe potenza ed il veicolo rallenta fino a fermarsi. Dunque, in piano ed in salita l'accelerazione e la decelerazione possono essere controllate da un unico pedale.

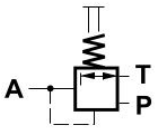


Il nostro veicolo è comunque dotato anche di un freno di servizio comandato da un apposito pedale. Il freno di servizio non è stato dimensionato.



Retta: $v = (V \cdot \omega_{diesel} \cdot 2 \cdot \pi \cdot d \cdot 3.6) \div (V_{motore} \cdot 60 \cdot 2)$

Il produttore Bosch Rexroth della pompa ha inserite nei rami di controllo del cilindro due valvole di regolazione della portata per evitare durante il controllo brusche accelerazioni o decelerazioni.

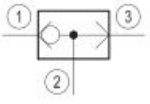
Foot Pedal with Pressure Reducing Valve	
Produttore	Bosch Rexroth
Modello	TH7
Simbolo	
Codice prodotto: 1TH7QL | 05 | / | M | 01 | / |	

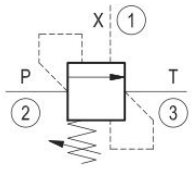
11. SISTEMA DI TAGLIO(CUT-OFF) DELLA PRESSIONE

-Bosch Rexroth Shuttle Valve-

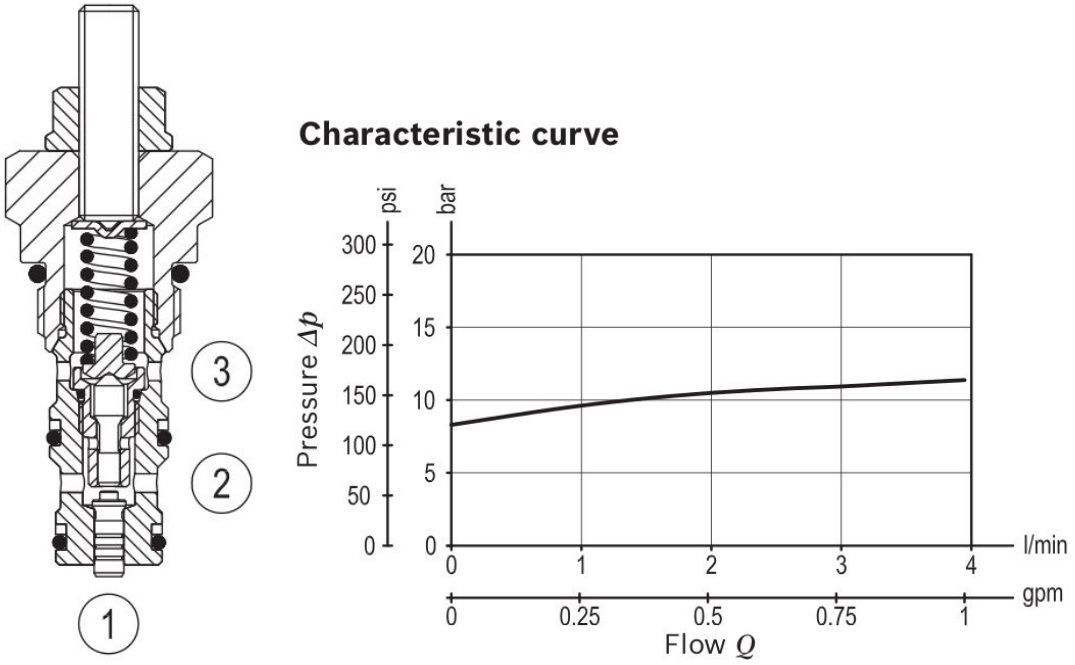
-Bosch Rexroth Pressure relief valve pilot operated-

Analogamente al sistema di regolazione della potenza, il sistema di taglio presente è incluso dal produttore Bosch Rexroth all'interno della pompa A4VG. In mancanza di documentazione fornita insieme alla pompa, sono state scelte le valvole singolarmente. Il funzionamento complessivo risulta lo stesso.
Il sistema di cut-off della pressione è un sistema di controllo della pressione che, dopo aver raggiunto il valore di pressione settato, riduce la cilindrata della pompa fino al valore minimo.
Questa valvola previene l'utilizzo delle valvole di alta pressione del circuito principale quando si verificano picchi di pressione nelle fasi di accelerazione e decelerazione.
Infatti, il sistema di cut-off è settato, come stabilito dalla Bosch Rexroth, ad un valore di 30 bar inferiore alle valvole di alta pressione.

Shuttle valve	
Produttore	Bosch Rexroth
Modello	SELB-08A
Simbolo	
Codice prodotto: 04.94.05.00 | 56 | 00 | 00 | / |	

Pressure Relief Valve Pilot Operated	
Produttore	Bosch Rexroth
Modello	VMSN-08A
Simbolo	
Codice prodotto: 04.75.21. | 08 | 56 | 35 | 00 |	
Settaggio: p = 310 bar	

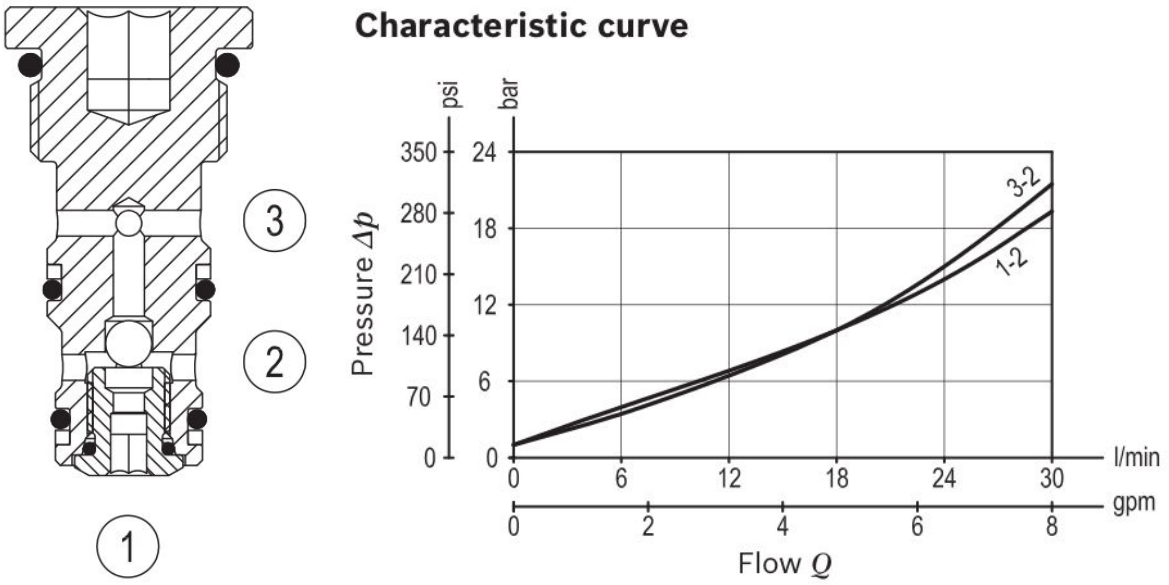
Descrizione del funzionamento della valvola limitatrice di pressione, dalla scheda tecnica:



(1): Pressione di pilotaggio, (2): Pompa, (3): Serbatoio

La valvola è generalmente chiusa, cioè è impedito il flusso dell'olio da (2) a (3), finché la pressione non supera il valore impostato, andando a comprimere la molla di controllo. Questa azione permette il passaggio del fluido da (2) a (3) con una minima caduta di pressione. Allo stesso modo, quando la pressione di pilotaggio in (1) supera il valore di pressione settato, la molla viene compressa, e viene scaricato l'olio in serbatoio.

Descrizione del funzionamento della valvola differenziale, dalla scheda tecnica:



(1): Alta/Bassa pressione, (2): Pressione di pilotaggio per la valvola limitatrice di pressione (3): Alta/Bassa pressione

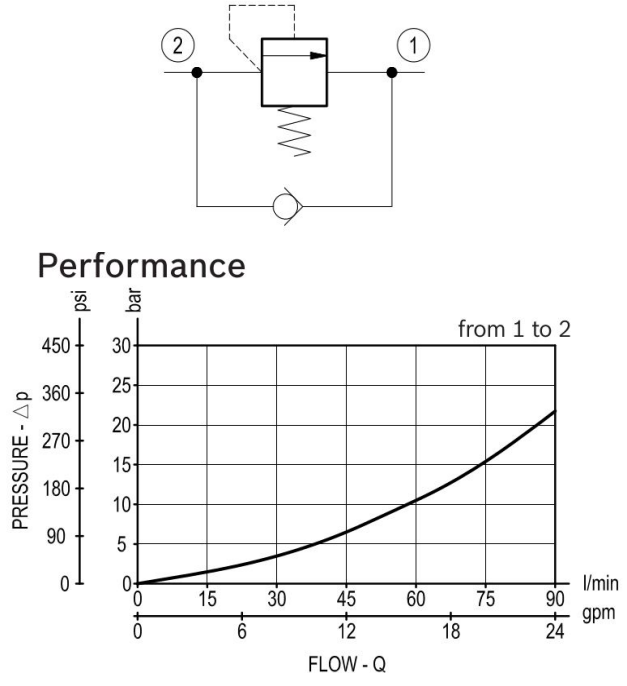
La valvola differenziale a sfera singola permette il passaggio del fluido dalla porta ad alta pressione (1) o (3) alla porta (2) che fornisce il fluido necessario al controllo della valvola limitatrice di pressione.

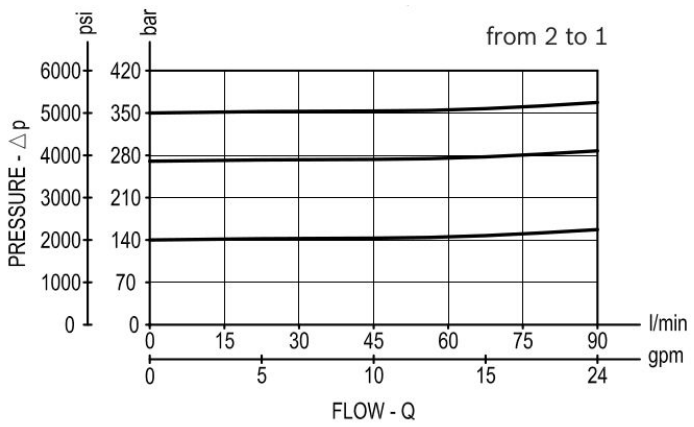
12. SICUREZZA NEL CIRCUITO PRINCIPALE

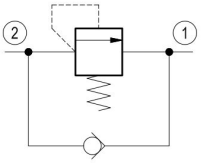
-Bosch Rexroth Pressure relief valve, direct acting and anti-cavitation function-

Tutto il sistema di sicurezza è già fornito dal produttore della pompa Bosch Rexroth. In mancanza di documentazione nella pompa abbiamo deciso di scegliere singolarmente le valvole adatte. Il funzionamento non è stato modificato.

Nel circuito chiuso sono presenti due valvole di alta pressione incrociate che proteggono la pompa, il motore e le valvole da picchi di pressione. Esse limitano la pressione massima nella relativa linea ad alta pressione scaricando l'olio nel ramo a bassa pressione. Le valvole di limitazione della pressione non sono valvole di lavoro e sono adatte solo per picchi di pressione. Il settaggio delle valvole è di 340 bar. Le valvole possiedono un ramo in parallelo che permette il transito all'olio nel senso opposto. Questa caratteristica è indispensabile poiché permette alla pompa ausiliaria di far affluire l'olio nel ramo che di volta in volta si trova a bassa pressione.





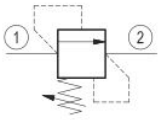
Pressure relief valve, direct acting and anti-cavitation function	
Produttore	Bosch Rexroth
Modello	VMA1.080
Simbolo	
Codice prodotto: 0T.M4.08 | 00 | 99 | 35 | 06 | * |	

13. SICUREZZA NEL CIRCUITO AUSILIARIO

-Bosch Rexroth Relief valve-

Il sistema di sicurezza nel circuito ausiliario è costituito da una valvola limitatrice di pressione che scarica nel serbatoio quando raggiunge la pressione massima impostata. La pompa ausiliaria lavora ad un massimo di 40 bar, come stabilito dalla Bosch Rexroth, e la pressione di pilotaggio della cilindrata deve avere una pressione di almeno 20 bar circa. Allora, la valvola limitatrice di pressione è stata settata a 35 bar.

Boost pump		
Nominal pressure $p_{Sp\ nom}$	25 bar	
Maximum pressure $p_{Sp\ max}$	40 bar	
Pressure at suction port **S** (inlet)		
Continuous $p_{S\ min}$ ($\nu \leq 30$ mm²/s)	≥ 0.8 bar absolute	
Momentary, during cold start (t < 3 min)	≥ 0.5 bar absolute	
Maximum pressure $p_{S\ max}$	≤ 5 bar absolute	
Control pressure		
Minimum control pressure $p_{St\ min}$		To ensure the function of the control, a minimum control pressure $p_{St\ min}$ at n = 2000 rpm is necessary depending on the rotational speed and working pressure
Controls EP, HD, HW	20 bar above case pressure	
Controls DA, DG, EZ, ET	25 bar above case pressure	

Pressure relief valve	
Produttore	Bosch Rexroth
Modello	VSBN-10A
Simbolo	
Codice prodotto: 04.11.55 | 03 | 85 | 05 | 00 | / |	

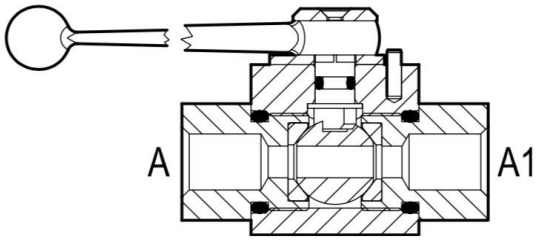
14. MISURAZIONE PRESSIONE

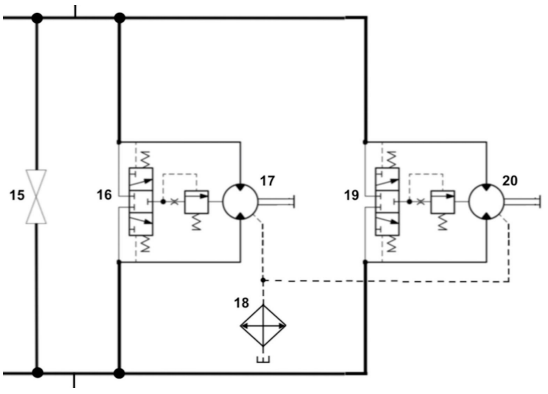
La misura della pressione nel sistema chiuso è eseguita dai sensori.
Per un'ulteriore sicurezza, come consigliato dalla Bosch Rexroth abbiamo inserito nella porta M_H un manometro che monitora la pressione nel sistema di cut-off.

-Manometri WIKA-

Manometri	
Produttore	WIKA
Modello	111.10
Dimensioni	63
Simbolo	

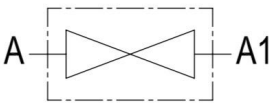
15. VALVOLA DI CORTOCIRCUITO





Nel progetto della trasmissione idrostatica si è pensato di inserire in parallelo ai due motori una valvola di by-pass. L'obiettivo è di poter cortocircuitare i due motori in caso di necessità per rendere facili alcune operazioni, come il traino del mezzo. Difatti aprendo la suddetta valvola si svincolano i motori dal circuito principale e quindi, per trainare il mezzo, è solamente necessario muovere il gruppo ruota-motore e l'olio del "relativo" circuito senza dover mettere moto l'olio dell'intero circuito e il gruppo pompa-motore principale.

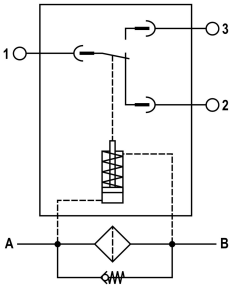
Per questo scopo è stata scelta una valvola di by-pass a sfera, comandata manualmente tramite leva. Ruotando di 90° la leva la valvola passa da totalmente chiusa a completamente aperta. Per reggere la pressione massima di esercizio e poter garantire una buona velocità di traino, quindi una sufficiente portata d'olio, è stato scelto il modello AD 13-E.

VALVOLA A SFERA	
Produttore	Bosch Rexroth
Modello	AD
Simbolo	
Codice prodotto: AD | 13-E	

16. FILTRO

Per proteggere i componenti della trasmissione idrostatica da eventuali impurezze accumulate nell'olio durante il servizio è necessario un filtro. Dato che il filtro viene inserito nel ramo di aspirazione della pompa ausiliaria, è soggetto a basse pressioni ed è quindi nel range ottimale di lavoro, rendendo non necessaria un'eventuale valvola di by-pass per proteggere il filtro da alte pressioni.

Le componenti del circuito chiuso (quali pompa e motore) richiedono un rapporto di filtraggio conforme a ISO 16889 di $\beta_{20} \geq 100$, alcuni componenti del circuito ausiliario richiedono un rapporto di filtraggio di $\beta_{10} \geq 100$ (es. regolatore di flusso), si è quindi scelto di garantire il filtraggio più fine.
Per rendere più comodo il ricambio del filtro è stato scelto un filtro esterno, rispetto ad uno inserito nel serbatoio, per poter essere collocato in un posto facilmente accessibile.
Il filtro scelto è dotato di sensore elettrico di intasamento, inoltre non è fornito di valvola di by-pass in quanto non necessaria.

Filtro tipo SPIN-ON	
Produttore	Bosch Rexroth
Modello	50 SL
Simbolo	
Codice prodotto: 50 SL | 45 |H10XL | S00 | 0 | 0 | M |1.5 | R0 | M | 0 |	

17. SERBATOIO

In una trasmissione idrostatica il serbatoio non viene collegato al circuito chiuso, ma al circuito ausiliario. Il vantaggio consiste nell'avere un circuito principale più semplice e di poter utilizzare una quantità d'olio notevolmente inferiore rispetto ad un equivalente circuito aperto.

Dato che il campo d'applicazione richiede il minor ingombro possibile, è stato scelto un serbatoio con una capienza di 60 l, con un volume pari a 1.5 volte la portata della pompa ausiliaria (ca. 40 l a 2200 rpm). Nel nostro caso il serbatoio scelto non necessita particolari caratteristiche per la dispersione del calore, in quanto si è scelto di inserire in prossimità del serbatoio uno scambiatore di calore che si occupi interamente del raffreddamento del fluido.

18. PERDITE DI CARICO

L'olio scelto per questa applicazione, VG 32 presenta il range di viscosità ottimale $\nu = 16 \div 40\ mm^2 s^{-1}$ tra le temperature $T_1 = 35\ °C\ e\ T_2 = 60\ °C$ e la densità $\rho = 857\ kg/m^3$

Per un tronco di tubo di diametro costante la perdita è espressa da:

$$\Delta p = \frac{L \lambda \rho v^2}{2 \cdot 10^2 d} \quad [bar]$$

dove

L = lunghezza del tubo	[m]
λ = numero di resistenza	[-]
ρ = densità del liquido	[kg/m^3]
v = velocità media nel tubo	[m/s]
d = diametro del tubo	[mm]

La distinzione tra regime laminare e turbolento si riconosce in base al numero di Reynolds

$$R_e = \frac{10^3 v d}{\nu}$$

dove

v = velocità media nel tubo	[m/s]
d = diametro interno del tubo	[mm]
ν = viscosità cinematica	[mm^2/s]

Dato che la perdita di carico è proporzionale al quadrato della velocità del fluido, è sufficiente valutare la perdita di carico massima, quando la pompa fornisce la portata massima.

I tubi scelti per il circuito principale hanno d = 1" (25.4 mm)
$L_1 = 2m\ e\ Q_1 = 200\ l/min$
$L_2 = 1m\ e\ Q_2 = 100\ l/min$

$$v_{max1} = \frac{Q_{max1}}{A} = 6.57\ m/s$$

$$v_{max2} = \frac{Q_{max2}}{A} = 3.28\ m/s$$

quindi, considerando un valore di viscosità ν = 30 mm^2/s, risulta:

$$R_{e1} = 5563$$
$$R_{e2} = 2777$$

Nel regime di massima portata si ha moto turbolento

Per il moto turbolento si ha un numero di resistenza indicativo dato dalla formula

$$\lambda = 0.316 \cdot R_e^{-0.25}$$

$$\lambda_1 = 0.0366$$
$$\lambda_2 = 0.0435$$

$$\Delta p_1 = 0.53\ bar$$
$$\Delta p_2 = 0.1\ bar$$

Si hanno 2 tubi L_1 (mandata e ritorno) e 2 tubi in parallelo L_2 (mandata e ritorno motori), quindi la perdita distribuita totala a regime di portata massima risulta essere:

$$\Delta p_d = 2\Delta p_1 + \Delta p_2 = 1.16\ bar$$

L'unica rilevante perdita di carico localizzata sul circuito chiuso risultano essere i due raccordi a T presenti all'imbocco e all'uscita dei tubi di mandata e ritorno dei motori.

Le perdite localizzate sono calcolate con la formula

$$\Delta p = \frac{K \rho v^2}{2 \cdot 10^5} \quad [\text{bar}]$$

dove
K = coefficiente di resistenza [-]
ρ = densità olio [kg/m^3]
v = velocità di flusso [m/s]
$K_T = 1.8$

$$\Delta p = 0.33\ bar$$

La perdita di carico localizzata totale risulta essere

$$\Delta p_l = 2\Delta p = 0.66\ bar$$

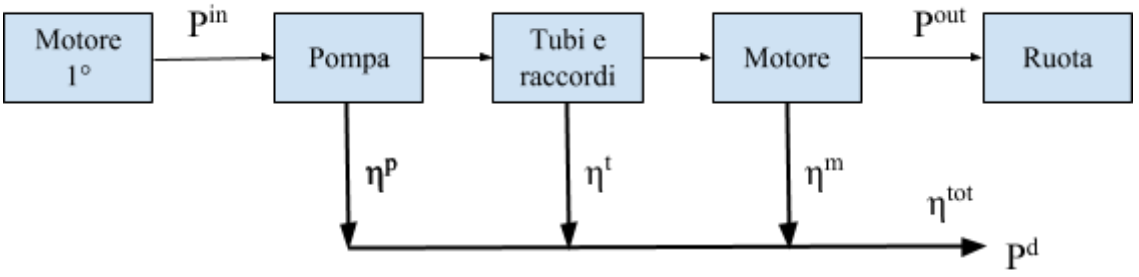
La perdita di carico totale nel circuito chiuso risulta essere

$$\Delta p_t = 1.82\ bar$$

19. POTENZA TERMICA DISSIPATA

In un sistema oleodinamico tutti i componenti sono fonte di perdite di potenza, questa potenza viene principalmente dissipata come calore e rumore. Il seguente calcolo della potenza termica dissipata è relativo alla situazione di portata massima che corrisponde al caso di massima perdita di potenza.

Schema semplificato della potenza dissipata



Per definizione il rendimento totale è espresso da

$\eta^{tot} = P^{out}/P^{in}$

Tale rendimento corrisponde al prodotto dei rendimenti dei tre blocchi (Pompa, Tubi, Motore)

$\eta^{tot} = \eta^{p} \cdot \eta^{t} \cdot \eta^{m}$

La potenza perduta dalla trasmissione oleodinamica è espressa da

$P^{d} = P^{in}(1 - \eta^{tot})$

La potenza perduta si converte interamente in potenza termica C immessa nel sistema

$P^{d} = C$

Dal motore primo viene fornita una potenza costante di 42 kW

Dai grafici delle rispettive sezioni di pompa e motore si deduce :

$\eta^{p} \simeq 0.90$

$\eta^{m} \simeq 0.9$

A regime di massima portata la pompa sviluppa circa

$p_p = 55$ bar

Considerando le perdite sui tubi

$\Delta p_t = 1.82 \ bar$

$\eta^{t} = \frac{p_p - \Delta p_t}{p_p} = 0.96$ (rendimento peggiore dei tubi)

$\eta^{tot} = 0.78$

La potenza termica dissipata nel caso peggiore risulta essere

$C = P^{in}(1 - 0.78) = 9.24 \ kW$

20. SCAMBIATORE DI CALORE

Per un'applicazione mobile risulta agevole installare uno scambiatore olio-aria alimentato da corrente continua. L'azienda Sesino fornisce la seguente indicazione per dimensionare approssimativamente lo scambiatore: "Le curve di rendimento forniscono la potenzialità di scambio specifica in kcal/h°C o in kW/°C in funzione della portata olio; per calcolare la quantità di calore che i vari scambiatori sono in grado di disperdere, è sufficiente moltiplicare tale potenzialità per la differenza tra le temperature dell'olio desiderata e dell'aria ambiente massima estiva."

Considerata una temperatura massima estiva di 35 °C e la temperatura massima dell'olio per avere una viscosità ottimale di 60 °C, la differenza di temperatura richiesta risulta essere

$\Delta T = 25\ °C$

Considerando la portata della pompa ausiliaria Q = 40 l/min e la potenza termica immessa calcolata precedentemente C = 9.24 kW è risultato sufficiente il modello APL 430

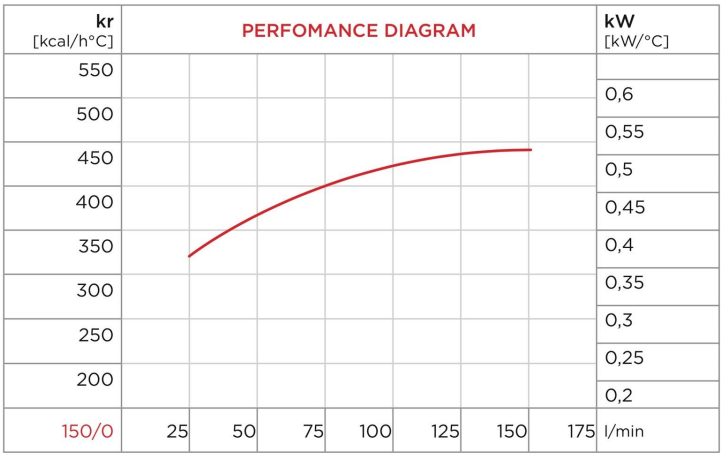


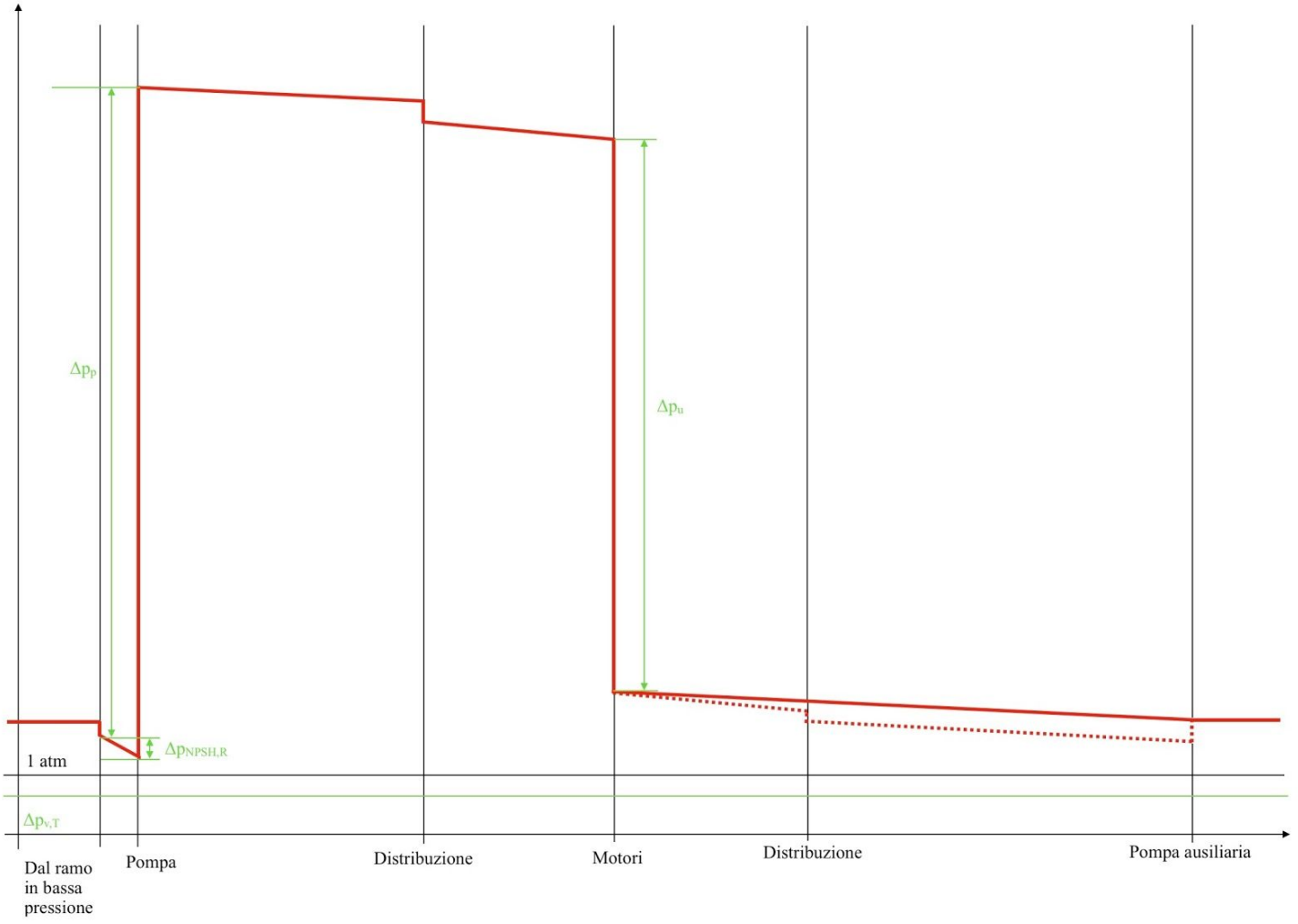
Grafico potenzialità di scambio specifica modello APL 430

Risulta infatti $0.37 \cdot 25 = 9.25 \simeq C$ per una portata di circa 40 l/min

Lo scambiatore di calore è fornito di un termostato e di un relè per il controllo automatico della temperatura, inoltre è fornito di una valvola di by-pass montata in parallelo per evitare eccessive contropressioni soprattutto al momento dell'avviamento della macchina con olio freddo.

21. DIAGRAMMA DELLE PRESSIONI

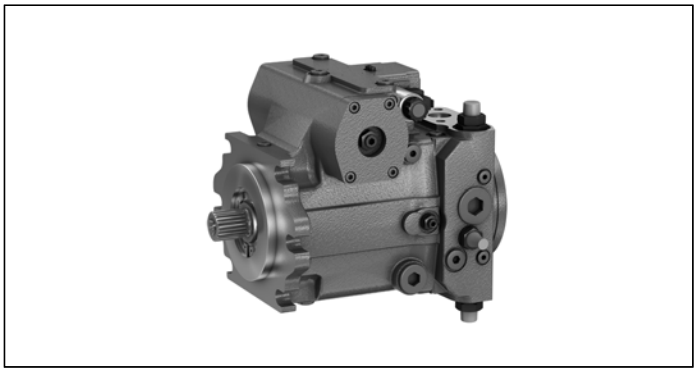
Nel diagramma delle pressioni che segue viene rappresentato l'andamento della pressione all'interno del circuito chiuso. Nel ramo di bassa pressione viene fornita dalla pompa ausiliaria una pressione di circa 10 bar, pressione consigliata da Bosch Rexroth nel ramo di bassa pressione per prevenire potenziali danni all'unità a pistoni assiali dovuti a fenomeni di cavitazione. Nella pompa A4VG è necessario mantenere sempre all'interno del case una pressione di poco superiore ad 1 atm (da catalogo). Di conseguenza il valore minimo di pressione raggiunto all'interno della pompa principale, nel lato di aspirazione, viene sempre garantito maggiore rispetto alla tensione di vapore alla temperatura d'esercizio.



Axial piston variable pump
A4VG Series 32

Europe

RE-E 92003
Edition: 06.2018
Replaces: 04.2016



- High-pressure pump for applications in a closed circuit
- Size 28 to 125
- Nominal pressure 400 bar
- Maximum pressure 450 bar
- Closed circuit

Features

- Integrated auxiliary pump for boost and pilot oil supply
- Flow direction changes smoothly when the swashplate is moved through the neutral position
- High-pressure relief valves with integrated boost function
- With adjustable pressure cut-off as standard
- Boost-pressure relief valve
- Through drive for mounting of further pumps up to same nominal size
- Large variety of controls
- Swashplate design

Contents

Type code

01	02	03	04	05	06	07	08	09		10	11		12	13	14	15	16	17	18	19	20	21	22
A4V	**G**			**D**					**/**	**32**		**–**	**N**										

Axial piston unit

01	Swashplate design, variable, nominal pressure 400 bar, maximum pressure 450 bar	**A4V**

Operating mode

02	Pump, closed circuit	**G**

Size (NG)

03	Geometric displacement, see “Technical data” on page 8	**28**	**40**	**56**	**71**	**90**	**125**	

Control device

			28	**40**	**56**	**71**	**90**	**125**	
04	Without control module		●	●	●	●	●	●	**NV**
	Proportional control, hydraulic	Pilot-pressure related p = 6 to 18 bar	●	●	●	●	●	●	**HD3**
		Mechanical servo	●	●	●	●	●	●	**HW**
	Proportional control, electric	U = 12 V	●	●	●	●	●	●	**EP3**
		U = 24 V	●	●	●	●	●	●	**EP4**
	Two-point control, electric	U = 12 V	●	●	●	●	●	●	**EZ1**
		U = 24 V	●	●	●	●	●	●	**EZ2**
	Automatic control, speed related	U = 12 V	●	●	●	●	●	●	**DA1**
		U = 24 V	●	●	●	●	●	●	**DA2**
	Hydraulic control, direct operated		●	●	●	●	●	●	**DG**
	Electric control, direct operated, two pressure reducing valves	U = 12 V	●	●	●	●	–	–	**ET5**
		U = 24 V	●	●	●	●	–	–	**ET6**

Pressure cut-off

05	Pressure cut-off (standard)	**D**

Neutral position switch

06	Without neutral position switch (without code)	●	
	Neutral position switch (for HW control only)	●	**L**

Mechanical stroke limiter

07	Without mechanical stroke limiter (without code)	●	
	Mechanical stroke limiter, externally adjustable	●	**M**

Stroking chamber pressure port

08	Without stroking chamber pressure port $\mathbf{X_3}$, $\mathbf{X_4}$ (without code)	●	
	Stroking chamber pressure port $\mathbf{X_3}$, $\mathbf{X_4}$	●	**T**

DA control valve

			NV	**HD**	**HW**	**DG**	**DA**	**EP**	**EZ**	
09	Without DA control valve		●	●	●	●	–	●	●	**1**
	DA control valve, fixed setting		–	●	●	●	●	●	–	**2**
	DA control valve, mechanically adjustable with position lever	direction of actuation, clockwise	–	●	●	●	●	●	–	**3R**
		direction of actuation, counter-clockwise	–	●	●	●	●	●	–	**3L**
	DA control valve, fixed setting, ports for pilot control device		–	●	●	–	●	●	–	**7**
	DA control valve, fixed setting and brake inch valve mounted, control with brake fluid	based on mineral oil	–	–	–	–	●	–	–	**8**

● = Available ○ = On request **–** = Not available ▭ = Preferred program

01	02	03	04	05	06	07	08	09		10	11		12	13	14	15	16	17	18	19	20	21	22
A4V	**G**			**D**					**/**	**32**		–	**N**										

Series

10	Series 3, index 2	**32**

Direction of rotation

11	Viewed on drive shaft	clockwise	**R**
		counter-clockwise	**L**

Sealing material

12	NBR (nitrile rubber), shaft seal in FKM (fluoroelastomer)	**N**

Drive shaft

			28	40	56	71	90	125	
13	Splined shaft DIN 5480	for single pump	●	●	●	●	●	●	**Z**
		for combination pump – 1st pump	–[1]	●	●	●	●	●	**A**
	Splined shaft ANSI B92.1a	for single pump	●	●	●	●	●	●	**S**
		for combination pump – 1st pump	–[2]	–[2]	●	●	–[2]	●	**T**
		only for combination pump – 2nd pump	–	●	–	–	●	–	**U**

Mounting flange

			28	40	56	71	90	125	
14	SAE J744	2-hole	●	●	●	–	–	–	**C**
		2+4-hole	–	–	–	●	●	●	**F**

Working port

			28	40	56	71	90	125	
15	SAE working port **A** and **B**, top and bottom	Suction port **S** bottom	–	●	●	●	●	●	**02**
	SAE working port **A** and **B**, top and bottom	Suction port **S** top	–	●	●	○	○	○	**03**
	SAE working port **A** and **B**, same side right[3]	Suction port **S** bottom	●	–	–	–	–	–	**10**
	SAE working port **A** and **B**, same side left[3]	Suction port **S** bottom	–	–	–	●	○	●	
	SAE working port **A** and **B**, same side right[3]	Suction port **S** top	–	–	–	○	○	○	**13**
	SAE working port **A** and **B**, same side left[3]	Suction port **S** top	●	–	●	–	–	–	

Boost pump

16	Without integrated boost pump	without through drive	**N**
		with through drive	**K**
	Integrated boost pump	with and without through drive	**F**

Through drive

			28	40	56	71	90	125	
17	Without through drive, versions N and F (no. 16) only		●	●	●	●	●	●	**00**
	Flange SAE J744[4]	Hub for splined shaft							
	82-2 (A)	5/8 in 9T 16/32DP[5]	●	●	●	●	●	●	**01**
	101-2 (B)	7/8 in 13T 16/32DP[5]	●	●	●	●	●	●	**02**
		1 in 15T 16/32DP[5]	●	●	●	●	●	●	**04**
	127-2 (C)[6]	1 in 15T 16/32DP[5]	–	●	–	–	–	–	**09**
		1 1/4 in 14T 12/24DP[5]	–	–	●	●	●	●	**07**
	152-2/4 (D)	W35 2×16×9 g[7]	–	–	–	–	●	–	**73**
		1 3/4 in 13T 8/16DP[5]	–	–	–	–	–	●	**69**

● = Available ○ = On request – = Not available = Preferred program

1) Standard for combination pump – 1st pump: Shaft Z
2) Standard for combination pump – 1st pump: Shaft S
3) Only possible without attachment filter
4) 2 = 2-hole; 4 = 4-hole
5) Hub for splined shaft to ANSI B92.1a
6) NG90 to 125 with additional 4-hole-flange (127-4)
7) Hub for splined shaft according to DIN 5480.

01	02	03	04	05	06	07	08	09		10	11		12	13	14	15	16	17	18	19	20	21	22
A4V	**G**			**D**					**/**	**32**		–	**N**										

High-pressure relief valve

		Setting range Δp		28	40	56	71	90	125	
18	High pressure relief valve, pilot operated	100 to 420 bar	with bypass	–	–	–	●	●	●	**1**
	High-pressure relief valve, direct operated, fixed setting	250 to 420 bar	without bypass	●	●	●	–	–	–	**3**
			with bypass	●	●	●	–	–	–	**5**
		100 to 250 bar	without bypass	●	●	●	–	–	–	**4**
			with bypass	●	●	●	–	–	–	**6**

Filtration boost circuit/external boost pressure supply

		28	40	56	71	90	125	
19	Filtration in the boost pump suction line	●	●	●	●	●	●	**S**
	Filtration in the boost pump pressure line Ports for external boost circuit filtration (**F_e** and **F_a**)	●	●	●	●	●	●	**D**
	Attachment filter with cold start valve	–	●	●	●	●	●	**F**
	Attachment filter with cold start valve and visual contamination indicator	–	●	●	●	●	●	**P**
	Attachment filter with cold start valve and electric contamination indicator	–	●	●	●	●	●	**B**
	External boost pressure supply (version without integrated boost pump - N00, K...)	●	●	●	●	●	●	**E**

Swivel angle sensor

20	Without swivel angle sensor (without code)	●	
	Electric swivel angle sensor[8)]	●	**R**

Connector for solenoids[9)]

21	Without connector (without code), only for purely hydraulic control		●	
	DEUTSCH molded connector, 2-pin	without suppressor diode	●	**P**
		with suppressor diode (only for EZ and DA)	●	**Q**

Standard / special version

22	Standard version	without code	
		combined with attachment part or attachment pump	**-K**
	Special version		**-S**
		combined with attachment part or attachment pump	**-SK**

● = Available ○ = On request – = Not available = Preferred program

Notice

- ▶ Note the project planning notes on page 70.
- ▶ In addition to the type code, please specify the relevant technical data when placing your order.

8) Please contact us if the swivel angle sensor is used for control
9) Connectors for other electric components may deviate

Hydraulic fluids

The A4VG variable pump is designed for operation with HLP mineral oil according to DIN 51524.
Application instructions and requirements for hydraulic fluids should be taken from the following data sheets before the start of project planning:

- 90220: Hydraulic fluids based on mineral oils and related hydrocarbons
- 90221: Environmentally acceptable hydraulic fluids
- 90222: Fire-resistant, water-free hydraulic fluids (HFDR/HFDU)
- 90225: Axial piston units for operation with water-free and water-containing fire-resistant hydraulic fluids (HFDR, HFDU, HFAE, HFAS, HFB, HFC).

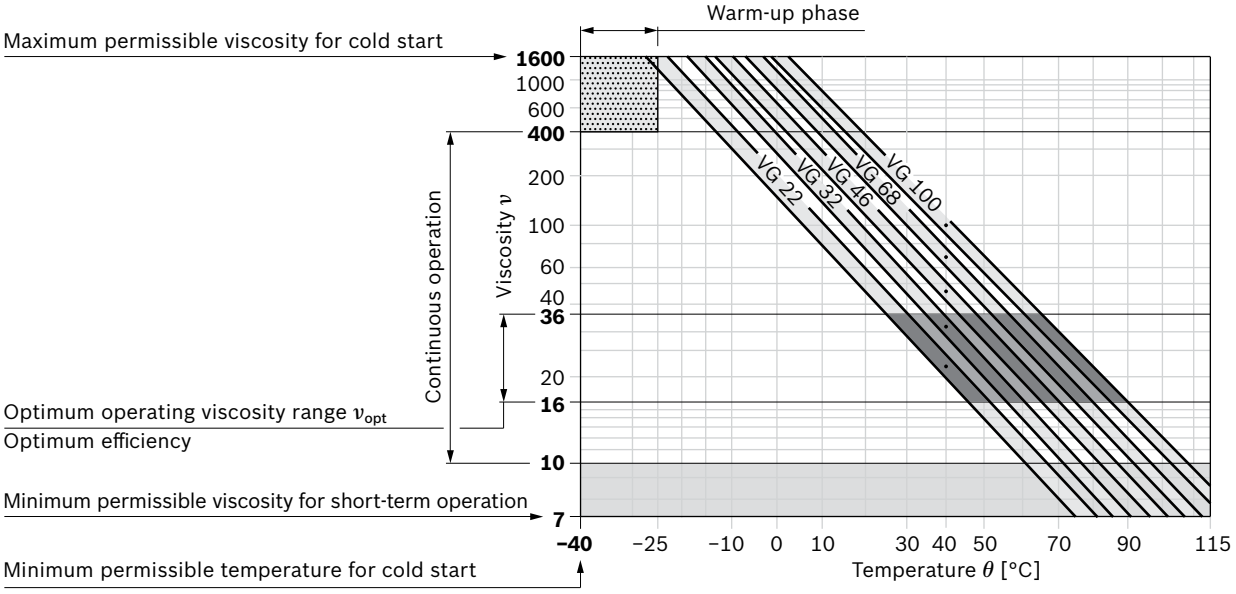
Notes on selection of hydraulic fluid
The hydraulic fluid should be selected such that the operating viscosity in the operating temperature range is within the optimum range (v_{opt} see selection diagram).

Notice
At no point of the component may the temperature be higher than 115 °C. The temperature difference specified in the table is to be taken into account when determining the viscosity in the bearing.
Please contact us if the above conditions cannot be met due to extreme operating parameters.

Viscosity and temperature of hydraulic fluids

	Viscosity	Temperature	Comment
Cold start	v_{max} ≤ 1600 mm²/s	θ_{St} ≥ −40 °C	t ≤ 3 min, n ≤ 1000 min^{-1}, without load p ≤ 50 bar
Permissible temperature difference		ΔT ≤ 25 K	between axial piston unit and hydraulic fluid in the system
Warm-up phase	v = 1600 to 400 mm²/s	θ = −40 °C to −25 °C	at p ≤ 0.7 x p_{nom}, n ≤ 0.5 x n_{nom} and t ≤ 15 min
Continuous operation	v = 400 to 10 mm²/s		this corresponds, for VG 46 for example, to a temperature range of +5 °C to +85 °C (see selection diagram below)
		θ = −25 °C to +110 °C	measured at port **T** Observe the permissible temperature range of the shaft seal (ΔT = approx. 5 K between bearing/shaft seal and port **T**)
	v_{opt} = 36 to 16 mm²/s		Range of optimum operating viscosity and efficiency
Short-term operation	v_{min} ≥ 7 mm²/s		t < 3 min, p < 0.3 × p_{nom}

▼ **Selection diagram**



Filtration of the hydraulic fluid

Finer filtration improves the cleanliness level of the hydraulic fluid, which increases the service life of the axial piston unit. A cleanliness level of at least 20/18/15 is to be maintained according to ISO 4406.

Depending on the system and the application, for the A4VG we recommend: Filter elements $\beta_{20} \geq 100$.

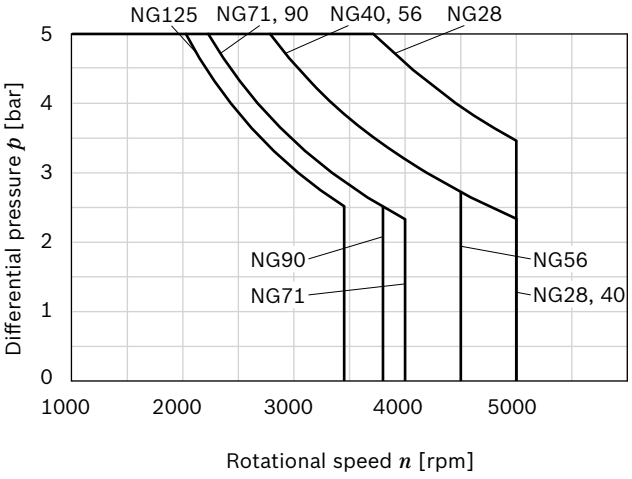
At very high hydraulic fluid temperatures (90 °C to maximum 110 °C, measured at port T), a cleanliness level of at least 19/17/14 according to ISO 4406 is necessary.

Shaft seal

Permissible pressure loading

The service life of the shaft seal is influenced by the speed of the axial piston unit and the leakage pressure in the housing (case pressure). Momentary (t < 0.1 s) pressure peaks of up to 10 bar are allowed. The service life of the shaft seal decreases with increasing frequency of pressure peaks and increasing mean differential pressure.

The case pressure must be higher than the ambient pressure.

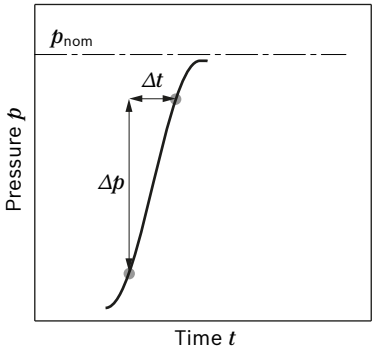


The FKM shaft seal ring may be used for leakage temperatures from −25 °C to +115 °C. For application cases below −25 °C, an NBR shaft seal is required (permissible temperature range: −40 °C to +90 °C).

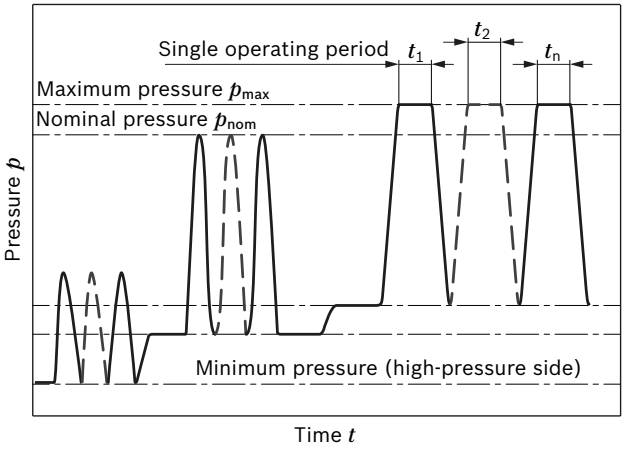
Working pressure range

Pressure at working port A or B		**Definition**
Nominal pressure p_{nom}	400 bar	The nominal pressure corresponds to the maximum design pressure.
Maximum pressure p_{max}	450 bar	The maximum pressure corresponds to the maximum working pressure within the single operating period. The sum of the single operating periods must not exceed the total operating period.
Single operating period	10 s	
Total operating period	300 h	
Minimum pressure (high-pressure side)	25 bar	Minimum pressure at the high-pressure side (**A** or **B**) which is required to prevent damage to the axial piston unit.
Minimum pressure (low-pressure side)	10 bar above case pressure	Minimum pressure at the low-pressure side (**A** or **B**) which is required to prevent damage to the axial piston unit.
Rate of pressure change $R_{A\,max}$	9000 bar/s	Maximum permissible rate of pressure build-up and reduction during a pressure change across the entire pressure range.
Boost pump		
Nominal pressure $p_{Sp\,nom}$	25 bar	
Maximum pressure $p_{Sp\,max}$	40 bar	
Pressure at suction port **S** (inlet)		
Continuous $p_{S\,min}$ ($\nu \leq 30$ mm²/s)	≥ 0.8 bar absolute	
Momentary, during cold start (t < 3 min)	≥ 0.5 bar absolute	
Maximum pressure $p_{S\,max}$	≤ 5 bar absolute	
Control pressure		
Minimum control pressure $p_{St\,min}$		To ensure the function of the control, a minimum control pressure $p_{St\,min}$ at n = 2000 rpm is necessary depending on the rotational speed and working pressure
Controls EP, HD, HW	20 bar above case pressure	
Controls DA, DG, EZ, ET	25 bar above case pressure	

▼ **Rate of pressure change $R_{A\,max}$**



▼ **Pressure definition**



Total operating period = $t_1 + t_2 + \ldots + t_n$

Notice

Working pressure range valid when using hydraulic fluids based on mineral oils. Please contact us for values for other hydraulic fluids.

Technical data

Size			NG		28	40	56	71	90	125
Displacement, geometric, per revolution										
	variable pump		$V_{g\,max}$	cm^3	28	40	56	71	90	125
	boost pump (at p = 20 bar)		$V_{g\,Sp}$	cm^3	6.1	8.6	11.6	19.6	19.6	28.3
Rotational speed[1]	maximum at $V_{g\,max}$		n_{nom}	rpm	4250	4000	3600	3300	3050	2850
	limited, maximum[2]		n_{max1}	rpm	4500	4200	3900	3600	3300	3250
	intermittent, maximum[3]		n_{max2}	rpm	5000	5000	4500	4100	3800	3450
	minimum		n_{min}	rpm	500	500	500	500	500	500
Flow	at n_{nom} and $V_{g\,max}$		q_v	l/min	119	160	202	234	275	356
Power[4]	at n_{nom}, $V_{g\,max}$ and Δp = 400 bar		P	kW	79	107	134	156	183	238
Torque[4]	at $V_{g\,max}$ and	Δp = 400 bar	T	Nm	178	255	357	452	573	796
		Δp = 100 bar	T	Nm	45	64	89	113	143	199
Rotary stiffness of drive shaft		S	c	kNm/rad	31.4	69	80.8	98.8	158.1	218.3
		T	c	kNm/rad	–	–	95	120.9	–	252.1
		A	c	kNm/rad	–	79.6	95.8	142.4	176.8	256.5
		Z	c	kNm/rad	32.8	67.5	78.8	122.8	137	223.7
		U	c	kNm/rad	–	50.8	–	–	107.6	–
Moment of inertia for rotary group			J_{TW}	kgm^2	0.0022	0.0038	0.0066	0.0097	0.0149	0.0232
Maximum angular acceleration[5]			α	rad/s^2	38000	30000	24000	21000	18000	14000
Case volume			V	l	0.9	1.1	1.5	1.3	1.5	2.1
Weight (without through drive) approx.			m	kg	29	31	38	50	60	80

Notice

- Theoretical values, without efficiency and tolerances; values rounded
- Operation above the maximum values or below the minimum values may result in a loss of function, a reduced service life or in the destruction of the axial piston unit. Bosch Rexroth recommend testing the loads by means of experiment or calculation / simulation and comparison with the permissible values.

Determining the operating characteristics

Flow	$q_v = \frac{V_g \times n \times \eta_v}{1000}$		[l/min]
Torque	$T = \frac{V_g \times \Delta p}{20 \times \pi \times \eta_{hm}}$		[Nm]
Power	$P = \frac{2 \pi \times T \times n}{60000}$	$= \frac{q_v \times \Delta p}{600 \times \eta_t}$	[kW]

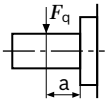
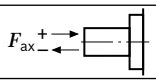
Key

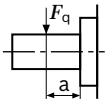
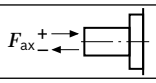
V_g	Displacement per revolution [cm^3]
Δp	Differential pressure [bar]
n	Rotational speed [rpm]
η_v	Volumetric efficiency
η_{hm}	Hydraulic-mechanical efficiency
η_t	Total efficiency ($\eta_t = \eta_v \times \eta_{hm}$)

1) The values are applicable:
   – for the optimum viscosity range from n_{opt} = 36 to 16 mm^2/s
   – for hydraulic fluid based on mineral oils (for HF hydraulic fluids, observe the technical data in 90225)
2) Valid at half corner power (e.g. at $V_{g\,max}$ and $p_N/2$)
3) Valid at Δp = 70 to 150 bar or Δp < 300 bar and t < 0.1 s
4) Without boost pump
5) The data are valid for values between the minimum required and maximum permissible rotational speed.
   Valid for external excitation (e.g. diesel engine 2 to 8 times rotary frequency, cardan shaft twice the rotary frequency).
   The limit value is only valid for a single pump.
   The load capacity of the connecting parts must be considered.

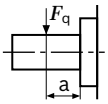
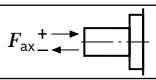
Permissible radial and axial forces on the drive shaft

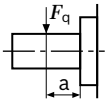
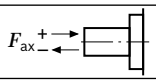
▼ **Splined shaft DIN 5480**

Size		**NG**		**28**	**40**	**40**	**56**	**56**	**71**
Drive shaft				W25	W30	W35	W30	W35	W35
Maximum radial force at distance a (from shaft collar)		$F_{q\,max}$	N	3030	3608	3092	5051	4329	5489
		a	mm	17.5	17.5	20	17.5	20	20
Maximum axial force		$+ F_{ax\,max}$	N	1557	2120	2120	2910	2910	4242
		$- F_{ax\,max}$	N	417	880	880	1490	1490	2758

Size		**NG**		**71**	**90**	**90**	**125**	**125**
Drive shaft				W40	W35	W45	W40	W45
Maximum radial force at distance a (from shaft collar)		$F_{q\,max}$	N	4803	6957	5411	8455	7516
		a	mm	22.5	20	25	22.5	25
Maximum axial force		$+ F_{ax\,max}$	N	4242	4330	4330	6053	6053
		$- F_{ax\,max}$	N	2758	2670	2670	3547	3547

▼ **Splined shaft ANSI B92.1a**

Size		**NG**		**28**	**40**	**40**	**56**	**56**	**71**
Drive shaft			in	1	1	1 1/4	1 1/4	1 3/8	1 1/4
Maximum radial force at distance a (from shaft collar)		$F_{q\,max}$	N	2983	4261	3409	4772	4338	6050
		a	mm	19	19	24	24	24	24
Maximum axial force		$+ F_{ax\,max}$	N	1557	2120	2120	2910	2910	4242
		$- F_{ax\,max}$	N	417	880	880	1490	1490	2758

Size		**NG**		**71**	**90**	**90**	**125**	**125**
Drive shaft			in	1 3/8	1 1/4	1 3/4	1 3/4	2
Maximum radial force at distance a (from shaft collar)		$F_{q\,max}$	N	5500	7670	5478	7609	6658
		a	mm	24	24	33.5	33.5	40
Maximum axial force		$+ F_{ax\,max}$	N	4242	4330	4330	6053	6053
		$- F_{ax\,max}$	N	2758	2670	2670	3547	3547

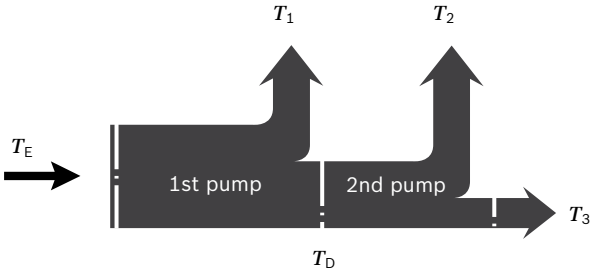
Notice

- The axial and radial forces generally influence the service life of the bearings.
- Special requirements apply in the case of belt drive and cardan shaft. Please contact us.

Permissible input and through-drive torques

Size		NG		28	40	56	71	90	125
Torque at $V_{g\,max}$ and Δp = 400 bar[1]		T	Nm	178	255	357	452	573	796
Maximum input torque at drive shaft[2]									
DIN 5480	Z	$T_{E\,max}$	Nm	352	522	522	912	912	1460
				W25	W30	W30	W35	W35	W40
	A	$T_{E\,max}$	Nm	–	912	912	1460	2190	2190
					W35	W35	W40	W45	W45
ANSI B92.1a (SAE J744)	S	$T_{E\,max}$	Nm	314	602	602	602	1640	1640
			in	1	1 1/4	1 1/4	1 1/4	1 3/4	1 3/4
	T	$T_{E\,max}$	Nm	–	–	970	970	–	2670
			in	–	–	1 3/8	1 3/8	–	2
	U[3]	$T_{E\,max}$	Nm	–	314	–	–	602	–
			in	–	1	–	–	1 1/4	–
Maximum through-drive torque[4]		$T_{D\,max}$	Nm	231	314	521	660	822	1110

▼ **Distribution of torques**



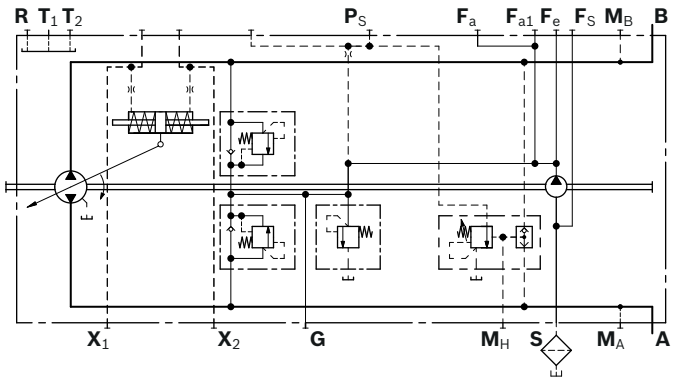
Torque at 1st pump	T_1		
Torque at 2nd pump	T_2		
Torque at 3rd pump	T_3		
Input torque	T_E	=	$T_1 + T_2 + T_3$
	T_E	<	$T_{E\,max}$
Through-drive torque	T_D	=	$T_2 + T_3$
	T_D	<	$T_{D\,max}$

1) Efficiency not considered
2) For drive shafts free of radial force
3) Shaft “U” is only permitted as drive shaft on the 2nd pump on a combination pump of the same size.
4) Note maximum input torque for shaft S!

NV – Version without control module

The mounting surface for the control module is machined and sealed with the standard seal for control modules and a cover plate. This version is ready for retrofitting to control modules (HD, HW, EP, EZ). When used directly for “DA” control and in combinations with “DA” control, the appropriate adjustments must be made to the spring assembly of the adjustment cylinder and control plate.

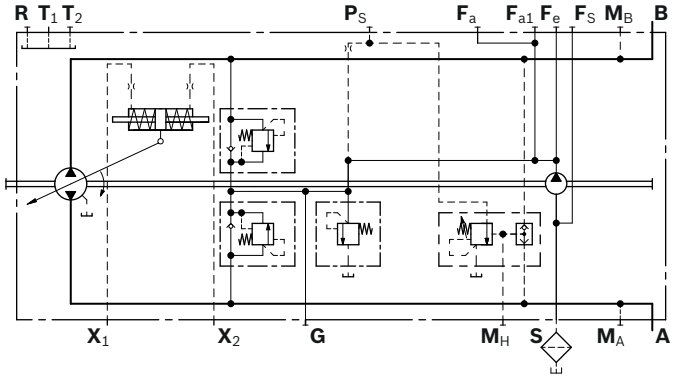
▼ **Standard version**[1)]



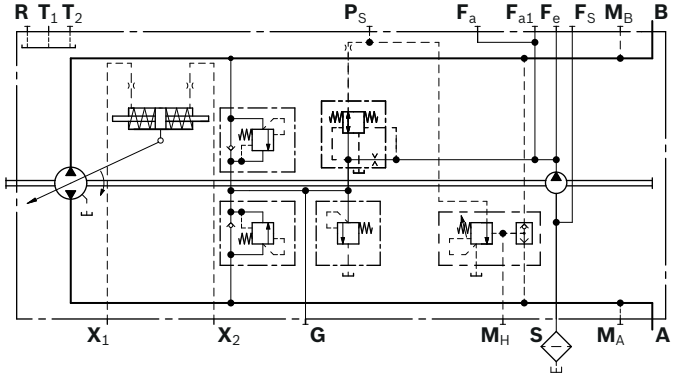
DG – Hydraulic control, direct operated

With the direct operated hydraulic control (DG), the output flow of the pump is controlled by a hydraulic control pressure, applied directly to the stroking piston through either port **X_1** or **X_2**.
Flow direction is determined by which control pressure port is pressurized (refer to table below).
Pump displacement is infinitely variable and proportional to the applied control pressure, but is also influenced by system pressure and pump drive speed.
In order to use the optional built-in pressure cut-off, port **P_S** must be used as the control pressure source for the selected control module.
See page 56 for a functional description of the pressure cut-off.
Maximum permissible control pressure: 40 bar
Use of the DG control requires a review of the engine and vehicle parameters to ensure that the pump is set up correctly. We recommend that all DG applications be reviewed by a Bosch Rexroth application engineer.
If the pump is also equipped with a DA control valve (see page 19), automotive operation is possible for travel drives.

▼ **Standard version**[1)]



▼ **Version with DA control valve**[1)]

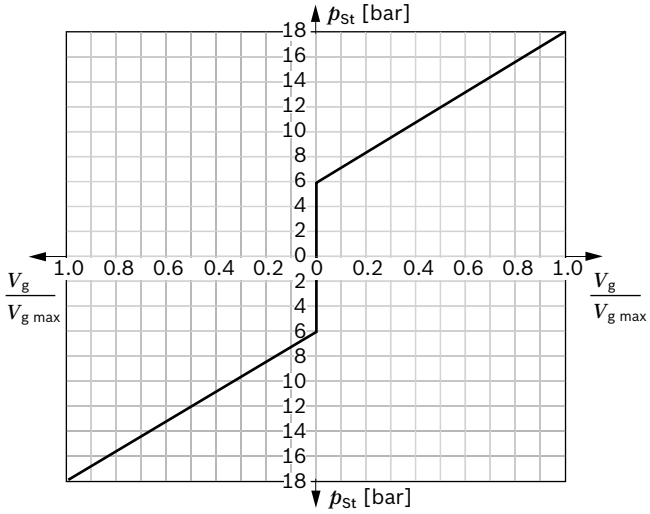


Correlation of direction of rotation, control and flow direction								
Direction of rotation	clockwise				counter-clockwise			
Size	28 to 56		71 to 125		28 to 56		71 to 125	
Control pressure	**X_1**	**X_2**	**X_1**	**X_2**	**X_1**	**X_2**	**X_1**	**X_2**
Flow direction	**A** to **B**	**B** to **A**	**B** to **A**	**A** to **B**	**B** to **A**	**A** to **B**	**A** to **B**	**B** to **A**
Working pressure	**M_B**	**M_A**	**M_A**	**M_B**	**M_A**	**M_B**	**M_B**	**M_A**

1) Size 28 without port **F_{a1}** and **F_S**

HD – Proportional control, hydraulic, pilot-pressure related

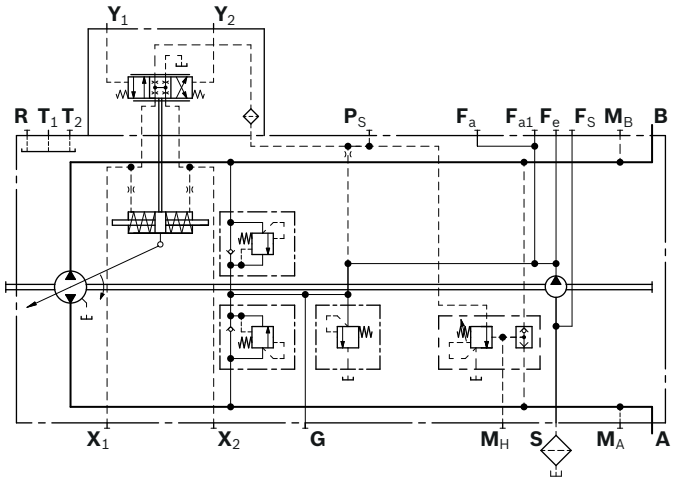
The output flow of the pump is infinitely variable between 0 and 100%, proportional to the difference in pilot pressure applied to the two pilot pressure ports (**Y**$_1$ and **Y**$_2$).
The pilot signal, coming from an external source, is a pressure signal. Flow is negligible, as the pilot signal acts only on the control spool of the control valve.
This control spool then directs control oil into and out of the stroking cylinder to adjust pump displacement as required.
A feedback lever connected to the stroking piston maintains the pump flow for any given pilot signal within the control range.
If the pump is also equipped with a DA control valve (see page 19), automotive operation is possible for travel drives.



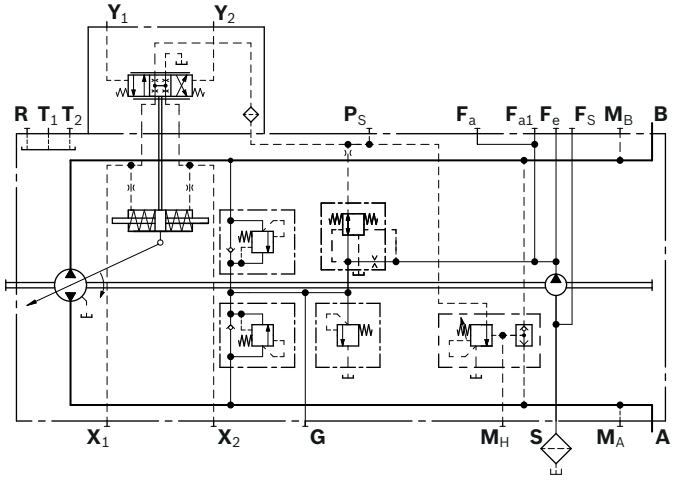
- V_g = Displacement at p_{St}
  $V_{g\,max}$ = Displacement at p_{St} = 18 bar
- Pilot signal p_{St} = 6 to 18 bar (at port **Y**$_1$, **Y**$_2$)
- Start of control at 6 bar
- End of control at 18 bar (maximum displacement $V_{g\,max}$)

Notice
In the neutral position, the HD control module must be vented to reservoir via the external pilot control device.

▼ **Standard version**[1)]

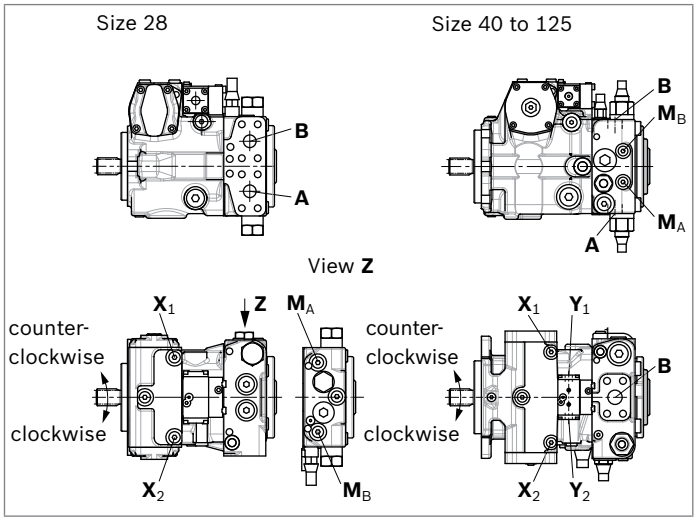


▼ **Version with DA control valve**[1)]



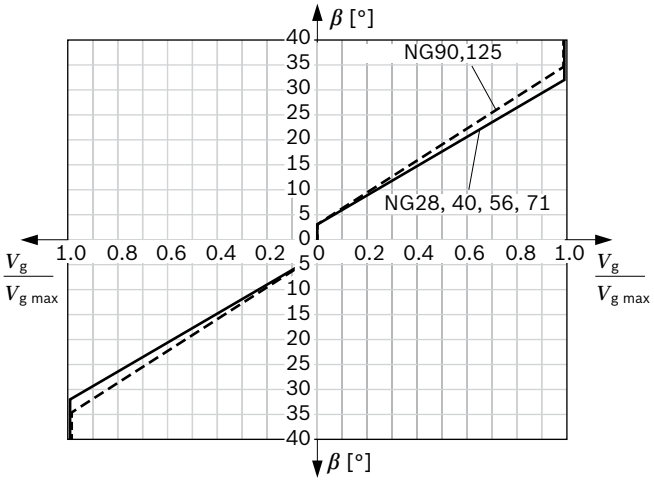
1) Size 28 without port **F**$_{a1}$ and **F**$_S$

Correlation of direction of rotation, control and flow direction								
Direction of rotation	clockwise				counter-clockwise			
Size	28 to 56		71 to 125		28 to 56		71 to 125	
Pilot signal	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2	Y_1	Y_2
Control pressure	X_1	X_2	X_1	X_2	X_1	X_2	X_1	X_2
Flow direction	**A** to **B**	**B** to **A**	**B** to **A**	**A** to **B**	**B** to **A**	**A** to **B**	**A** to **B**	**B** to **A**
Working pressure	M_B	M_A	M_A	M_B	M_A	M_B	M_B	M_A



HW – Proportional control, hydraulic, mechanical servo

The output flow of the pump is infinitely variable between 0 and 100%, proportional to the swivel angle of the control lever.
A feedback lever connected to the stroking piston maintains the pump flow for any given position of the control lever.
If the pump is also equipped with a DA control valve (see page 19), automotive operation is possible for travel drives.



Swivel angle β at the control lever for pump displacement change:

- Start of control at β = ±3°
- End of control at β (max. displacement $V_{g\,max}$)
  - Size 28 to 71 at ±32°
  - Size 90 to 125 at ±34.5°
- Rotational limit β of the control lever (internal) ±38°

The maximum required torque at the lever is 170 Ncm. To prevent damage to the HW control module, a positive mechanical stop of 36.5° ± 1 must be provided for the HW control lever on the customer side.

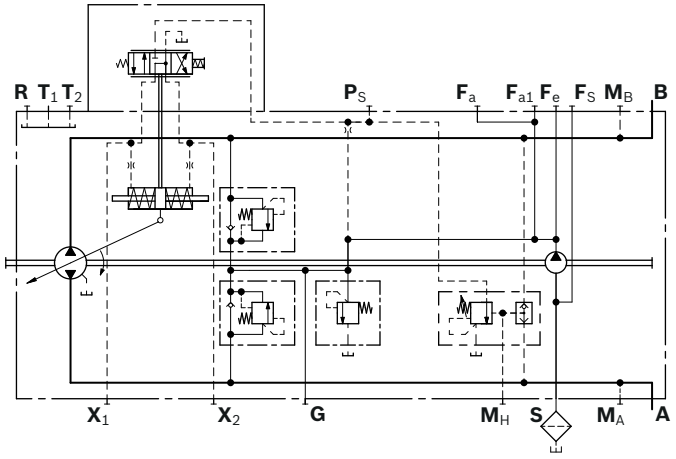
Notice

- Spring centering enables the pump, depending on pressure and speed, to move automatically to the neutral position (V_g = 0) as soon as there is no longer any torque on the control lever of the HW control module.
- If necessary, the position of the lever can be changed. The procedure is defined in the instruction manual.
- On delivery, the position of the lever may differ from that shown in the drawing.

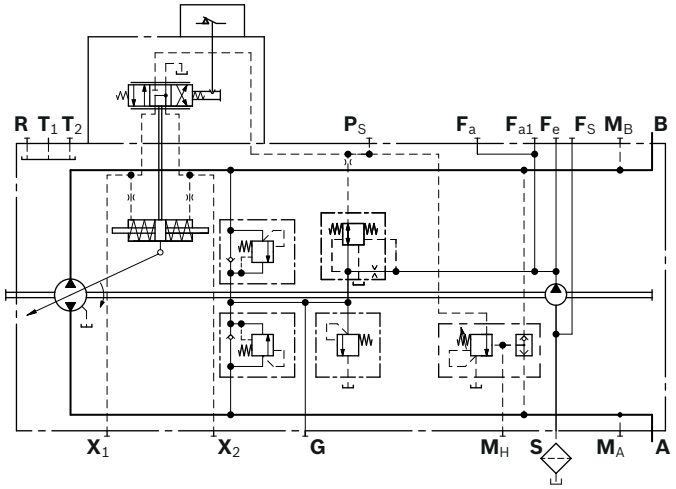
Option: Neutral position switch
The switch contact in the neutral position switch is closed when the control lever on the HW control module is in its neutral position. The switch opens when the control lever is moved out of the central position in either direction. Thus, the neutral position switch provides a monitoring function for drive units that require the pump to be in the neutral position during certain operating conditions (e.g. starting diesel engines).

Technical Data	
Load capacity	20 A (continuous), without switching operations
Switching capacity	15 A / 32 V (resistive load)
	4 A / 32 V (inductive load)
Connector version	DEUTSCH DT04-2P-EP04 (mating connector, see page 64)

▼ **Standard version**[1)]

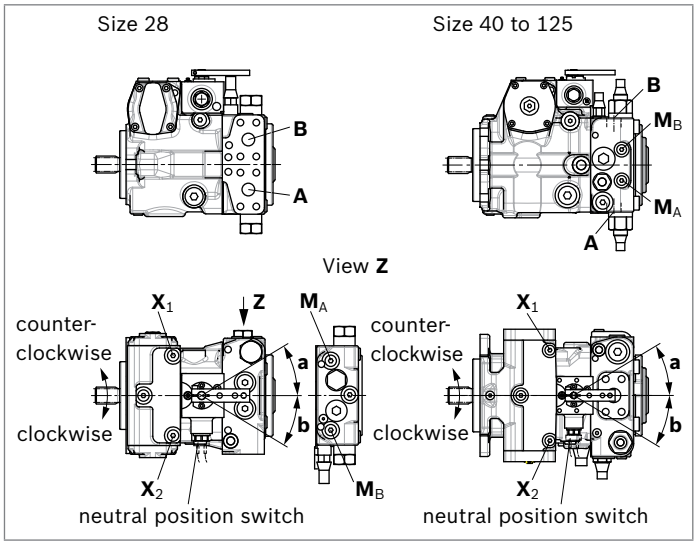


▼ **Version with DA control valve and neutral position switch**[1)]



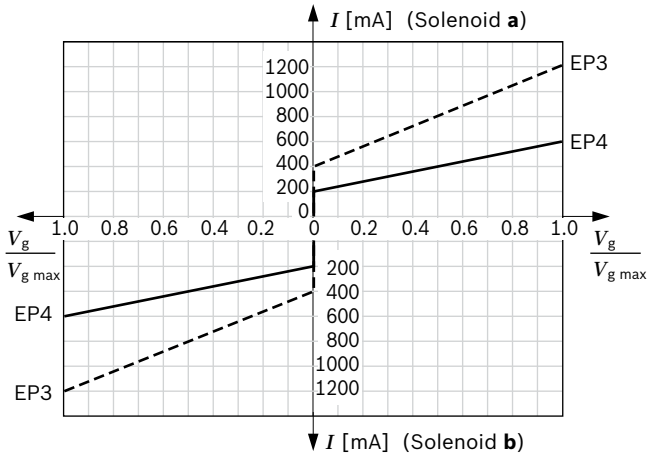
1) Size 28 without port F_{a1} and F_S

Correlation of direction of rotation, control and flow direction								
Direction of rotation	clockwise				counter-clockwise			
Size	28 to 56		71 to 125		28 to 56		71 to 125	
Lever direction	**a**	**b**	**a**	**b**	**a**	**b**	**a**	**b**
Control pressure	X_2	X_1	X_2	X_1	X_2	X_1	X_2	X_1
Flow direction	**B** to **A**	**A** to **B**	**A** to **B**	**B** to **A**	**A** to **B**	**B** to **A**	**B** to **A**	**A** to **B**
Working pressure	M_A	M_B	M_B	M_A	M_B	M_A	M_A	M_B



EP – Proportional control, electric

The output flow of the pump is infinitely variable between 0 and 100%, proportional to the electrical current supplied to solenoid **a** or **b**.
The electrical energy is converted into a force acting on the control spool.
This control spool then directs control oil into and out of the stroking cylinder to adjust pump displacement as required.
A feedback lever connected to the stroking piston maintains the pump flow for any given current within the control range.
If the pump is also equipped with a DA control valve (see page 19), automotive operation is possible for travel drives.

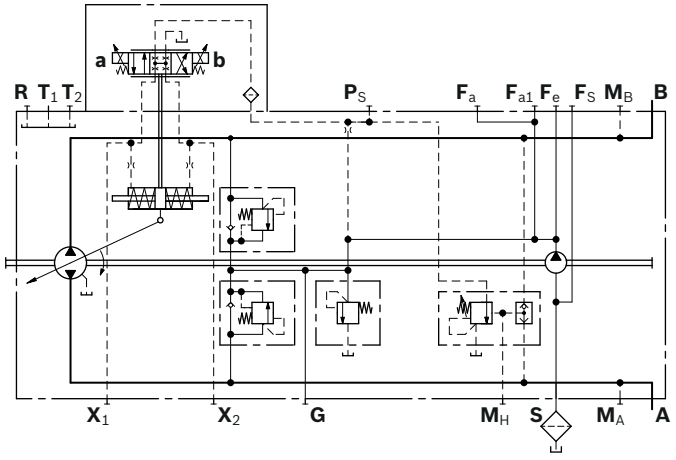


Notice
The proportional solenoids do not have manual override. Proportional solenoids with manual override and spring return are available on request.

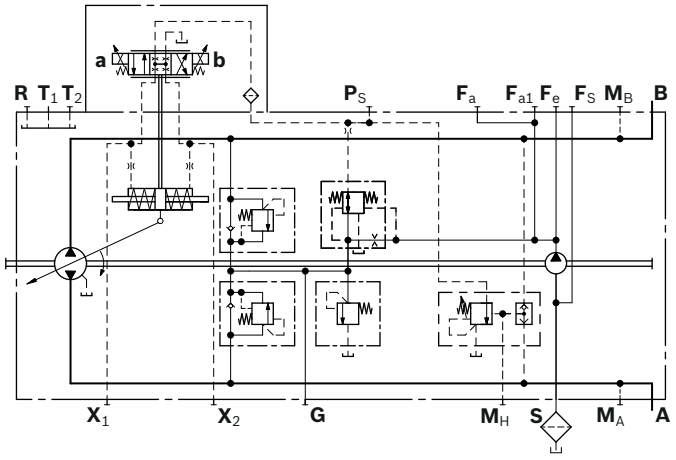
Technical data, solenoid	EP3	EP4
Voltage	12 V (±20%)	24 V (±20%)
Control current		
Start of control at V_g = 0	400 mA	200 mA
End of control at $V_{g\,max}$	1200 mA	600 mA
Current limit	1.54 A	0.77 A
Nominal resistance (at 20 °C)	5.5 Ω	22.7 Ω
Dither		
Frequency	100 Hz	100 Hz
Minimum oscillation range[1)]	240 mA	120 mA
Duty cycle	100%	100%
Type of protection: see connector version page 64		

Various BODAS controllers with application software and amplifiers are available for controlling the proportional solenoids.
Further information can also be found on the Internet at www.boschrexroth.com/mobile-electronics

▼ **Standard version**[2)]

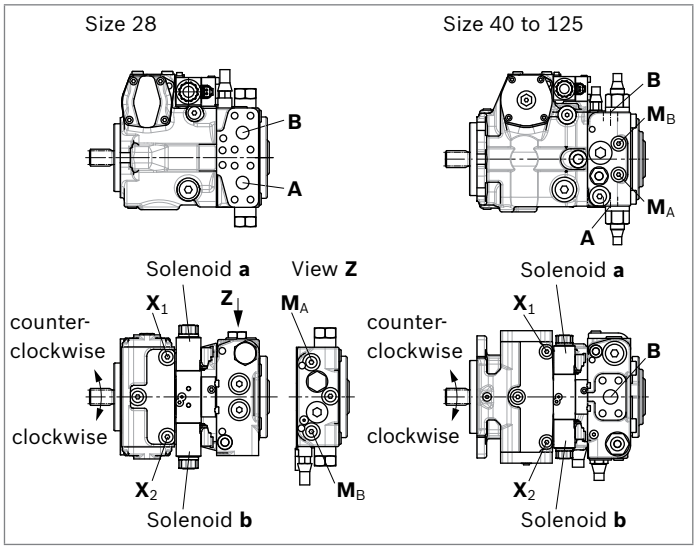


▼ **Version with DA control valve**[2)]



1) Minimum required oscillation range of the control current $\Delta I_{p\text{-}p}$ (peak to peak) within the respective control range (start of control to end of control)
2) Size 28 without port $\mathbf{F_{a1}}$ and $\mathbf{F_S}$

Correlation of direction of rotation, control and flow direction								
Direction of rotation	clockwise				counter-clockwise			
Size	28 to 56		71 to 125		28 to 56		71 to 125	
Actuation of solenoid	**a**	**b**	**a**	**b**	**a**	**b**	**a**	**b**
Control pressure	X_1	X_2	X_1	X_2	X_1	X_2	X_1	X_2
Flow direction	**A** to **B**	**B** to **A**	**B** to **A**	**A** to **B**	**B** to **A**	**A** to **B**	**A** to **B**	**B** to **A**
Working pressure	M_B	M_A	M_A	M_B	M_A	M_B	M_B	M_A

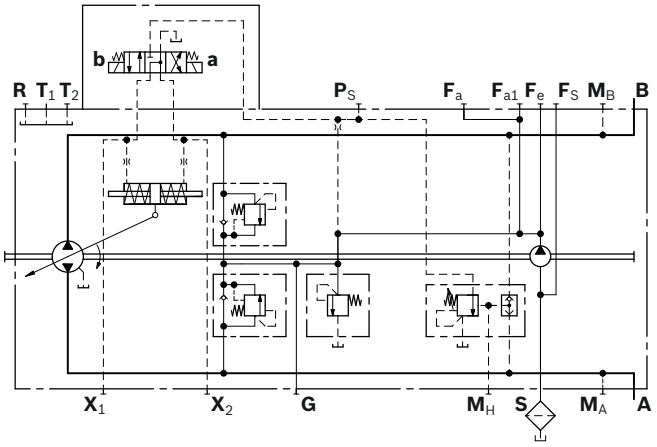


EZ – Two-point control, electric

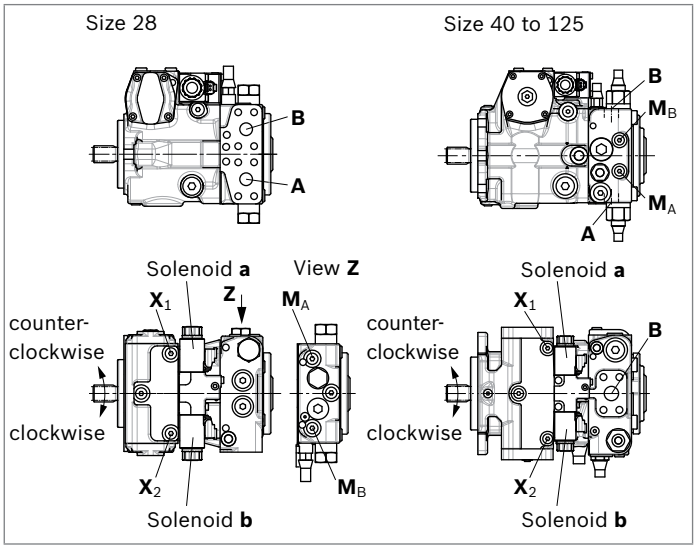
By actuating either switching solenoid **a** or **b**, internal control pressure is applied directly to the stroking piston and the pump swivels to maximum displacement. The EZ control enables pump flow to be switched between V_g = 0 and $V_{g\,max}$.
Flow direction is determined by which solenoid is energized.

Technical data, solenoid	EZ1	EZ2
Voltage	12 V (±20%)	24 V (±20%)
Neutral position V_g = 0	de-energized	de-energized
Position $V_{g\,max}$	energized	energized
Nominal resistance (at 20 °C)	5.5 Ω	21.7 Ω
Nominal power	26.2 W	26.5 W
Minimum active current required	1.32 A	0.67 A
Duty cycle	100%	100%
Type of protection: see connector version page 64		

▼ **Standard version**[1)]



Correlation of direction of rotation, control and flow direction								
Direction of rotation	clockwise				counter-clockwise			
Size	28 to 56		71 to 125		28 to 56		71 to 125	
Actuation of solenoid	**a**	**b**	**a**	**b**	**a**	**b**	**a**	**b**
Control pressure	X_2	X_1	X_2	X_1	X_2	X_1	X_2	X_1
Flow direction	**B** to **A**	**A** to **B**	**A** to **B**	**B** to **A**	**A** to **B**	**B** to **A**	**B** to **A**	**A** to **B**
Working pressure	M_A	M_B	M_B	M_A	M_B	M_A	M_A	M_B



1) Size 28 without port F_{a1} and F_S

DA – Automatic control, speed related

The DA closed loop control is an engine speed-dependent system for travel drives. The built-in DA control valve generates a pilot pressure that is proportional to pump (engine) drive speed. This pilot pressure is directed to the stroking cylinder of the pump by an electromagnetically actuated 4/3-way directional valve. The pump displacement is infinitely variable in each flow direction and is influenced by both pump drive speed and system pressure. The flow direction (e.g. machine moving forward or backward) is determined by either solenoid **a** or **b** being activated.
Increasing the pump drive speed generates a higher pilot pressure from the DA control valve, with a subsequent increase in pump flow.
Depending on the selected pump operating characteristics, increasing system pressure (e.g. machine load) causes the pump to swivel back towards a smaller displacement. An overload protection for the engine (against stalling) is achieved by combining this pressure-dependent reduction in pump stroke with a reduction in pilot pressure as the engine speed drops.
Any additional power requirement, e.g. for hydraulic functions from attachments, could cause the engine speed to drop further. This will cause a further reduction in pilot pressure and thus of the pump displacement. Automatic power distribution and full exploitation of the available power are achieved in this way, both for the travel drive and for the implement hydraulics, with priority given to the implement hydraulics.
Various override options are available for DA control function to allow controlled operation of the implement hydraulics with high rpm at reduced vehicle speed.
The DA control valve can also be used in pumps with EP, DG, HW and HD control modules to protect the combustion engine against overload.

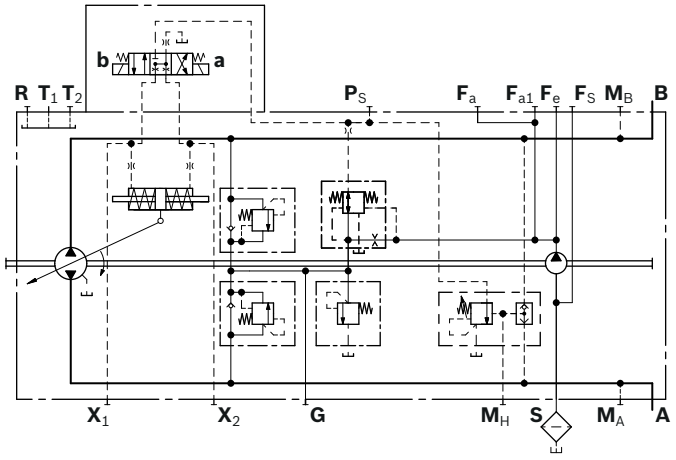
Notice
DA closed loop control is only suitable for certain types of travel drive systems and requires review of the engine and vehicle parameters to ensure that the pump is used correctly and that machine operation is safe and efficient. We recommend that all DA applications be reviewed by a Bosch Rexroth application engineer.

Technical data, solenoid	DA1	DA2
Voltage	12 V (±20%)	24 V (±20%)
Neutral position $V_g = 0$	de-energized	de-energized
Position $V_{g\ max}$	energized	energized
Nominal resistance (at 20 °C)	5.5 Ω	21.7 Ω
Nominal power	26.2 W	26.5 W
Minimum required active current	1.32 A	0.67 A
Duty cycle	100%	100%
Type of protection: see connector version page 64		

DA..2 – DA control valve, fixed setting

Pilot pressure is generated in relation to drive speed.

▼ **DA control valve, fixed setting, DA**1D**2**/**DA**2D**2**[1)]



1) Size 28 without port **F**$_{a1}$ and **F**$_S$

DA..3 – DA control valve, mechanically adjustable with position lever

Pilot pressure is generated in relation to drive speed.
Any reduction of pilot pressure possible, independently of drive speed, through mechanical actuation of the position lever (inch function).
The maximum permissible actuation torque at the position lever is T_{max} = 4 Nm.
Maximum angle of rotation 70°, lever position: any.

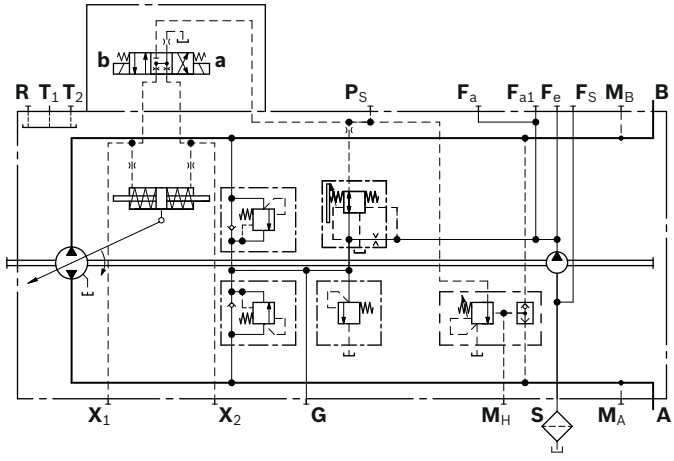
DA..3R

Direction of actuation of the position lever: clockwise

DA..3L

Direction of actuation of the position lever: counter-clockwise

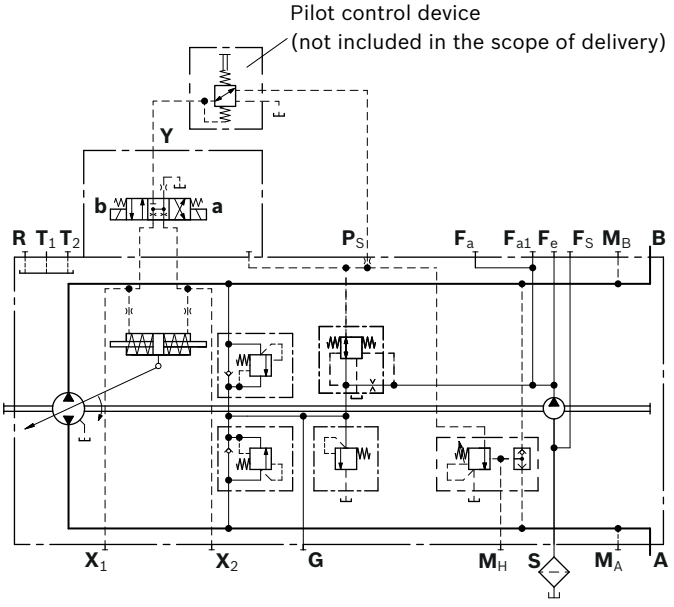
▼ **Circuit diagram DA**1D**3/DA**2D**3**[1)]



DA..7 – DA control valve, fixed setting, ports for pilot control device as inch valve

Any reduction of the pilot pressure possible, independent of the drive speed is achieved by the mechanical actuation of the pilot control device.
The pilot control device is installed separately from the pump (for example in the driver's cabin) and connected to the pump by two hydraulic control lines via ports **P**S and **Y**.
A suitable pilot control device must be ordered separately and is not included in the scope of delivery.
Note: Rotary inch valves, see page 65.

▼ **Circuit diagram DA**1D**7/DA**2D**7**[1)]



1) Size 28 without port **F**a1 and **F**S

DA..8 – DA control valve, fixed setting and brake inch valve mounted

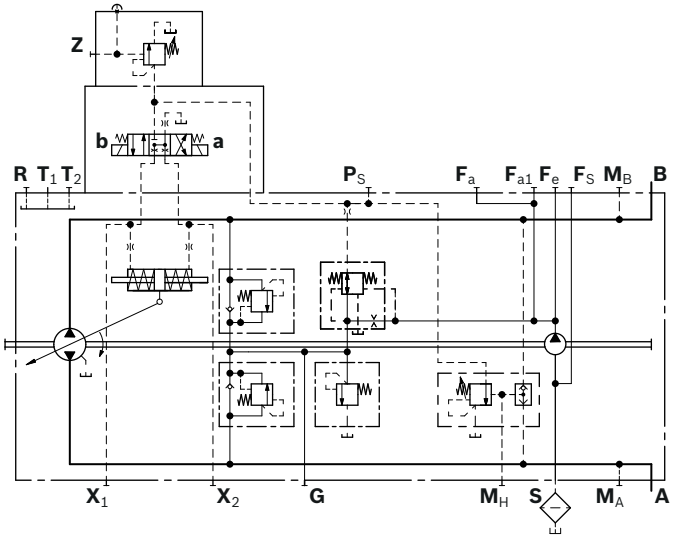
Only for pumps with DA control module

- Version with throttle valve size 28, 40, 56, 71
- Version with pressure reducing valve size 90, 125

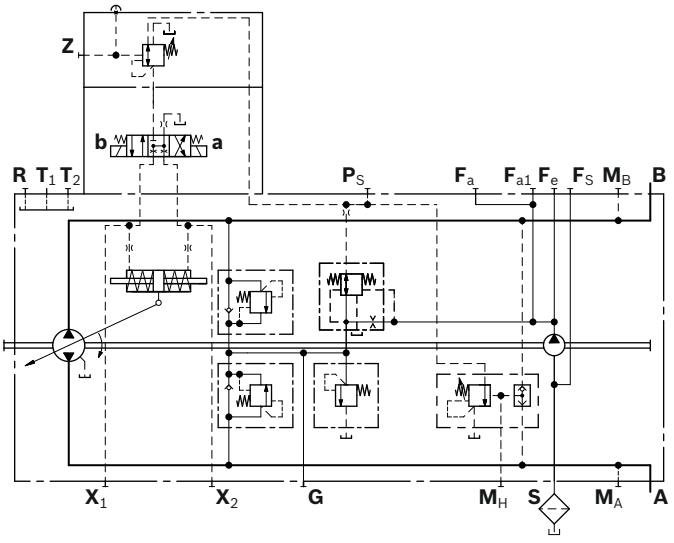
Permits reduction of the pilot pressure, independently of the drive speed via hydraulic control (port **Z**).

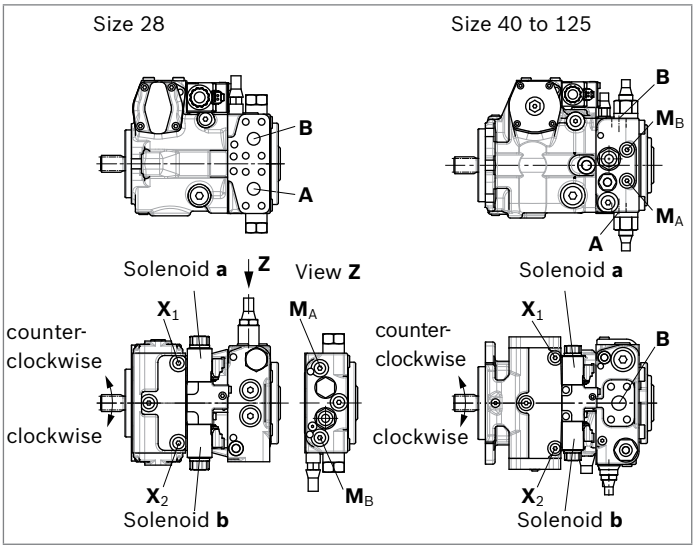
Control at port **Z** by means of brake fluid based on mineral oil.

▼ **Circuit diagram DA1D8/DA2D8 with throttle valve**[1)]



▼ **Circuit diagram DA1D8/DA2D8 with pressure reducing valve**[1)]





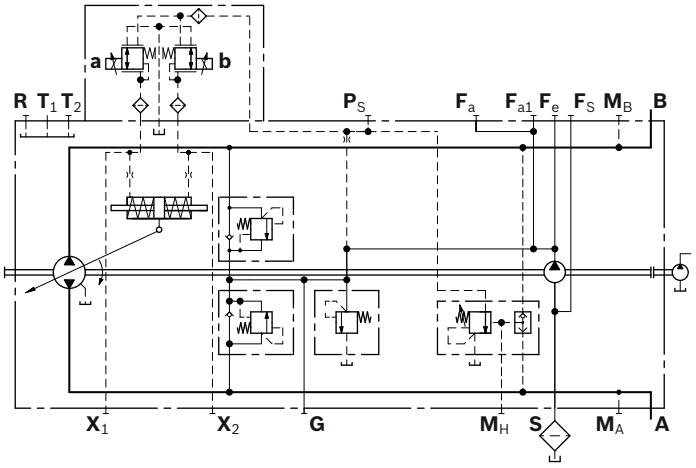
Correlation of direction of rotation, control and flow direction								
Direction of rotation	clockwise				counter-clockwise			
Size	28 to 56		71 to 125		28 to 56		71 to 125	
Actuation of solenoid	**a**	**b**	**a**	**b**	**a**	**b**	**a**	**b**
Control pressure	X_2	X_1	X_2	X_1	X_2	X_1	X_2	X_1
Flow direction	**B** to **A**	**A** to **B**	**A** to **B**	**B** to **A**	**A** to **B**	**B** to **A**	**B** to **A**	**A** to **B**
Working pressure	M_A	M_B	M_B	M_A	M_B	M_A	M_A	M_B

1) Size 28 without port F_{a1} and F_S

ET – Electric control, direct operated

The output flow of the pump is infinitely variable between 0 to 100%. Depending on the preselected current **I** at solenoids **a** and **b** of the pressure reducing valves, the stroking cylinder of the pump is proportionally supplied with control pressure. The two control pressures $\mathbf{X_1}$ and $\mathbf{X_2}$ can be controlled independently. The pump displacement that arises at a certain control current is dependent on the speed and working pressure of the pump. A different flow direction is associated with each pressure reducing valve. Maximum permissible control pressure $\mathbf{P_S}$: 40 bar.

▼ **Standard version**[1)]



Technical data, solenoid	**ET5**	**ET6**
Voltage	12 V (±20%)	24 V (±20%)
Current limit	1.54 A	0.77 A
Nominal resistance (at 20 °C)	5.5 Ω	22.7 Ω
Dither		
Frequency	100 Hz	100 Hz
Minimum oscillation range[1)]	240 mA	120 mA
Duty cycle	100%	100%
Type of protection: see connector version page 64		

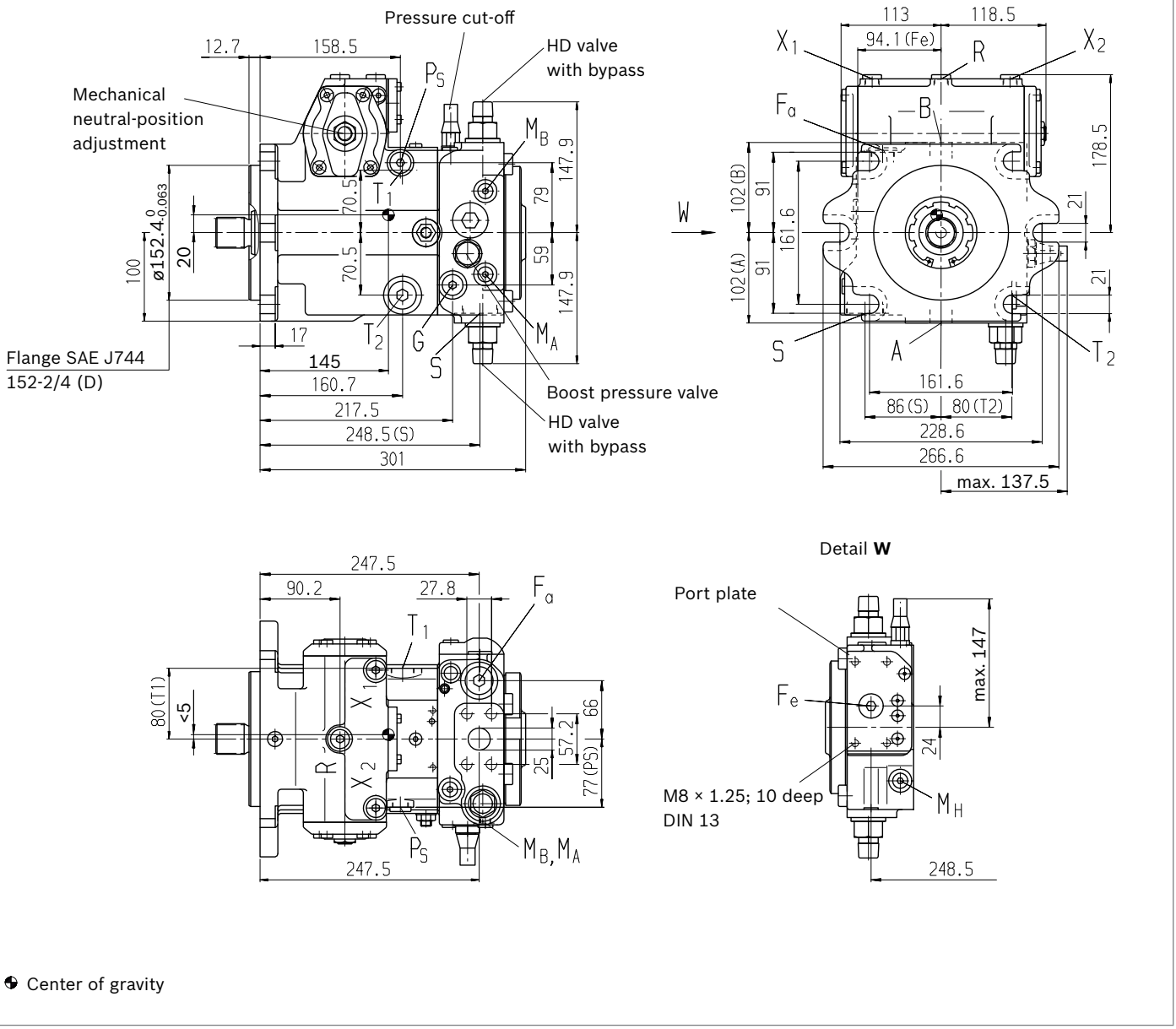
Correlation of direction of rotation, control and flow direction								
Direction of rotation	clockwise				counter-clockwise			
Size	28 to 56		71		28 to 56		71	
Actuation of solenoid	**a**	**b**	**a**	**b**	**a**	**b**	**a**	**b**
Control pressure	$\mathbf{X_1}$	$\mathbf{X_2}$	$\mathbf{X_1}$	$\mathbf{X_2}$	$\mathbf{X_1}$	$\mathbf{X_2}$	$\mathbf{X_1}$	$\mathbf{X_2}$
Flow direction	**A** to **B**	**B** to **A**	**B** to **A**	**A** to **B**	**B** to **A**	**A** to **B**	**A** to **B**	**B** to **A**
Working pressure	$\mathbf{M_B}$	$\mathbf{M_A}$	$\mathbf{M_A}$	$\mathbf{M_B}$	$\mathbf{M_A}$	$\mathbf{M_B}$	$\mathbf{M_B}$	$\mathbf{M_A}$

1) Size 28 without port $\mathbf{F_{a1}}$ and $\mathbf{F_S}$

Dimensions, size 90

NV – Version without control module

Standard: SAE working port **A** and **B** top and bottom, suction port **S** bottom (02)

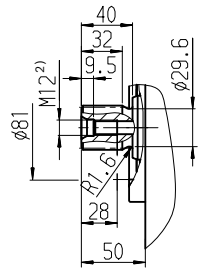


Notice

Option: SAE working port **A** and **B** top and bottom, suction port **S** top (03). Port plate (02) rotated through 180°, installation drawing on request

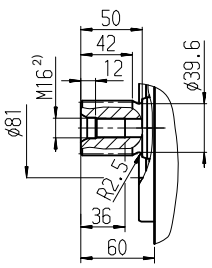
▼ **Splined shaft DIN 5480**

Z – W35×2×16×9 g



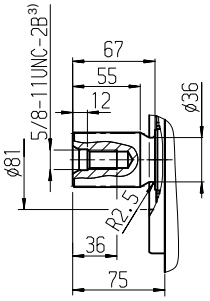
▼ **Splined shaft DIN 5480**

A – W45×2×21×9 g



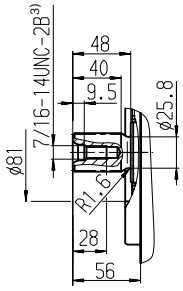
▼ **Splined shaft ANSI B92.1a**

S – 1 3/4 in 13T 8/16DP[1)]



▼ **Splined shaft ANSI B92.1a**

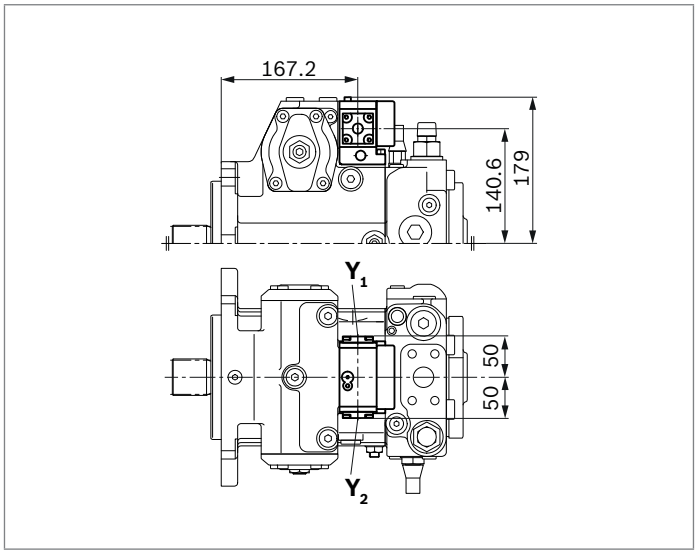
U – 1 1/4 in 14T 12/24DP[1)]



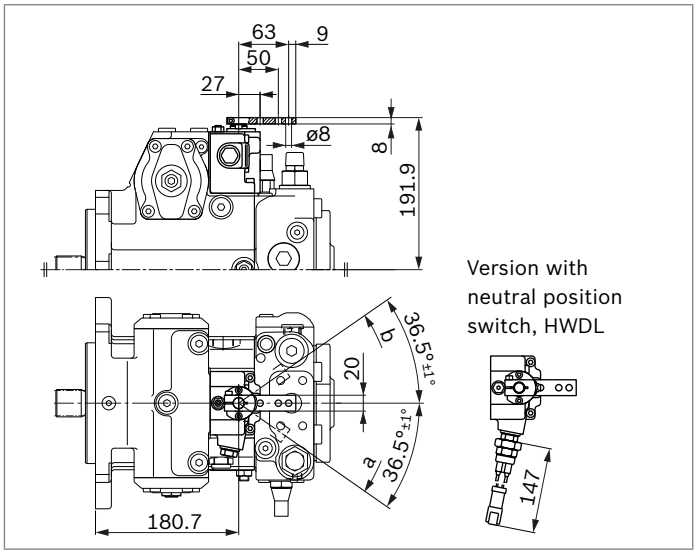
Ports		Standard	Size	p_{max} [bar][4)]	State[10)]
A, B	Working port Fastening thread	SAEJ518[5)] DIN 13	1 in M12 × 1.75; 17 deep	450	O
S	Suction port	DIN 3852[8)]	M42 × 2; 20 deep	5	O[6)]
T_1	Drain port	DIN 3852[8)]	M26 × 1.5; 16 deep	3	O[7)]
T_2	Drain port	DIN 3852[8)]	M26 × 1.5; 16 deep	3	X[7)]
R	Air bleed port	DIN 3852[8)]	M16 × 1.5; 12 deep	3	X
X_1, X_2	Control pressure port (upstream of orifice)	DIN 3852[8)]	M16 × 1.5; 12 deep	40	X
X_1, X_2	Control pressure port (upstream of orifice, DG only)	DIN 3852[8)]	M16 × 1.5; 12 deep	40	O
X_3, X_4[9)]	Stroking chamber pressure port	DIN 3852[8)]	M12 × 1.5; 12 deep	40	X
G	Boost pressure port inlet	DIN 3852[8)]	M18 × 1.5; 12 deep	40	X
P_S	Pilot pressure port	DIN 3852[8)]	M18 × 1.5; 12 deep	40	X
P_S	Pilot pressure port (DA..7 only)	DIN 3852[8)]	M18 × 1.5; 12 deep	40	O
Y	Pilot pressure port outlet (DA..7 only)	DIN 3852[8)]	M18 × 1.5; 12 deep	40	O
M_A, M_B	Measuring port pressure A, B	DIN 3852[8)]	M12 × 1.5; 12 deep	450	X
M_H	Measuring port, high pressure	DIN 3852[8)]	M12 × 1.5; 12 deep	450	X
F_a	Boost pressure port inlet	DIN 3852[8)]	M26 × 1.5; 16 deep	40	X
F_{a1}	Boost pressure port inlet (attachment filter)	DIN 3852[8)]	M22 × 1.5; 14 deep	40	X
F_e	Boost pressure port outlet	DIN 3852[8)]	M22 × 1.5; 14 deep	40	X
F_S	Line from filter to suction port (cold start)	DIN 3852[8)]	M22 × 1.5; 14 deep	40	X
Y_1, Y_2	Pilot pressure port (pilot signal HD only)	DIN 3852[8)]	M14 × 1.5; 12 deep	40	O
Z	Pilot pressure port (inch signal DA..8 only)	DIN 3852[8)]	M10 × 1; 8 deep	40	X

1) Involute spline according to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Thread according to ASME B1.1
4) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.
6) Plugged at external boost pressure supply.
7) Depending on installation position, **T_1** or **T_2** must be connected (see also installation instructions on page 67).
8) The countersink can be deeper than as specified in the standard.
9) Optional, see page 58
10) O = Must be connected (plugged when delivered)
X = Plugged (in normal operation)

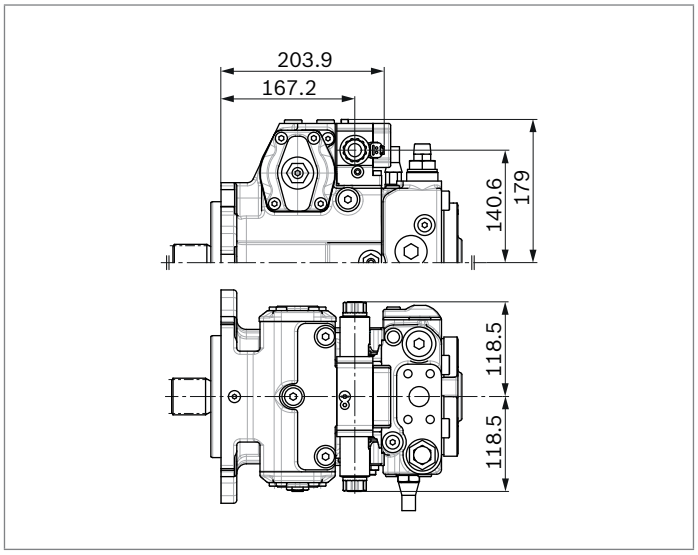
▼ **HD** – Proportional control, hydraulic, pilot-pressure related



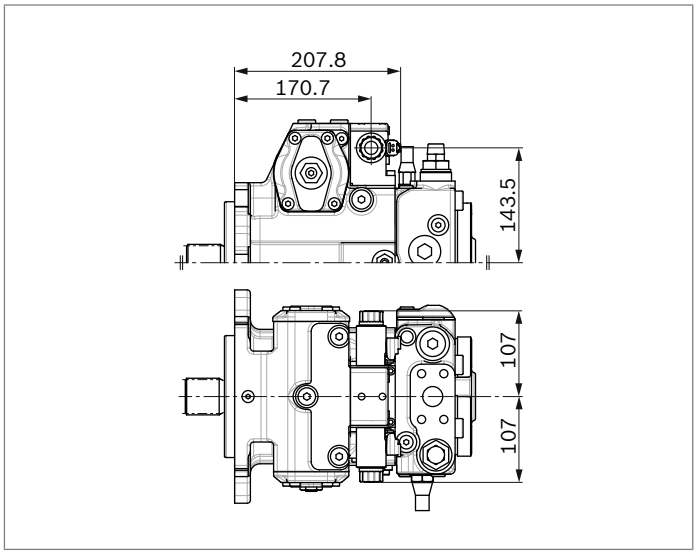
▼ **HW** – Proportional control, hydraulic, mechanical servo



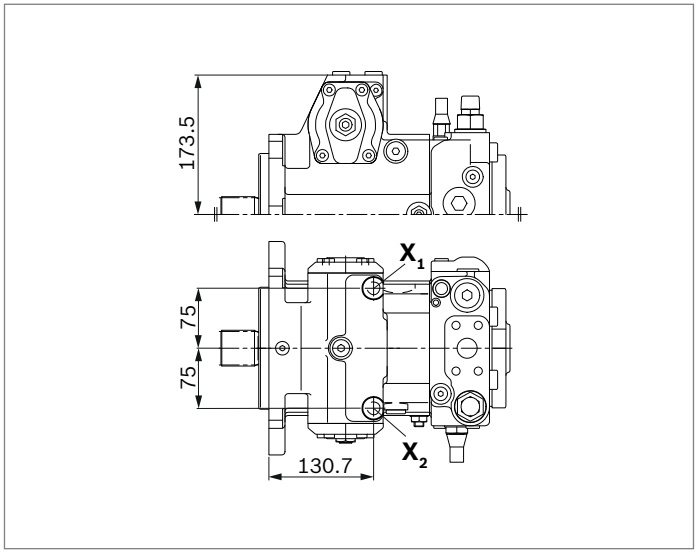
▼ **EP** – Proportional control, electric



▼ **EZ** – Two-point control, electric

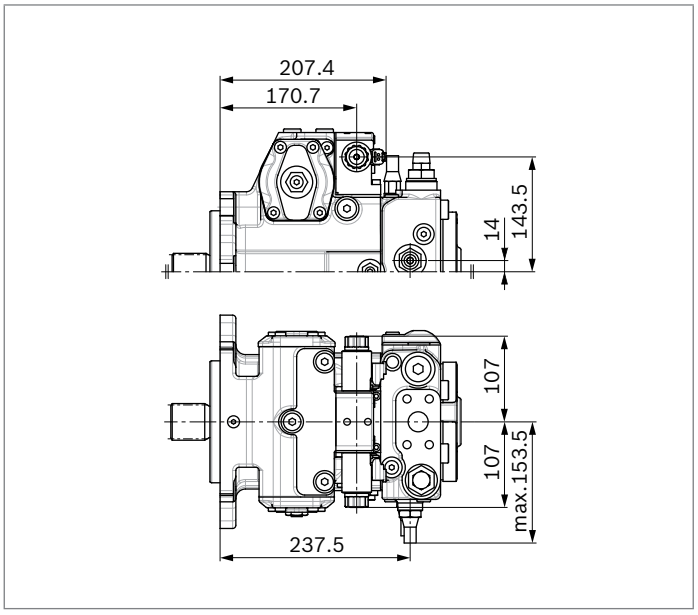


▼ **DG** – Hydraulic control, direct operated

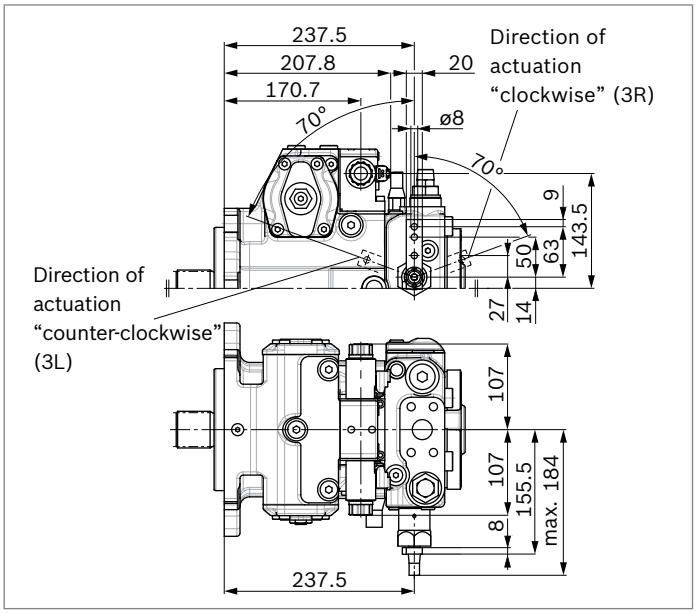


DA control valve

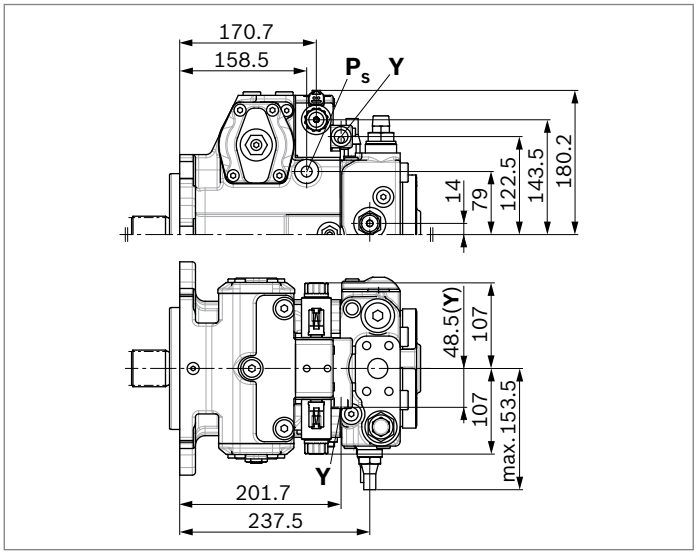
▼ **DA..2** – Fixed setting



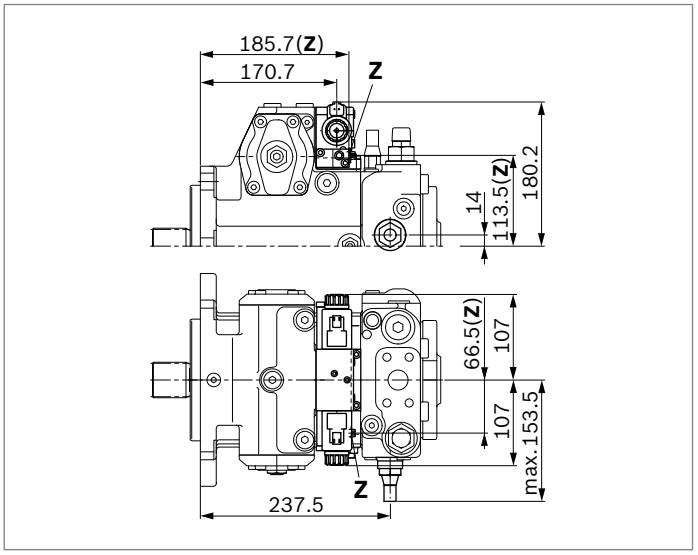
▼ **DA..3** – Mechanically adjustable with position lever



▼ **DA..7** – Fixed setting and ports for pilot control device



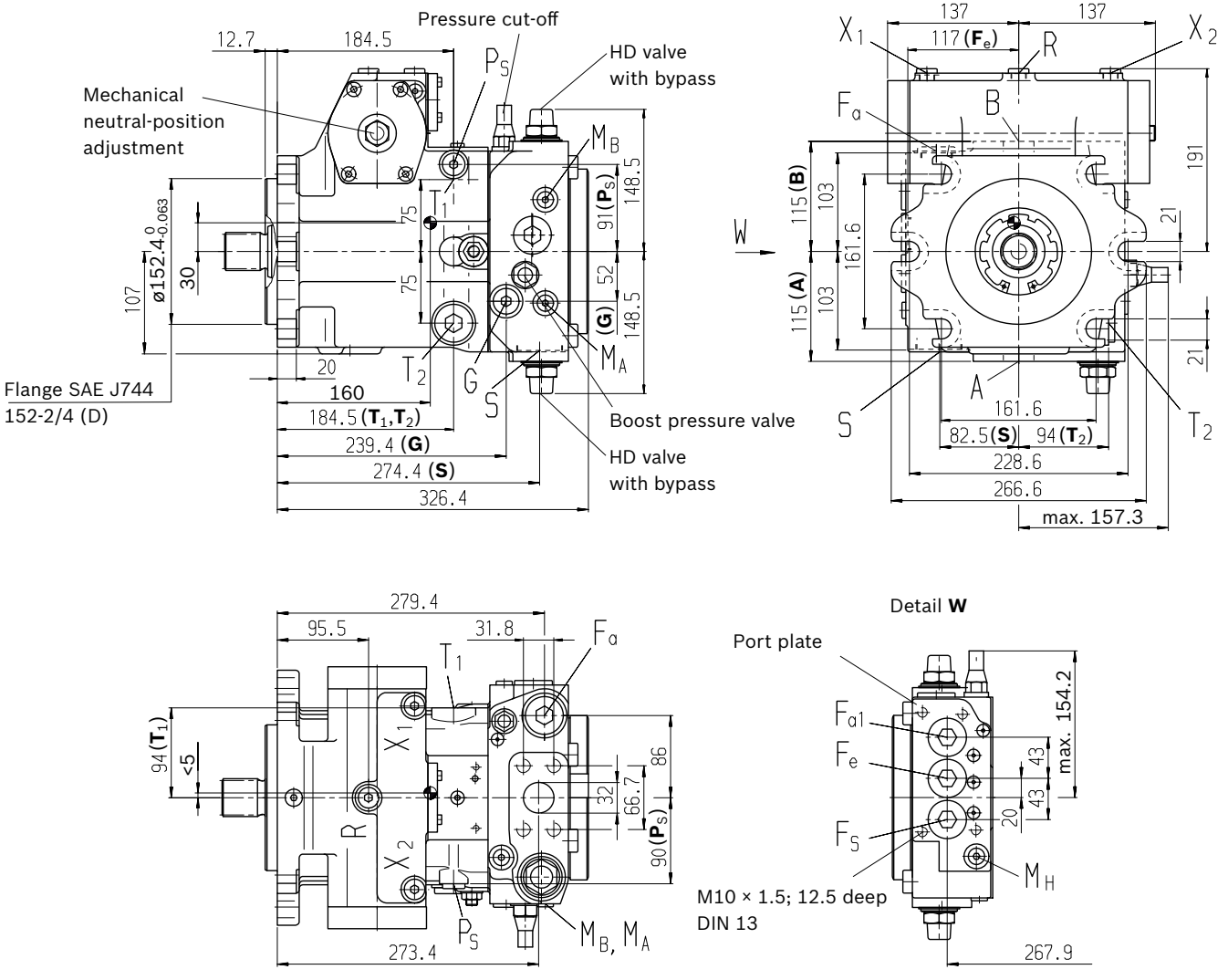
▼ **DA..8** – Fixed setting and inch valve mounted



Dimensions, size 125

NV – Version without control module

Standard: SAE working port **A** and **B** top and bottom, suction port **S** bottom (02)

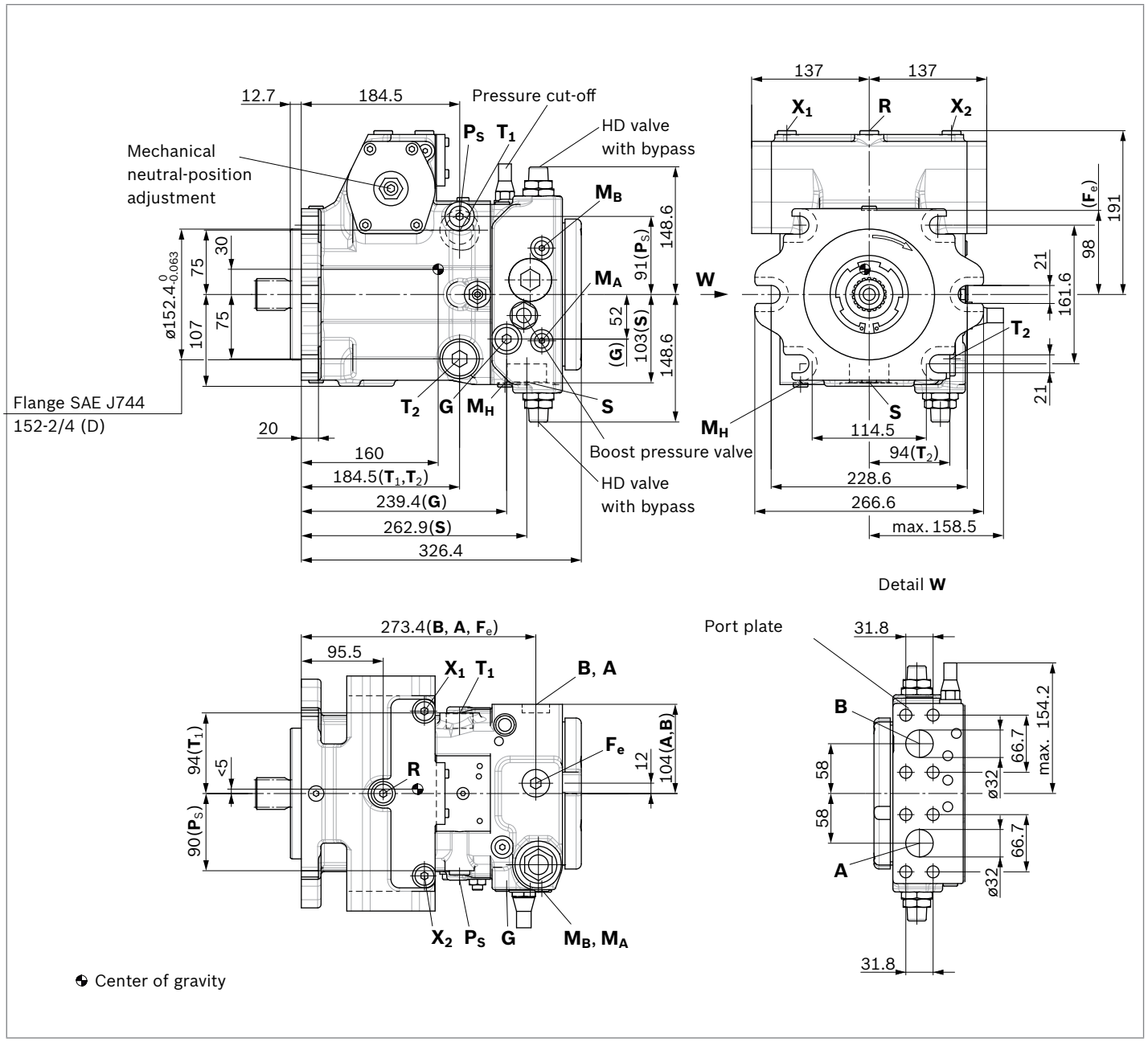


Notice

Option: SAE working port **A** and **B** top and bottom, suction port **S** top (03). Port plate (02) rotated through 180°, installation drawing on request

NV – Version without control module

Standard: SAE working port **A** and **B**, same side left, suction port **S** bottom (10)

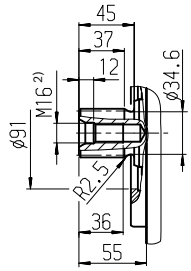


Notice

Option: SAE working port **A** and **B**, same side right, suction port **S** top (13), installation drawing on request

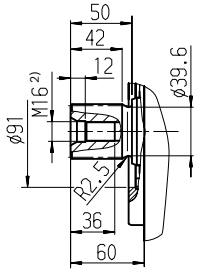
▼ **Splined shaft DIN 5480**

Z – W40×2×18×9 g



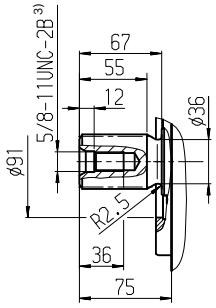
▼ **Splined shaft DIN 5480**

A – W45×2×21×9 g



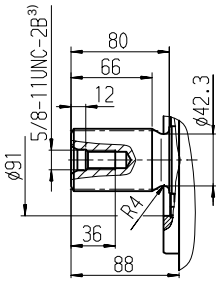
▼ **Splined shaft ANSI B92.1a**

S – 1 3/4 in 13T 8/16DP[1)]



▼ **Splined shaft ANSI B92.1a**

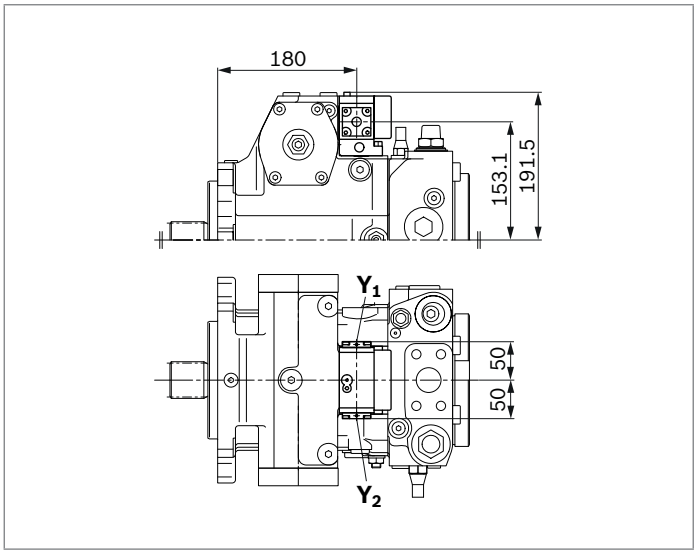
T – 2 in 15T 8/16DP[1)]



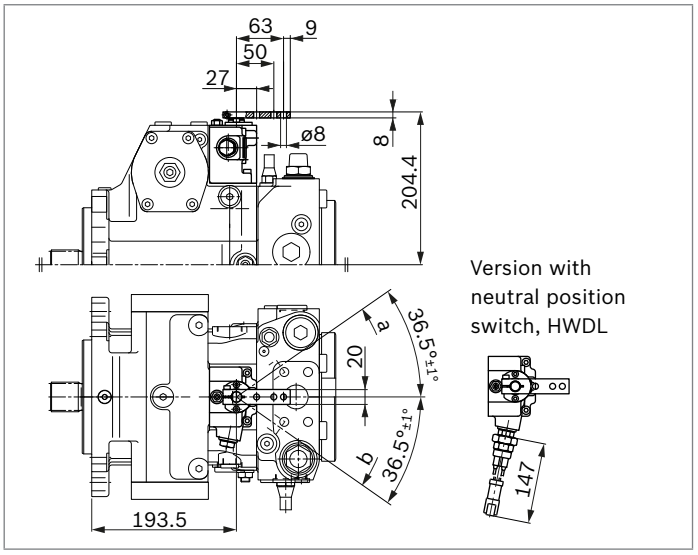
Ports		Standard	Size	p_{max} [bar][4)]	State[10)]
A, B	Working port Fastening thread	SAEJ518[5)] DIN 13	1 1/4 in M14 × 2; 19 deep	450	O
S	Suction port	DIN 3852[8)]	M48 × 2; 22 deep	5	O[6)]
T_1	Drain port	DIN 3852[8)]	M33 × 2; 18 deep	3	O[7)]
T_2	Drain port	DIN 3852[8)]	M33 × 2; 18 deep	3	X[7)]
R	Air bleed port	DIN 3852[8)]	M16 × 1.5; 12 deep	3	X
X_1, X_2	Control pressure port (upstream of orifice)	DIN 3852[8)]	M16 × 1.5; 12 deep	40	X
X_1, X_2	Control pressure port (upstream of orifice, DG only)	DIN 3852[8)]	M16 × 1.5; 12 deep	40	O
X_3, X_4[9)]	Stroking chamber pressure port	DIN 3852[8)]	M12 × 1.5; 12 deep	40	X
G	Boost pressure port inlet	DIN 3852[8)]	M22 × 1.5; 12 deep	40	X
P_S	Pilot pressure port	DIN 3852[8)]	M18 × 1.5; 12 deep	40	X
P_S	Pilot pressure port (DA..7 only)	DIN 3852[8)]	M18 × 1.5; 12 deep	40	O
Y	Pilot pressure port outlet (DA..7 only)	DIN 3852[8)]	M18 × 1.5; 12 deep	40	O
M_A, M_B	Measuring port pressure A, B	DIN 3852[8)]	M12 × 1.5; 12 deep	450	X
M_H	Measuring port, high pressure	DIN 3852[8)]	M12 × 1.5; 12 deep	450	X
F_a	Boost pressure port inlet	DIN 3852[8)]	M33 × 2; 18 deep	40	X
F_{a1}	Boost pressure port inlet (attachment filter)	DIN 3852[8)]	M33 × 2; 18 deep	40	X
F_e	Boost pressure port outlet	DIN 3852[8)]	M33 × 2; 18 deep	40	X
F_S	Line from filter to suction port (cold start)	DIN 3852[8)]	M33 × 2; 18 deep	40	X
Y_1, Y_2	Pilot pressure port (pilot signal HD only)	DIN 3852[8)]	M14 × 1.5; 12 deep	40	O
Z	Pilot pressure port (inch signal DA..8 only)	DIN 3852[8)]	M10 × 1; 8 deep	40	X

1) Involute spline according to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Center bore according to DIN 332 (thread according to DIN 13)
3) Thread according to ASME B1.1
4) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.
5) Only dimensions according to SAE J518, metric fastening thread is a deviation from the standard.
6) Plugged at external boost pressure supply.
7) Depending on installation position, **T_1** or **T_2** must be connected (see also installation instructions on page 67).
8) The countersink can be deeper than as specified in the standard.
9) Optional, see page 58
10) O = Must be connected (plugged when delivered)
X = Plugged (in normal operation)

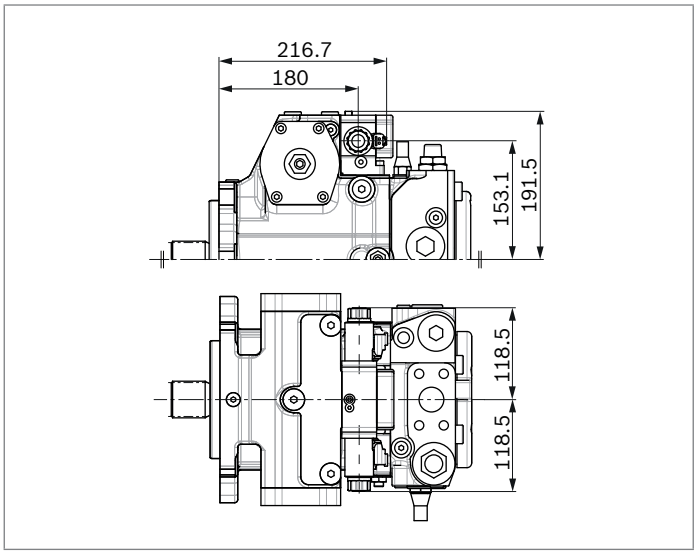
▼ **HD** – Proportional control, hydraulic, pilot-pressure related



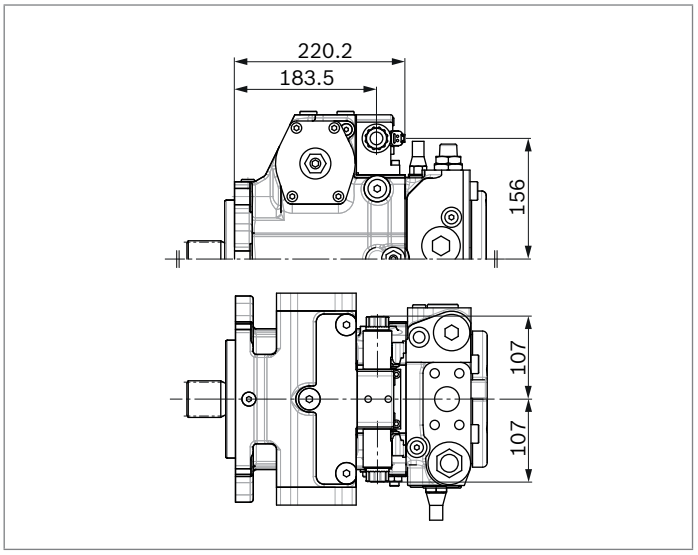
▼ **HW** – Proportional control, hydraulic, mechanical servo



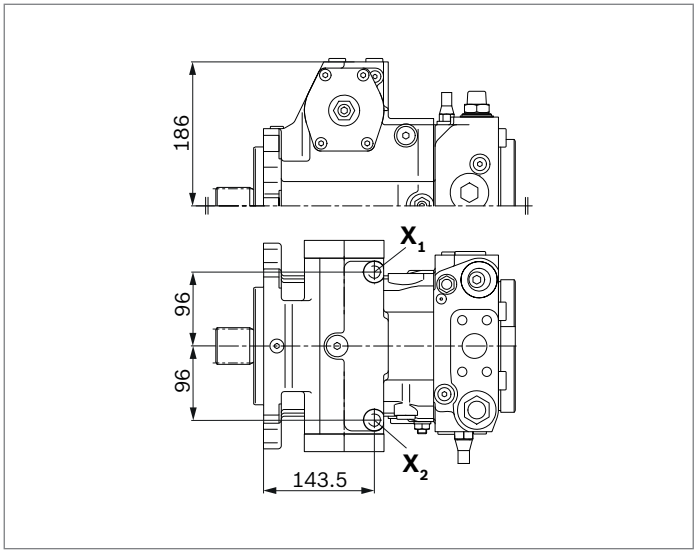
▼ **EP** – Proportional control, electric



▼ **EZ** – Two-point control, electric

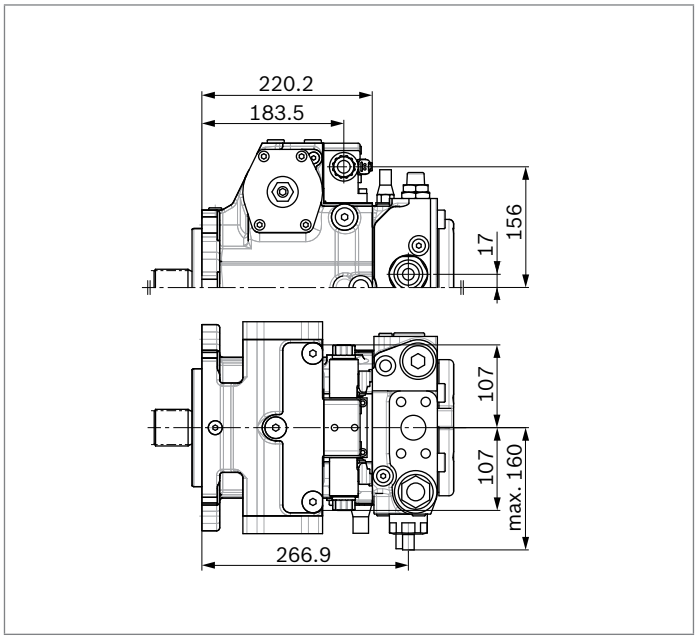


▼ **DG** – Hydraulic control, direct operated

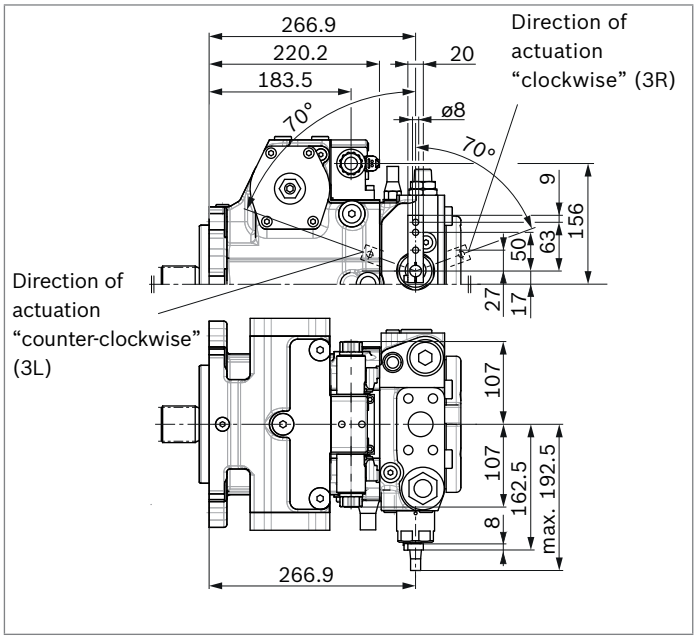


DA control valve

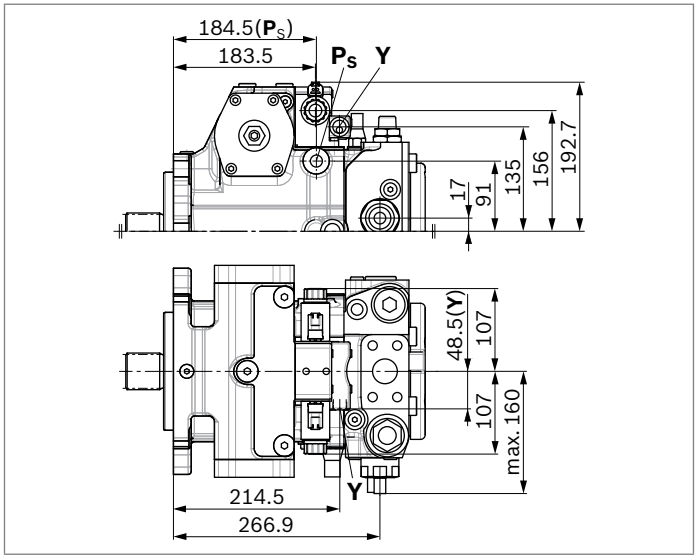
▼ **DA..2** – Fixed setting



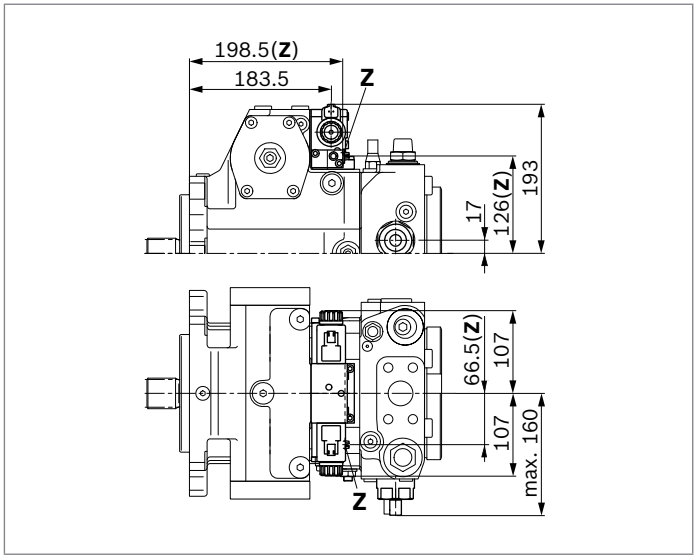
▼ **DA..3** – Mechanically adjustable with position lever



▼ **DA..7** – Fixed setting and ports for pilot control device



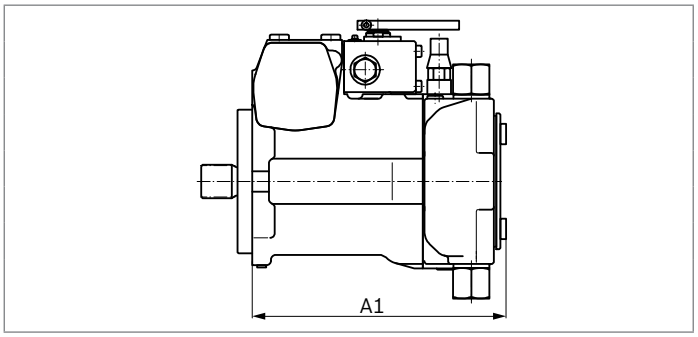
▼ **DA..8** – Fixed setting and inch valve mounted



Dimensions, through drive

Flange SAE J744	Hub for splined shaft[1)]	28	40	56	71	90	125	Code
Without through drive		●	●	●	●	●	●	**00**
82-2 (A)	5/8 in 9T 16/32DP	●	●	●	●	●	●	**01**

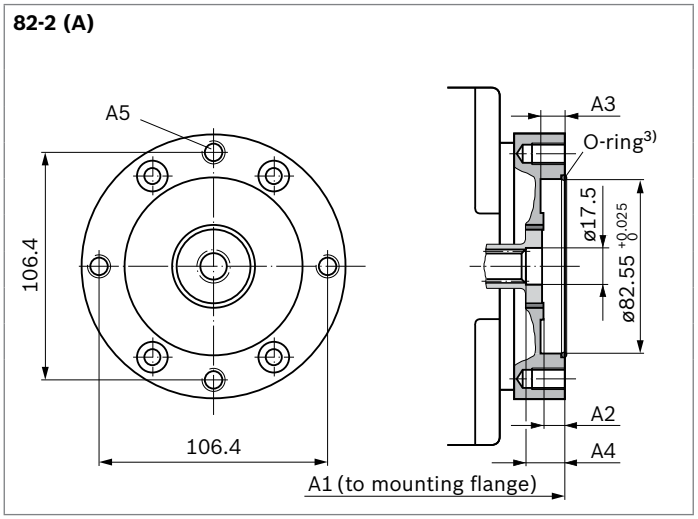
▼ **N00 –** without boost pump, without through drive / **F00** – with boost pump, without through drive



NG	A1 (N00)	A1 (F00)
28	213.9	223.4
40	220.2	235.7
56	239.4	256.4
71	279.1	293.6
90	287	301
125	320.9	326.4

▼ **F01/K01**[4)]

82-2 (A)



NG	A1 (F01)	A1 (K01)	A2	A3	A4
28	227.9	227.9	7.5	7.5	14.5
40	239.7	234.2	9	9	18
56	261.4	254.9	10	10	18
71	297.6	297.6	9	10	17
90	304	304	9	8	–
125	330.9	330.9	10.5	9	–

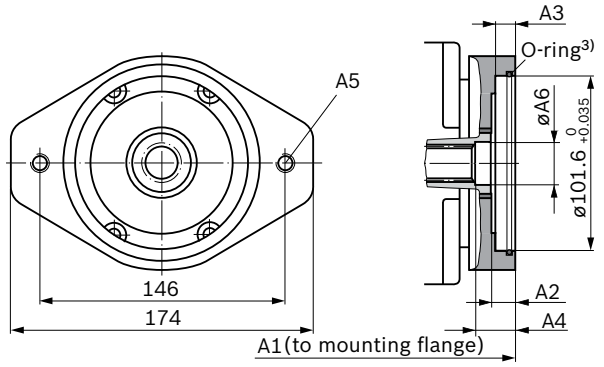
NG	A5[2)]
28 to 125	M10 × 1.5; 15 deep

1) Involute spline according to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Thread according to DIN 13
3) O-ring included in the scope of delivery
4) The illustration shows the 2-hole version. Please state in plain text whether the 2-hole horizontal or the 2-hole vertical version is used.

Flange SAE J744	Hub for splined shaft[1)]	28	40	56	71	90	125	Code
101-2 (B)	7/8 in 13T 16/32DP	●	●	●	●	●	●	**02**
	1 in 15T 16/32DP	●	●	●	●	●	●	**04**
127-2 (C)	1 in 15T 16/32DP	–	●	–	–	–	–	**09**

▼ **F02/K02; F04/K04**[4)]

101-2 (B)

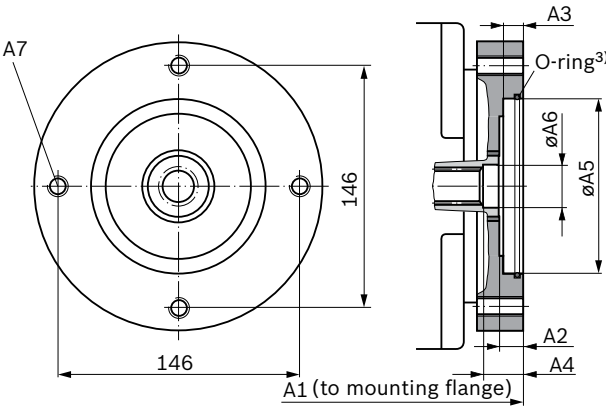


NG	A1	A2	A3	A4 (02)	A4 (04)	A5[2)]
28	230.4	9.7	9.7	16.2	13.7	M12 × 1.75; 19 deep
40	240.7	11	11[5)]	17	16	M12 × 1.75; 19 deep
56	262.4	12	11	19.5	18.5	M12 × 1.75; 19 deep

	øA6
F02 / K02	24
F04 / K04	27

▼ **F02/K02; F04/K04**[4)]

101-2 (B)



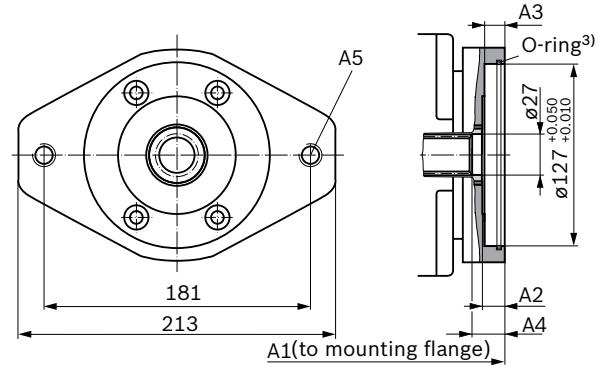
NG	A1	A2	A3	A4 (02)	A4 (04)	ØA5	(K)	(F)
71	300.6	13	9.8	17	15.5	101.6	+0.035 0	+0.035 0
90	305	9	11	17	15	101.6	+0.035 0	+0.022 0
125	330.9	10	11	17	16.5	101.6	+0.025 0	+0.025 0

NG	A7[2)]
71, 90	M12 × 1.75; 21 deep
125	M12 × 1.75; 18 deep

	øA6
F02 / K02	24
F04 / K04	27

▼ **F09/K09**

127-2 (C)



NG	A1	A2	A3	A4
40	244.7	14	14	19.5

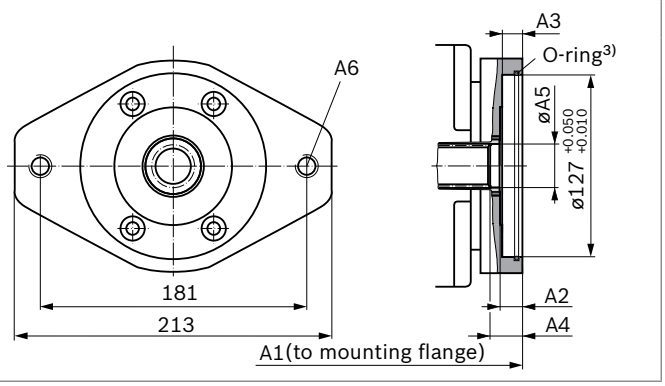
NG	A5[2)]
40	M16 × 2; 20 deep

1) Involute spline according to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Thread according to DIN 13
3) O-ring included in the scope of delivery
4) The illustration shows the 2-hole version. Please state in plain text whether the 2-hole horizontal or the 2-hole vertical version is used.
5) For F04/K04 9.7 mm

Flange SAE J744	Hub for splined shaft	28	40	56	71	90	125	Code
127-2 (C)	1 1/4 in 14T 12/24DP[1)]	–	–	●	●	●	●	**07**
152-2/4 (D)	W35 2×16×9 g (according to DIN 5480)	–	–	–	–	●	–	**73**
	1 3/4 in 13T 8/16DP[1)]	–	–	–	–	–	●	**69**

▼ **F07/K07**[4)]

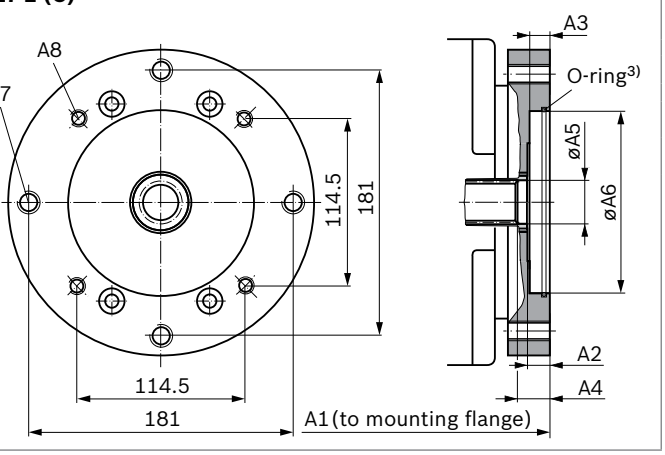
127-2 (C)[5)]



NG	A1	A2	A3	A4	øA5	A6[2)]
56	266.4	15	14	17.5	32.7	M16 × 2; 20 deep
71	303.6	15	13.5	20	33.5	M16 × 2; 24 deep

▼ **F07/K07**[4)]

127-2 (C)[5)]

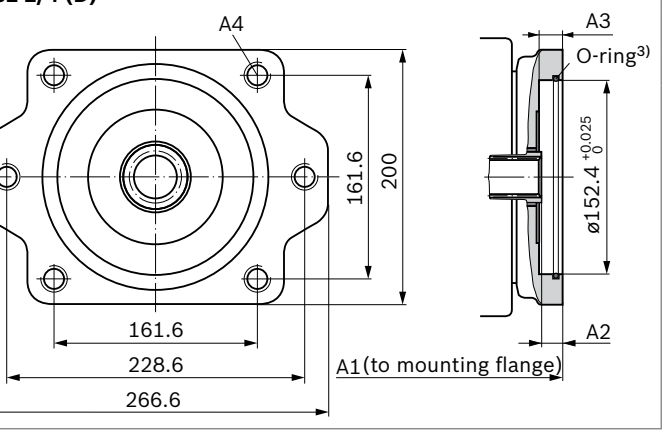


NG	A1	A2	A3	A4	øA5	øA6
90	309	13	14	20.5	33.5	127 $^{+0.025}_{0}$
125	335.9	15	15.5	22.5	33.5	127 $^{+0.025}_{0}$

NG	A7[2)]	A8[2)]
90, 125	M16 × 2; 23 deep	M12 × 1.75; 18 deep

▼ **F73/K73; F69/K69**[6)]

152-2/4 (D)



NG	A1	A2	A3	A4[2)]
90	309	12	14	M20 × 2.5; 20 deep
125	343.9	18	14	M20 × 2.5; 20 deep

1) Involute spline according to ANSI B92.1a, 30° pressure angle, flat root, side fit, tolerance class 5
2) Thread according to DIN 13
3) O-ring included in the scope of delivery
4) The illustration shows the 4- and the 2-hole version. Please state in plain text whether the 4-hole, the 2-hole horizontal or the 2-hole vertical version is used.
5) NG90 to 125 with additional 4-hole-flange (127-4)
6) The illustration shows the 4+2-hole version. Please state in plain text whether the 2-hole, the 4-hole or the 4+2-hole vertical version is used.

Overview of mounting options

Through drive[1]			**Mounting option – 2. pump**					
Flange	**Hub for splined shaft**	**Code**	**A4VG/32 NG (shaft)**	**A10V(S)O/3X NG (shaft)**	**A10V(S)O/5X NG (shaft)**	**A11VO/1 NG (shaft)**	**A10VG NG (shaft)**	**External gear pump**[2]
82-2 (A)	5/8 in	**F/K01**	–	18 (U)	10, 18 (U)	–	–	AZPF NG4 to 22
101-2 (B)	7/8 in	**F/K02**	–	28 (S) 45 (U)	28 (S) 45 (U)	–	18 (S)	AZPN NG20 to 36 AZPG NG32 to 50
	1 in	**F/K04**	28 (S)	45 (S)	45 (S) 60, 63, 72 (U)	40 (S)	28 (S) 45 (S)	–
127-2 (C)[3]	1 in	**F/K09**	40 (U)	71 (U)	60, 63, 71 (U)	–	–	–
	1 1/4 in	**F/K07**	40, 56, 71 (S)	71 (S) 100 (U)	60, 63, 71 (S) 85, 100 (U)	60 (S)	63 (S)	–
152-2/4 (D)	W35	**F/K73**	90 (Z)	–	–	–	–	–
	1 3/4 in	**F/K69**	90, 125 (S)	140 (S)	–	95, 130, 145 (S)	–	–

1) Availability of the individual sizes, see type code on page 3.

2) Bosch Rexroth recommends special versions of the gear pumps. Please contact us.

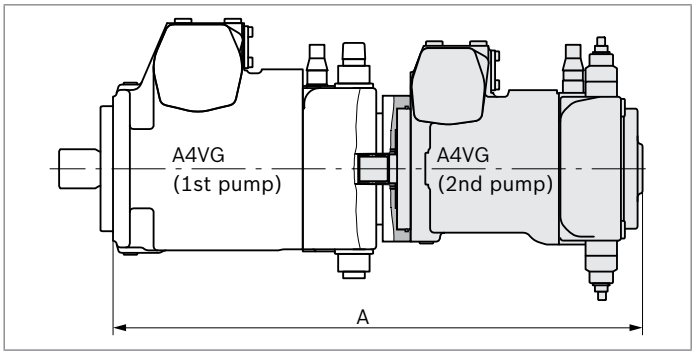
3) A10VO/5X with 4-hole flange attachable only to A4VG NG90 to 125

Combination pumps A4VG + A4VG

Total length A

A4VG	A4VG 2. Pump[1)]					
1st pump	**NG28**	**NG40**	**NG56**	**NG71**	**NG90**	**NG125**
NG28	453.8	–	–	–	–	–
NG40	464.1	480.4	–	–	–	–
NG56	485.8	502.1	522.8	–	–	–
NG71	524.0	539.3	560.0	597.2	–	–
NG90	528.4	544.7	565.4	602.6	610.0	–
NG125	554.3	571.6	592.3	629.5	644.9	670.3

By using combination pumps, it is possible to have independent circuits without the need for splitter gearboxes. When ordering combination pumps, the type designations of the 1st and 2nd pumps must be linked by a "**+**".
Order example:
A4VG56EP3D1/32R-NAC02F073SP + A4VG56EP3D1/32R-NSC02F003SP
A tandem pump, with two pumps of equal size, is permissible without additional supports, assuming that the dynamic acceleration does not exceed maximum 10 *g* (= 98.1 m/s²).
From size 71 upward, we recommend using the 4-hole mounting flange.
For combination pumps consisting of more than two pumps, the mounting flange must be rated for the permissible moment of inertia, please contact us.



1) 2nd pump without through drive and with boost pump, F00

High-pressure relief valves

The two high-pressure relief valves protect the hydrostatic transmission (pump and motor) from overloading. They limit the maximum pressure in the respective high-pressure line and serve simultaneously as boost valves.
High-pressure relief valves are not working valves and are only suitable for pressure peaks or high rates of pressure change.

Setting ranges

High-pressure relief valve, direct operated (NG28 to 56)	Differential pressure setting Δp_{HD}
Valve setting range **3**, **5** Δp 250 to 420 bar (see type code)	420 bar
	400 bar
	360 bar
	340 bar
	320 bar
	300 bar
	270 bar
	250 bar
Valve setting range **4**, **6** Δp 100 to 250 bar (see type code)	250 bar
	230 bar
	200 bar
	150 bar
	100 bar

High-pressure relief valve, pilot operated (NG71 to 125)	Differential pressure setting Δp_{HD}
Valve setting range **1** Δp 100 to 420 bar (see type code)	420 bar
	400 bar
	360 bar
	340 bar
	320 bar
	300 bar
	270 bar
	250 bar
	230 bar
	200 bar
	150 bar
	100 bar

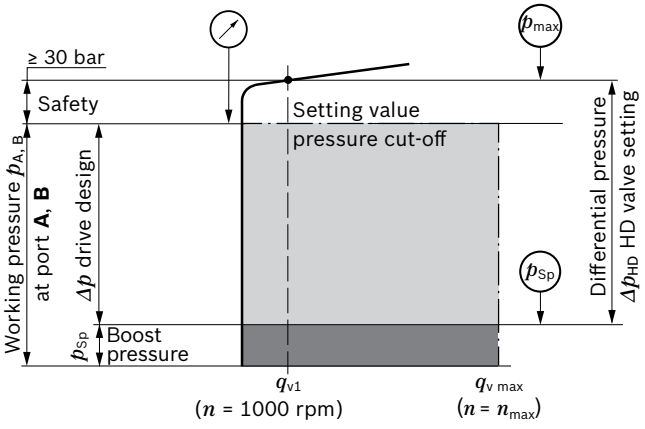
Settings on high-pressure relief valve A and B	
Differential pressure setting	Δp_{HD} = ... bar
Cracking pressure of the HD valve (at $q_{V\,1}$) ($p_{max} = \Delta p_{HD} + p_{Sp}$)	p_{max} = ... bar

- The valve settings are made at n = 1000 rpm and at $V_{g\,max}$ ($q_{v\,1}$). There may be deviations in the cracking pressures with other operating parameters.
- When ordering, state differential pressure setting in plain text.

▼ **Example**

Working pressure		Boost pressure		Safety		Differential pressure
$p_{A,B}$	–	p_{Sp}	+	30 bar	=	Δp_{HD}
400 bar		30 bar				**400 bar**

▼ **Setting diagram**



Bypass function

A connection between the two high-pressure channels **A** and **B** can be established using the bypass valve (e.g. for machine towing).

- **Towing speed**
  The maximum towing speed is dependent on the gear ratio in the vehicle and must be calculated by the vehicle manufacturer. The corresponding flow of q_v = 30 l/min may not be exceeded.
- **Towing distance**
  The vehicle may only be towed out of the immediate danger zone.

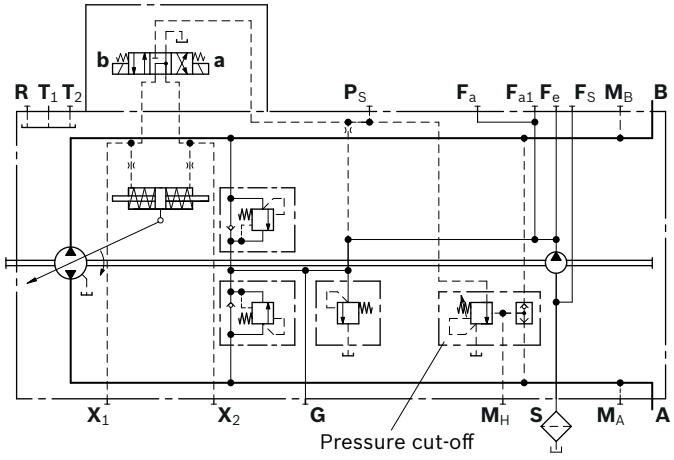
For further information on the bypass function, see the instruction manual.

Notice
The bypass function and the pilot-operated high pressure relief valves (size 71 to 125) are not illustrated in the circuit diagrams.

Pressure cut-off

The pressure cut-off is a pressure control which, after reaching the set pressure, adjusts the displacement of the pump back to $V_{g\,min}$.
This valve prevents the operation of the high-pressure relief valves when accelerating or decelerating.
The high-pressure relief valves protect against the pressure peaks which occur during fast swiveling of the swashplate and limit the maximum pressure in the system.
The setting range of the pressure cut-off may be anywhere within the entire working pressure range. However, it must be set 30 bar lower than the setting value of the high-pressure relief valves (see setting diagram, page 55).
Please state the setting value of the pressure cut-off in plain text when ordering.

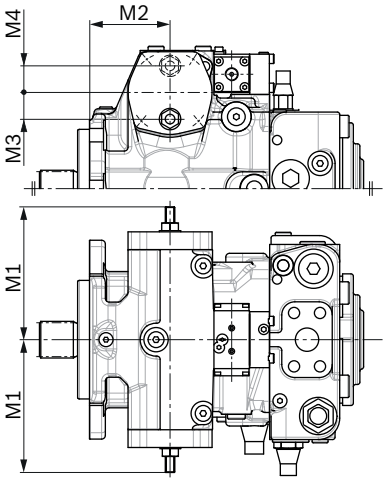
▼ **Circuit diagram with pressure cut-off**
Example: Two-point electric control, EZ1D/EZ2D



Mechanical stroke limiter

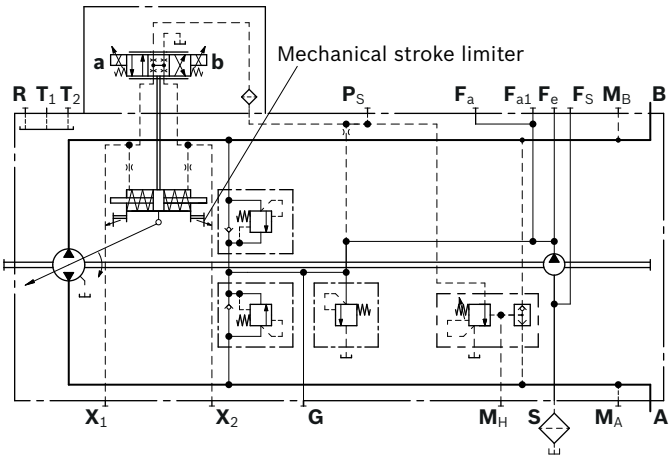
The mechanical stroke limiter is an auxiliary function allowing the maximum displacement of the pump to be steplessly reduced, regardless of the control module used.
By means of two threaded pins, the stroke of the stroking piston and thus the maximum swivel angle of the pump can be limited.

Dimensions



NG	M1 max	M2	M3	M4
28	110.6	40.1	24	–
40	110.6	38.1	24	
56	130.5	44	25.5	–
71	135.4	86.3	–	28.5
90	147	95.7	31.5	–
125	173.7	104.5	–	35.5

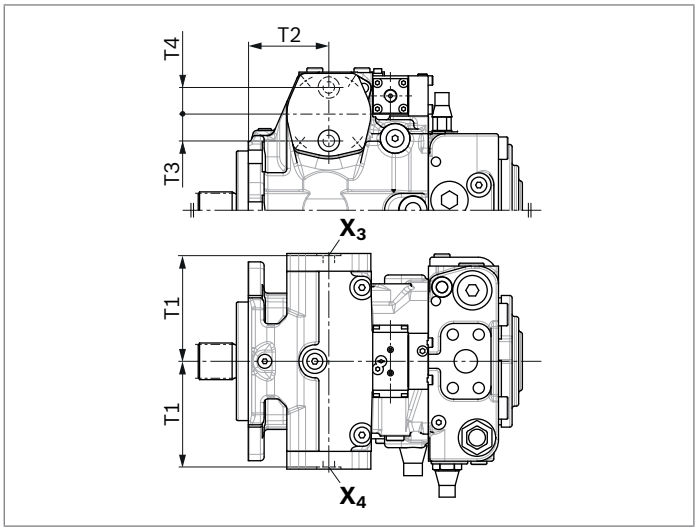
▼ **Circuit diagram**[1)]



1) Size 28 without port $\mathbf{F_{a1}}$ and $\mathbf{F_S}$

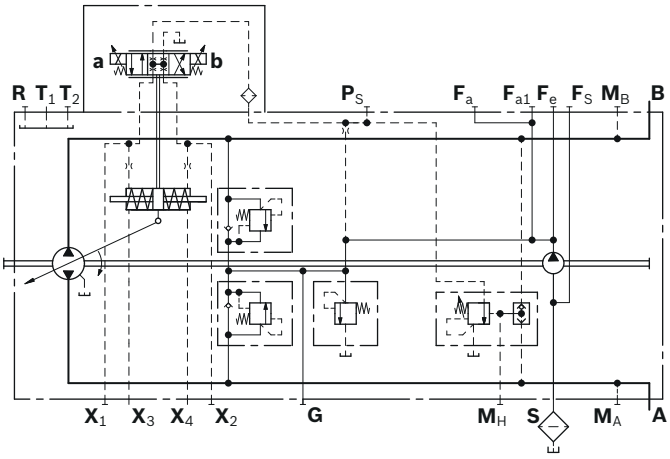
Stroking chamber pressure port X_3 and X_4

Dimensions



NG	T1	T2	T3	T4
28	92	40.1	–	24
40	92	38.1	–	24
56	104.5	44	–	25
71	113.5	86.3	28	–
90	111.5	95.7	–	30
125	136	104.5	34	–

▼ **Circuit diagram**[1)]



Ports		Standard[2)]	Size	p_{max} [bar][3)]	State[4)]
X_3, X_4	Stroking chamber pressure port	DIN 3852	M12 × 1.5; 12 deep	40	X

1) Size 28 without port F_{a1} and F_S
2) The countersink can be deeper than as specified in the standard.
3) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.
4) X = Plugged (in normal operation)

Filtration in the boost pump suction line

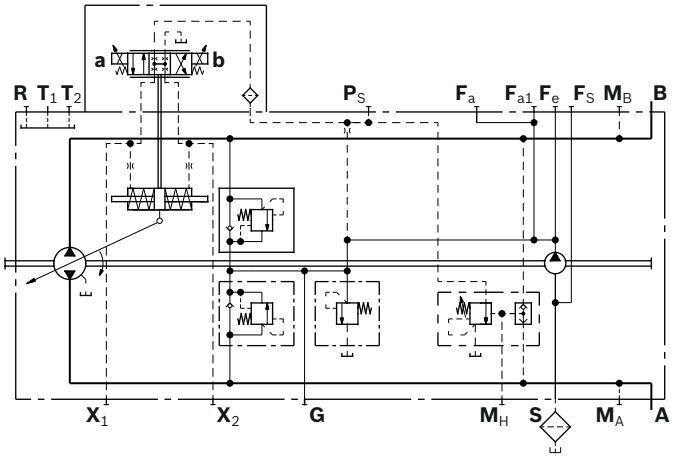
Version S

Filter version	**Suction filter without bypass**
Recommendation	With contamination indicator
Recommended flow resistance at filter element	
At ν = 30 mm²/s, $n = n_{max}$	$\Delta p \leq 0.1$ bar
At ν = 1000 mm²/s, $n = n_{max}$	$\Delta p \leq 0.3$ bar
Pressure at suction port S	
Continuous $p_{S\ min}$ ($\nu \leq 30$ mm²/s)	≥ 0.8 bar absolute
Short-term, at a cold start (t < 3 min)	≥ 0.5 bar absolute
Maximum pressure $p_{S\ max}$	≤ 5 bar absolute

Use of version S is preferred.

The suction filter is not included in the scope of delivery.

▼ **Circuit diagram**



Filtration in the boost pump pressure line

Version D

Ports for external boost circuit filtration

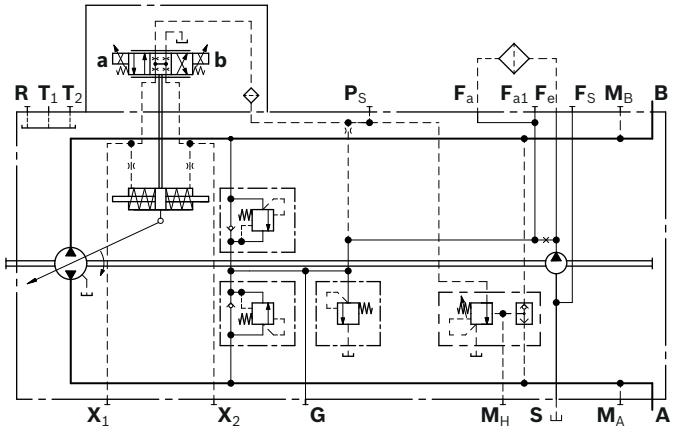
Ports	
Boost pressure inlet	Port $\mathbf{F_a}$
Boost pressure outlet	Port $\mathbf{F_e}$
Filter version	**Boost pressure filter without bypass**
Recommendation	With contamination indicator
Filter arrangement	**Separate in the pressure line (inline filter)**
Permissible flow resistance at filter element[1)]	
At ν = 30 mm²/s	$\Delta p \leq 1$ bar
For cold start	$\Delta p \leq 3$ bar

Notice

- Filters with a bypass **not recommended**, (exception DG, see below). Please contact us for applications with a bypass.
- On versions with DG control (with pilot pressure not from a boost circuit), a filter **with** a bypass and **with** a contamination indicator must be used.

The boost pressure filter is not included in the scope of delivery.

▼ **Circuit diagram**



1) Valid for entire speed range n_{min} to n_{max}

Version F[3)]

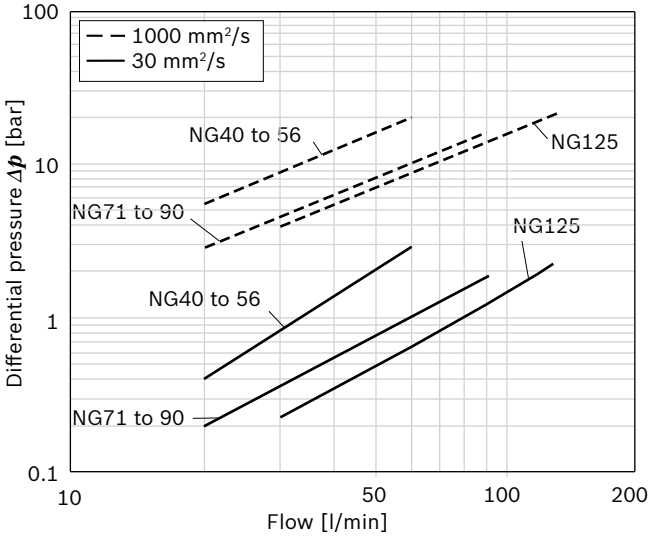
Attachment filter with cold start valve

Filter version	Attachment filter without bypass
Recommendation	Version with contamination indicator, see P, B (differential pressure Δp = 5 bar)
Filter grade (absolute)	20 µm
Filter material	Glass fiber
Pressure rating	100 bar
Filter arrangement	Mounted on pump

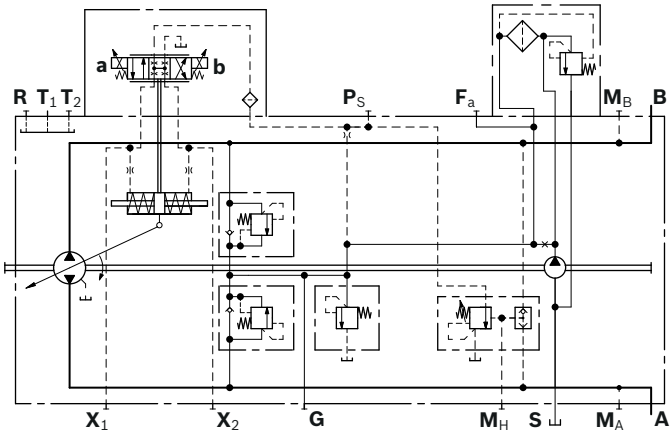
The attachment filter is equipped with a cold start valve and thereby protects the pump from damage. The valve opens at flow resistance of Δp ≥ 6 bar.

▼ **Filter characteristics**

Differential pressure/flow characteristics to ISO 3968 (valid for clean filter element).



▼ **Circuit diagram**



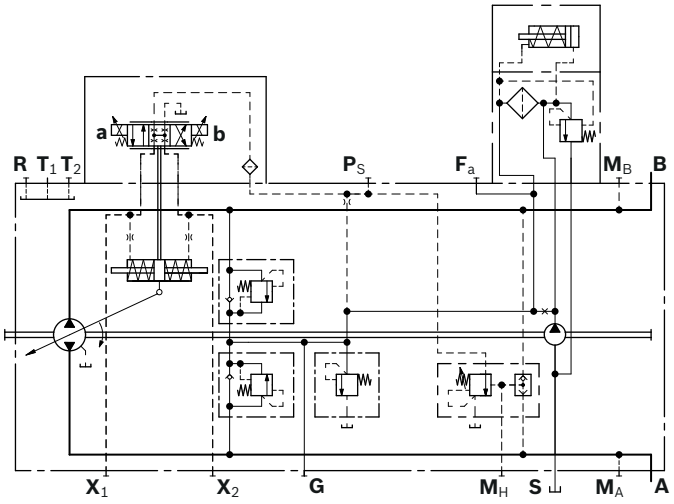
Version P[1)]

Attachment filter with cold start valve and visual contamination indicator

Filtration similar to version F, however with additional visual contamination indicator.

Technical data	
Display type	Green/red window
Differential pressure (switching pressure)	Δp = 5 bar

▼ **Circuit diagram**



1) Valid for entire speed range n_{min} – n_{max}

2) Thread according to DIN 3852;
The countersink may be deeper than specified in the standard.

3) To protect the filter element against electrostatic charge, the hydraulic fluid must have a minimum conductivity of 300 pS/m on versions with attachment filter F, P and B. Please contact us if this value cannot be observed.

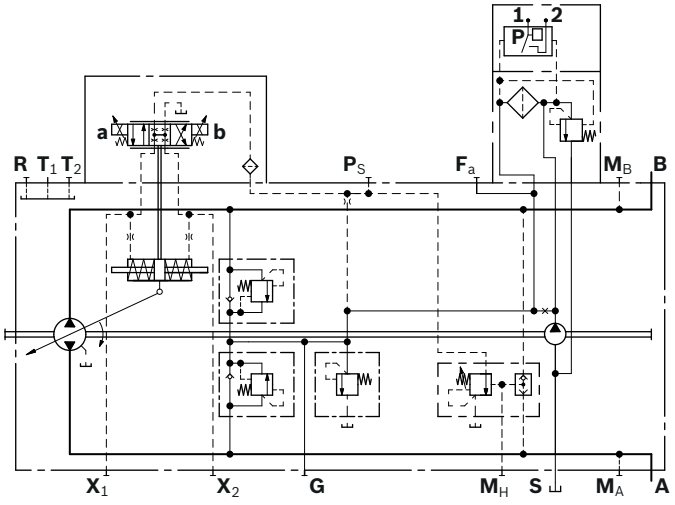
Version B[1)]

Attachment filter with cold start valve and electric contamination indicator

Filtration similar to version F, however with additional electric contamination indicator.

Technical data		
Display type	Electrical	
Connector version (mating connector, see page 64)	DEUTSCH DT04-2P-EP04	
Differential pressure (switching pressure)	Δp = 5 bar	
Maximum switching capacity	12 V DC	24 W
	24 V DC	48 W
Type of protection IP67	DIN EN 60529	

▼ **Circuit diagram**



External boost pressure supply

Version E

This variation should be used in versions without integrated boost pump (**N** and **K**).

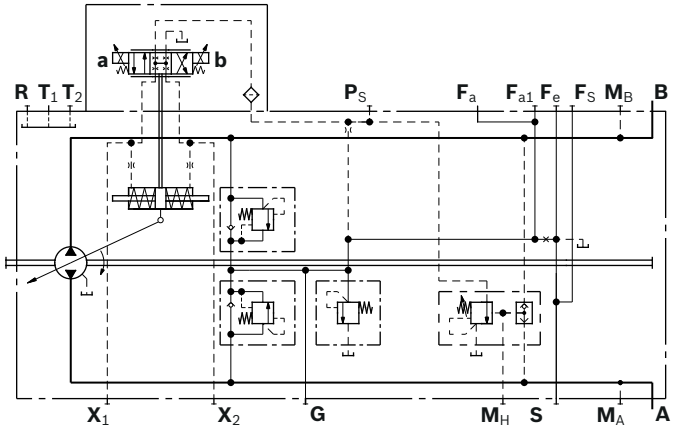
Port **S** is plugged.

The boost pressure supply comes from port $\mathbf{F_a}$.

The filter should be installed separately on port $\mathbf{F_a}$ before the boost pressure supply.

To ensure the functional reliability, maintain the required cleanliness level for the boost fluid fed in at port $\mathbf{F_a}$ (see page 6).

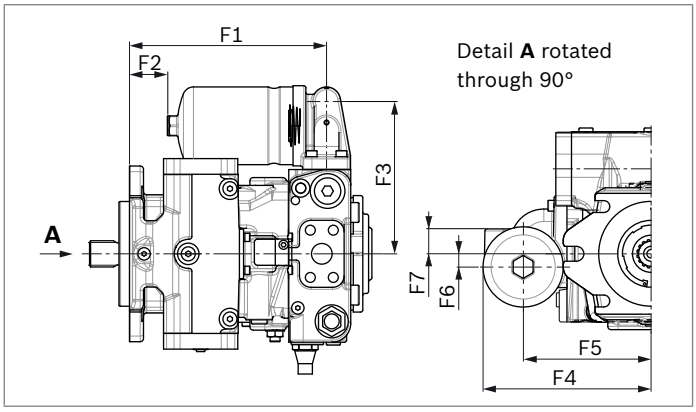
▼ **Circuit diagram**



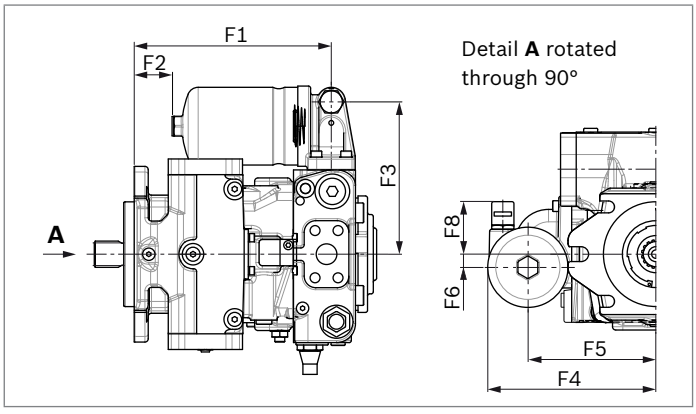
1) To protect the filter element against electrostatic charge buildup, the hydraulic fluid must have a minimum conductivity of 300 pS/m on versions with attachment filter F, P and B. Please contact us if this value cannot be observed.

Dimensions with filter fitted

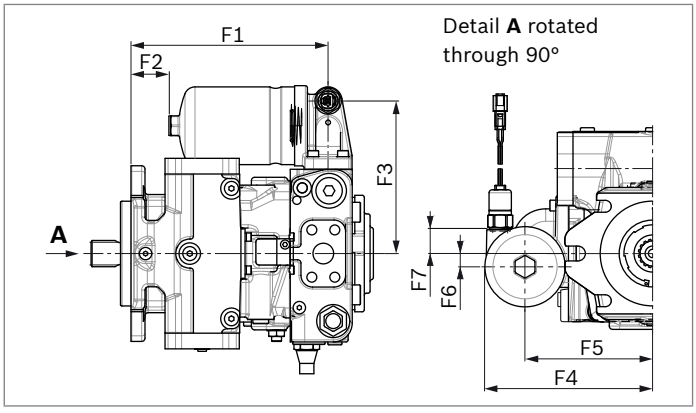
▼ **Version F**
Attachment filter with cold start valve



▼ **Version P**
Attachment filter with cold start valve and visual contamination indicator



▼ **Version B**
Attachment filter with cold start valve and electric contamination indicator



NG	F1	F2	F3	F4	F5	F6	F7	F8
40	201.7	47.7	160	175	135	0	42	78.5
56	218.4	64.4	163	178	138	0	42	78.5
71	239	46.5	185	203.5	155	16	29	65.5
90	248.5	56	179	197.5	149	0	45	81.5
125	235.9	59.4	201	219.5	171	0	53	89.5

Swivel angle sensor

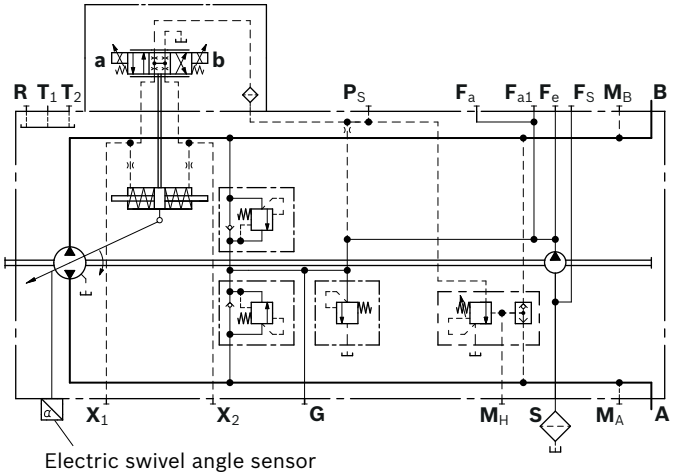
The swivel angle sensor is used to detect the swivel angle of axial piston units and thus the displacement using a Hall-effect based sensor IC. The determined measurement value is converted into an analog signal.
Please contact us if the swivel angle sensor is used for control.

Characteristics			
Supply voltage U_b	10 to 30 V DC		
Output voltage U_a	0.5 V ($V_{g\,max}$)	2.5 V ($V_{g\,0}$)	4.5 V ($V_{g\,max}$)
Reverse polarity protection	Short-circuit resistant		
EMC resistance	Details on request		
Operating temperature range	-40 °C to +115 °C		
Vibration resistance, sinusoidal vibration EN 60068-2-6	10 g / 5 to 2000 Hz		
Shock resistance: continuous shock IEC 68-2-29	25 g		
Salt spray resistance (DIN 50 021-SS)	96 h		
Type of protection with installed mating connector	IP67 – DIN/EN 60529 IP69K – DIN 40050-9		
Housing material	Plastic		
Connector version	AMP Super Seal 1.5		

Output voltage

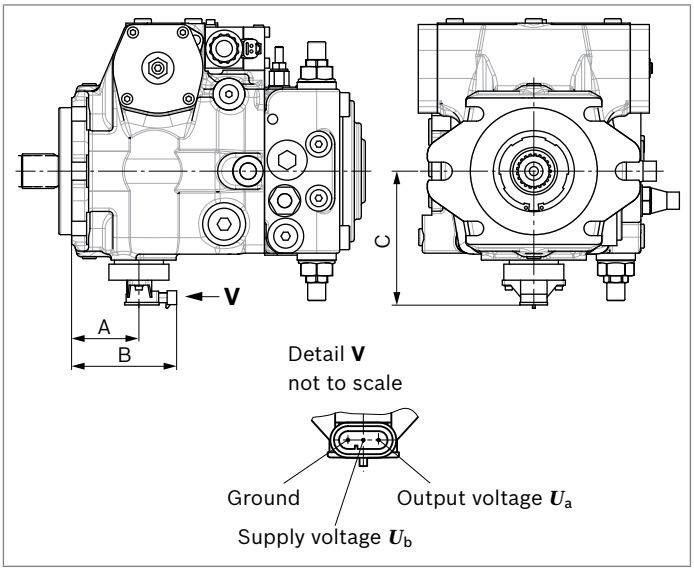
Direction of rotation	Flow direction	Working pressure	Output voltage at $V_{g\,0}$	Output voltage at $V_{g\,max}$
clockwise	**A** to **B**	M_B	2.5 V	4.5 V
	B to **A**	M_A	2.5 V	0.5 V
counter-clockwise	**B** to **A**	M_A	2.5 V	4.5 V
	A to **B**	M_B	2.5 V	0.5 V

▼ **Circuit diagram**



Electric swivel angle sensor

Dimensions



NG	A	B	C
28	56.6	94	119
40	58.6	96	119
56	60.5	97.5	128.5
71	71.6	108.6	137.5
90	70.7	107.7	145.5
125	78	115	152.5

Mating connector AMP Superseal 1.5; 3-pin

Consisting of	AMP No.
1 socket housing, 3-pin	282087-1
3 single-wire seals, yellow	281934-2
3 socket contacts 1.8 - 3.3 mm	183025-1

The mating connector is not included in the scope of delivery. This can be supplied by Bosch Rexroth on request (material number R902602132).

Notice
It is not possible to retrofit existing units with a swivel angle sensor.

Connector for solenoids

DEUTSCH DT04-2P-EP04

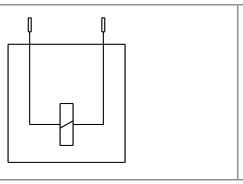
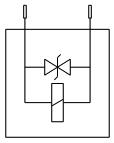
- **P**: Molded, 2-pin, without bidirectional suppressor diode (standard).
- **Q**: Molded, 2-pin, with bidirectional suppressor diode (only for switching solenoids on control module EZ and DA)

The following type of protection ensues with the installed mating connector:

- IP67 (DIN/EN 60529) and
- IP69K (DIN 40050-9)

The protection circuit with bidirectional suppressor diode is needed to limit overvoltages. Overvoltages are caused by switching off the current with switches, relay contacts or by disconnecting the mating connector while voltage is applied.

▼ **Switching symbol**

Without bidirectional suppressor diode	**With** bidirectional suppressor diode
	

▼ **Mating connector DEUTSCH DT06-2S-EP04**

Consisting of	DT designation
1 housing	DT06-2S-EP04
1 wedge	W2S
2 sockets	0462-201-16141

The mating connector is not included in the scope of delivery. This can be supplied by Bosch Rexroth on request (material number R902601804).

Notice

- If necessary, you can change the position of the connector by turning the solenoid.
- The procedure is defined in the instruction manual.

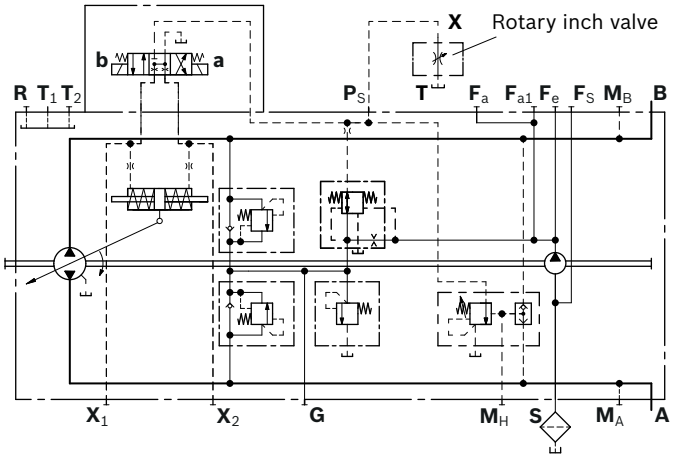
Rotary inch valve

Any reduction of the pilot pressure possible, independently of the drive speed, through mechanical actuation of the position lever. Maximum angle of rotation 90°, lever position: any.
The valve is arranged separately from the pump and is connected to the pump by a hydraulic control line via port $\mathbf{P}_S$ (maximum line length: approx. 2 m).
The rotary inch valve must be ordered separately.

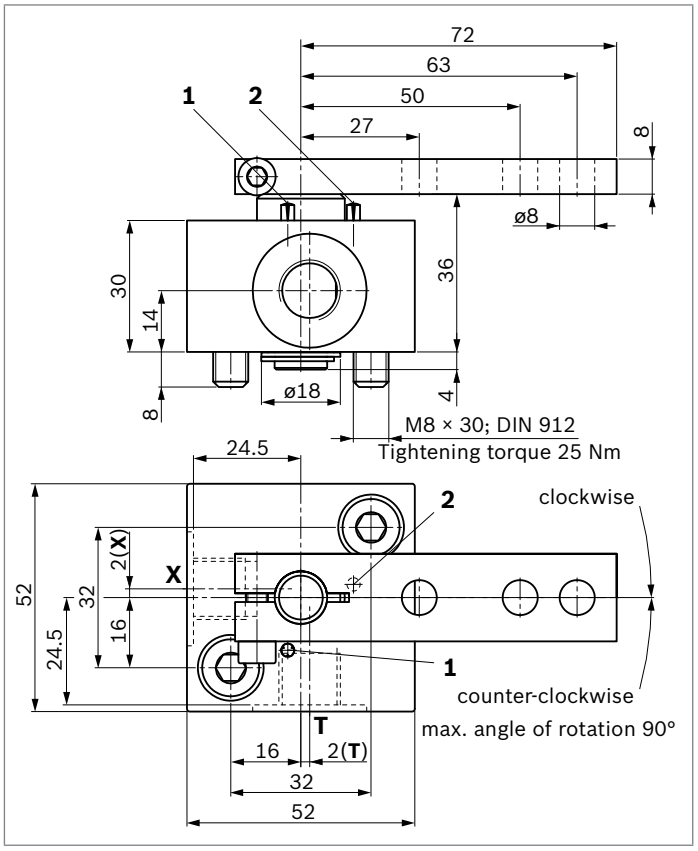
NG	Material number	Direction of actuation of the position lever	Throttle cross-section ⌀
28, 40, 56, 71, 90	R902048734	Clockwise	4.6
	R902048735	Counter-clockwise	4.6
	R902070172	Clockwise	2.7
	R902066994	Counter-clockwise	2.7
125	R902048740	Clockwise	4.7
	R902048741	Counter-clockwise	4.7

Notice
The rotary inch valve can be used regardless of the control module.

▼ **Circuit diagram:**
Hydraulic control, speed-related,
DA with separately attached rotary inch valve



Dimensions



Notice
Limitation **1** and **2** are function stops for inching. They are not to be used as a mechanical limitation within the system. We recommend limiting the angle of rotation to 85° within the system.

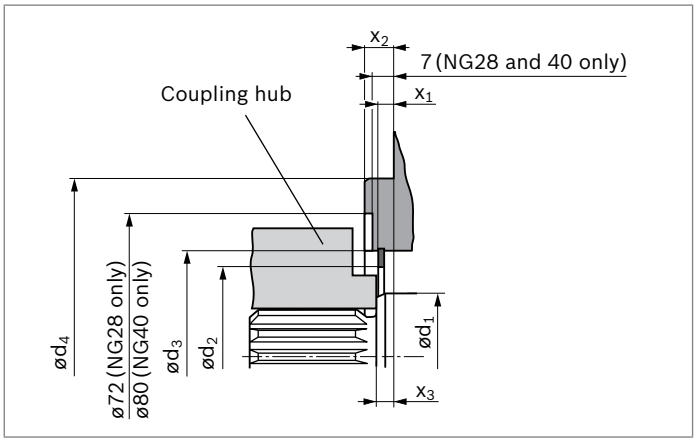
Ports		Standard[1)]	Size	p_{max} [bar][2)]	State[3)]
X	Pilot pressure port	DIN 3852	M14 x 1.5; 12 deep	40	O
T	Drain port	DIN 3852	M14 x 1.5; 12 deep	3	O

1) The countersink can be deeper than as specified in the standard.
2) Depending on the application, momentary pressure peaks can occur. Keep this in mind when selecting measuring devices and fittings.
3) O = Must be connected (plugged on delivery)

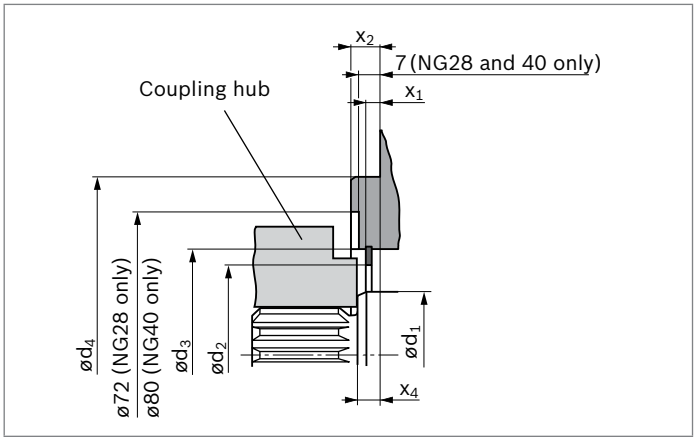
Installation dimensions for coupling assembly

To ensure that rotating components (coupling hub on drive shaft) and fixed components (housing, snap ring) do not come into contact with each other, the installation conditions described here must be observed. This depends on the pump size and the splined shaft.

SAE splined shaft (spline according to ANSI B92.1a)
Splined shaft **S** or **T**
The outer diameter of the coupling hub must be smaller than the inner diameter of the snap ring (dimension d_2) in the area near the drive shaft collar (dimension $x_2 - x_3$).
Observe diameter of relief on sizes 28 and 40.



DIN splined shaft (spline according to DIN 5480)
Splined shaft **Z** or **A**
The outer diameter of the coupling hub must be smaller than the case diameter d_3 in the area near the drive shaft collar (dimension $x_2 - x_4$).
Observe diameter of relief on sizes 28 and 40.



NG	ød$_1$	ød$_{2\ min}$	ød$_3$	ød$_4$	x$_1$	x$_2$	x$_3$	x$_4$
28	35	43.4	55±0.1	101.6	$3.3^{+0.2}$	$9.5_{-0.5}$	$8\ ^{+0.9}_{-0.6}$	$10\ ^{+0.9}_{-0.6}$
40	40	51.4	63±0.1	127	$4.3^{+0.2}$	$12.7_{-0.5}$	$8\ ^{+0.9}_{-0.6}$	$10\ ^{+0.9}_{-0.6}$
56	40	54.4	68±0.1	127	$7.0^{+0.2}$	$12.7_{-0.5}$	$8\ ^{+0.9}_{-0.6}$	$10\ ^{+0.9}_{-0.6}$
71	45	66.5	81±0.1	127	$7.0^{+0.2}$	$12.7_{-0.5}$	$8\ ^{+0.9}_{-0.6}$	$10\ ^{+0.9}_{-0.6}$
90	50	66.5	81±0.1	152.4	$6.8^{+0.2}$	$12.7_{-0.5}$	$8\ ^{+0.9}_{-0.6}$	$10\ ^{+0.9}_{-0.6}$
125	55	76.3	91±0.1	152.4	$7.0^{+0.2}$	$12.7_{-0.5}$	$8\ ^{+0.9}_{-0.6}$	$10\ ^{+0.9}_{-0.6}$

Installation instructions

General

The axial piston unit must be filled with hydraulic fluid and air bled during commissioning and operation. This must also be observed following a longer standstill as the axial piston unit may empty via the hydraulic lines.
Particularly in the installation position “drive shaft upwards”, filling and air bleeding must be carried out completely as there is, for example, a danger of dry running.
The leakage in the housing area must be directed to the reservoir via the highest drain port (**T_1**, **T_2**). For combination pumps, the leakage must be drained off at each pump. If a shared drain line is used for several units, make sure that the respective case pressure is not exceeded. The shared drain line must be dimensioned to ensure that the maximum permissible case pressure of all connected units is not exceeded in any operating conditions, specifically on cold start. If this is not possible, separate drain lines must be laid if necessary.
To achieve favorable noise values, decouple all connecting lines using elastic elements and avoid above-reservoir installation.
Under all operating conditions, the suction line and drain line must flow into the reservoir below the minimum fluid level. The permissible suction height h_S results from the overall loss of pressure. However, it must not be higher than $h_{S\ max}$ = 800 mm.
The suction pressure at port **S** must also not fall below the minimum value of 0.8 bar absolute during operation (cold start 0.5 bar absolute).

Installation position

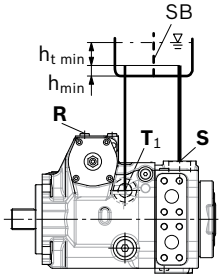
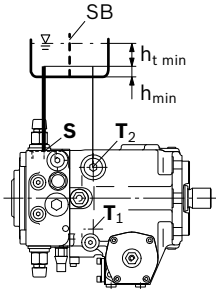
See the following examples 1 to 12.
Further installation positions are available upon request.
Recommended installation position: 1 and 2.

Notice

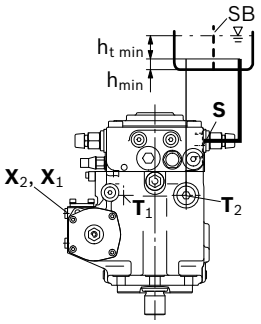
- Size 71 to 125
  For installation position “drive shaft upward”, an **R_1** port is needed (special version).
- If filling the stroking chambers via **X_1** to **X_4** is not possible in the final installation position, then this must take place before installation, e. g. in installation position 2.
- To prevent unexpected actuation and damage, the stroking chambers must be air bled via the ports **X_1**, **X_2**, or **X_3**, **X_4** depending on the installation position.
- In certain installation positions, an influence on the control characteristic can be expected. Gravity, dead weight and case pressure can cause minor shifts in control characteristic curves and changes in response time.

Below-reservoir installation (standard)

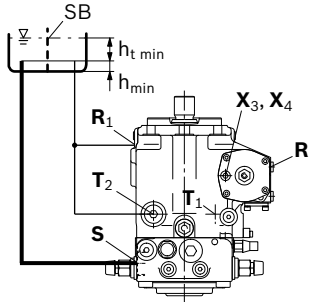
Below-reservoir installation means that the axial piston unit is installed outside of the reservoir and below the minimum fluid level of the reservoir.

Installation position	Air bleeding the housing	Air bleeding the stroking chamber	Filling
1	**R**	**X_1, X_2**	**S** + **T_1** + **X_1** + **X_2**
			
2	–	–	**S** + **T_2**
			

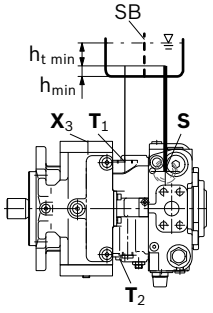
Installation position	Air bleeding the housing	Air bleeding the stroking chamber	Filling
3	–	**X_1, X_2**	**S** + **T_2** + **X_1** + **X_2**



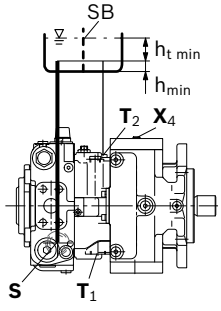
4	**R_1**	**X_3, X_4**	**S** + **T_2** + **X_3** + **X_4**



5	–	**X_3**	**S** + **T_1** + **X_3**



6	–	**X_4**	**S** + **T_2** + **X_4**

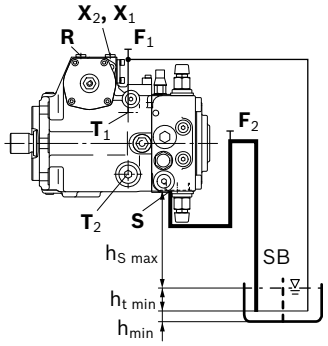


Above-reservoir installation

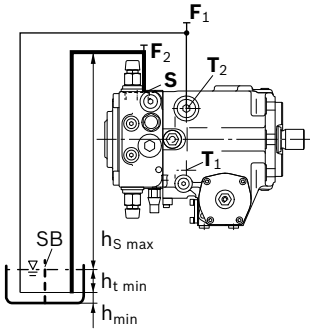
Above-reservoir installation means that the axial piston unit is installed above the minimum fluid level of the reservoir. Observe the maximum permissible suction height $h_{S\,max}$ = 800 mm.

Recommendation for installation position 10 (drive shaft upward): A check valve in the drain line (cracking pressure 0.5 bar) can prevent the housing area from draining.

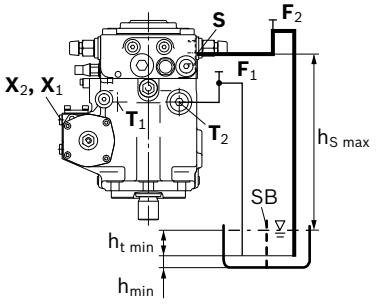
Installation position	Air bleeding the housing	Air bleeding the stroking chamber	Filling
7	**F_2** + **R**	**X_1, X_2**	**F_1** + **F_2** + **X_1** + **X_2**

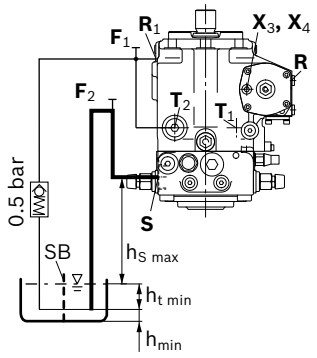
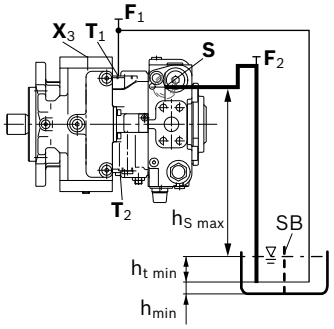
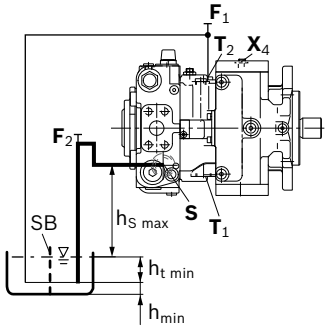


8	**F_2** (**S**) + **F_1** (**T_2**)	–	**F_2** (**S**) + **F_1** (**T_2**)



9	**F_2** (**S**) + **F_1** (**T_2**)	**X_1, X_2**	**F_2** (**S**) + **F_1** (**T_2**) + **X_1** + **X_2**



Installation position	Air bleeding the housing	Air bleeding the stroking chamber	Filling
10	F_2 + R_1	X_3, X_4	F_1 + F_2 + X_3 + X_4
			
11	F_2 (**S**) + F_1 (T_1)	X_3	F_2 (**S**) + F_1 (T_1) + X_3
			
12	F_2 (**S**) + F_1 (T_2)	X_4	F_2 (**S**) + F_1 (T_2) + X_4
			

Key	
F_1, F_2	Filling / air bleeding
R	Air bleed port
R_1	Air bleed port (special version)
S	Suction port
T_1, T_2	Drain port
X_1, X_2	Control pressure port
X_3, X_4	Stroking chamber pressure port
SB	Baffle (baffle plate)
$h_{t\ min}$	Minimum required immersion depth (200 mm)
h_{min}	Minimum required distance to reservoir bottom (100 mm)
$h_{S\ max}$	Maximum permissible suction height (800 mm)

Notice

Ports F_1 and F_2 are part of the external piping and must be provided on the customer side to make filling and air bleeding easier.

Project planning notes

- The pump A4VG is designed to be used in closed circuit.
- The project planning, installation and commissioning of the axial piston unit requires the involvement of qualified skilled personnel.
- Before using the axial piston unit, please read the corresponding instruction manual completely and thoroughly. If necessary, these can be requested from Bosch Rexroth.
- Before finalizing your design, please request a binding installation drawing.
- The specified data and notes contained herein must be observed.
- Depending on the operating conditions of the axial piston unit (working pressure, fluid temperature), the characteristic curve may shift.
- Preservation: Our axial piston units are supplied as standard with preservative protection for a maximum of 12 months. If longer preservative protection is required (maximum 24 months), please specify this in plain text when placing your order. The preservation periods apply under optimal storage conditions, details of which can be found in the data sheet 90312 or the instruction manual.
- Not all versions of the product are approved for use in a safety function according to ISO 13849. Please consult the responsible contact person at Bosch Rexroth if you require reliability parameters (e.g. $MTTF_d$) for functional safety.
- Depending on the type of control used, electromagnetic effects can be produced when using solenoids. When a direct current is applied, solenoids do not cause electromagnetic interference nor is their operation impaired by electromagnetic interference.
  Other behavior can result when a modulated direct current (e.g. PWM signal) is applied. Potential electromagnetic interference for persons (e.g. persons with a pacemaker) and other components must be tested by the machine manufacturer.
- The pressure cut-off is not a safeguard against pressure overload. Be sure to add a pressure relief valve to the hydraulic system.
- Please note the details regarding the tightening torques of port threads and other threaded joints in the instruction manual.
- Working ports:
  - The ports and fastening threads are designed for the specified maximum pressure. The machine or system manufacturer must ensure that the connecting elements and lines correspond to the specified application conditions (pressure, flow, hydraulic fluid, temperature) with the necessary safety factors.
  - The working ports and function ports are only intended to accommodate hydraulic lines.

Safety instructions

- During and shortly after operation, there is a risk of getting burnt on the axial piston unit and especially on the solenoids. Take appropriate safety measures (e.g. by wearing protective clothing).
- Moving parts in control equipment (e.g. valve spools) can, under certain circumstances get blocked in position as a result of contamination (e.g. impure hydraulic fluid, abrasion, or residual dirt from components). As a result, the hydraulic fluid flow and the build-up of torque in the axial piston unit can no longer respond correctly to the operator's specifications. Even the use of various filter elements (external or internal flow filter) will not rule out a fault but merely reduce the risk.
  The machine/system manufacturer must test whether remedial measures are needed on the machine for the application concerned in order to set the consumer being driven to a safe position (e.g. safe stop) and if necessary to ensure it is properly implemented.
- Moving parts in high-pressure relief valves may in certain circumstances become stuck in an undefined position due to contamination (e.g. impure hydraulic fluid). This can result in restriction or loss of the load holding function in lifting winches.
  The machine/system manufacturer must check whether additional measures are required on the machine for the relevant application in order to keep the load in a safe position and ensure they are properly implemented.

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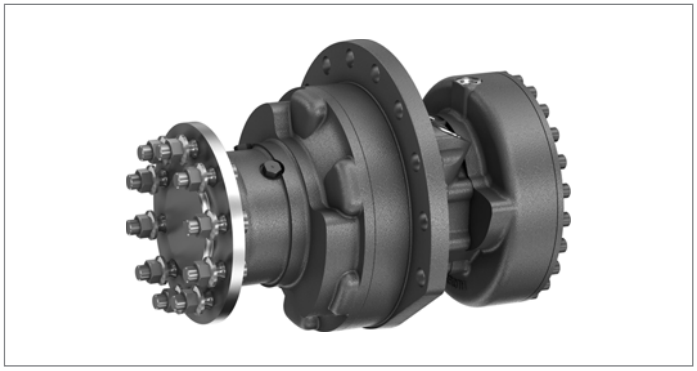
Radial piston motor for wheel drives
MCR-F

RE 15198
Edition: 02.2017
Replaces 07.2015



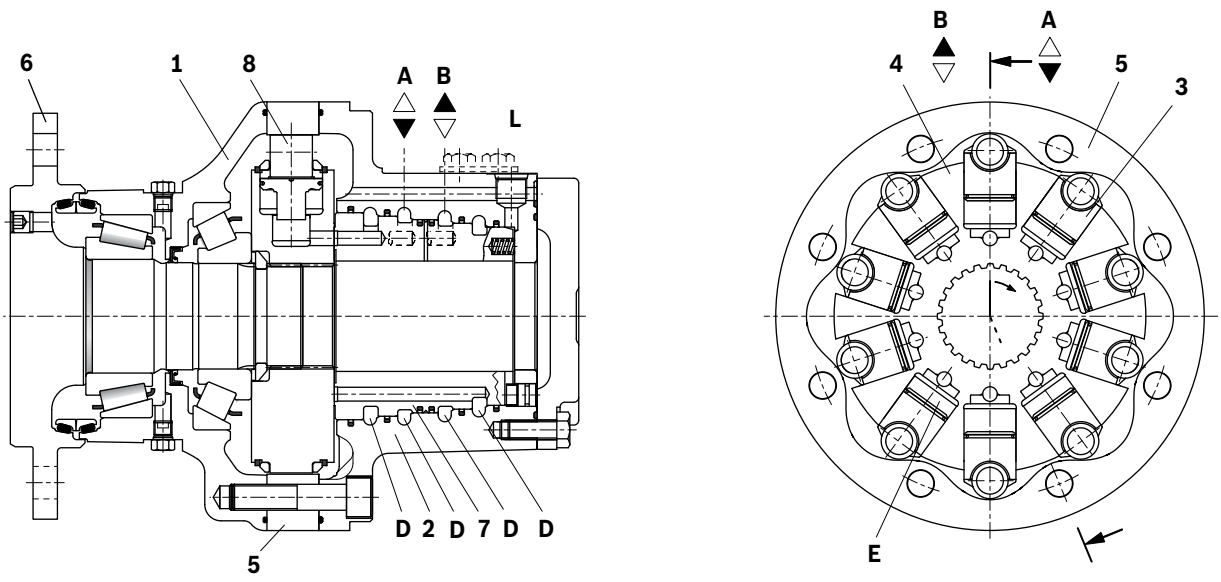
- Frame size MCR3, MCR5, MCR10, MCR15 (for frame size 20 see MCR20-C)
- Displacement 160 cc to 2150 cc
- Differential pressure up to 450 bar
- Torque output up to 13687 Nm
- Speed up to 875 rpm
- Open and closed circuits

Features

- Compact robust construction
- High volumetric and mechanical efficiencies
- Rear case mount
- Wheel flange with wheel studs
- High reliability
- Low maintenance
- Smooth running at very low speeds
- Low noise
- Bi-directional
- Sealed tapered roller bearings
- High radial forces permitted on drive shaft
- Freewheeling possible
- Available with:
  - Holding brake (multi-disc) or dynamic (drum) brake
  - Bi-directional two speed
  - Integrated flushing valve
  - Speed sensor

Contents

Functional description

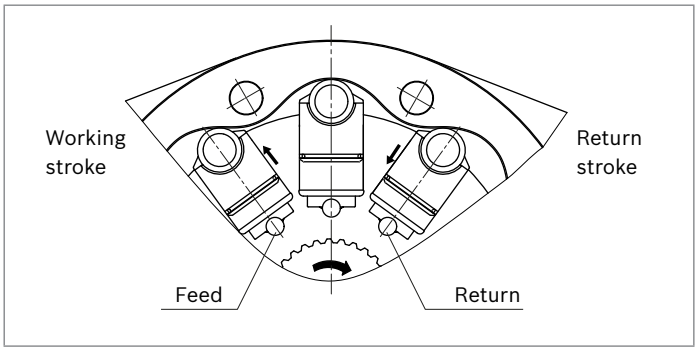


Hydraulic motors of the type MCR-F are radial piston motors with rear case mounting and flange shaft. The MCR-F motors are intended for wheel drives in open or closed circuits. These motors are used in a wide range of applications such as municipal vehicles, fork lift trucks, agricultural and forestry machines. The integrated flange with wheel studs allows easy installation of standard wheel rims.

Construction
Two part housing (**1**, **2**), rotary group (**3**, **4, 8**), cam (**5**), drive shaft (**6**) and flow distributor (**7**)

Transmission
The cylinder block (**4**) is connected to the shaft (**6**) by means of splines. The pistons (**3**) are arranged radially in the cylinder block (**4**) and make contact with the cam (**5**) via rollers (**8**).

Torque generation



The number of working and return strokes corresponds to the number of lobes on the cam multiplied by number of pistons in the cylinder block.

Flow paths
The ports **A** and **B**, which are located in the rear case, carry oil through the distributor to the cylinder chambers (**E**).

Bearings
Tapered roller bearings capable of transmitting high axial and radial forces are fitted as standard.

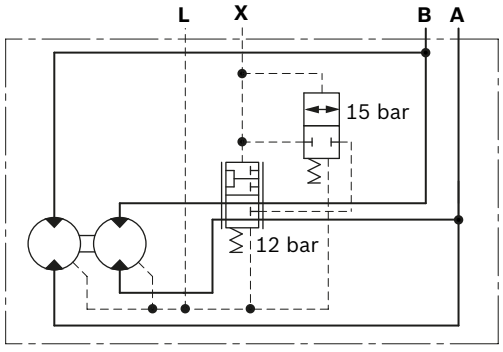
Freewheeling
In certain applications there may be a requirement to free-wheel the motor. This may be achieved by connecting ports **A** and **B** to zero pressure and simultaneously applying a pressure of 2 bar to the housing through port **L**. In this condition, the pistons are forced into the cylinder block which forces the rollers to lose contact with the cam thus allowing free rotation of the shaft.

Two speed operation (2W)

In mobile applications where vehicles are required to operate at high speed with low motor loads, the motor can be switched to a low-torque and high-speed mode. This is achieved by operating an integrated valve which directs hydraulic fluid to only one half of the motor while continuously re-circulating the fluid in the other half. This “reduced displacement” mode reduces the flow required for a given speed and gives the potential for cost and efficiency improvements. The motor maximum speed remains unchanged.

Bosch Rexroth has developed a special spool valve to allow smooth switching to reduced displacement whilst on the move. This is known as “soft-shift” and is a standard feature of 2W motors. The spool valve requires either an additional sequence valve or electro-proportional control to operate in “soft-shift” mode.

▼ **Schematic**

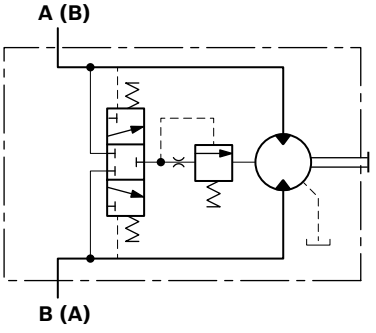


Flushing valve

In a closed circuit, the same hydraulic fluid continuously flows between the pump and the motor. This could therefore lead to overheating of the hydraulic fluid.

The function of the flushing valve option is to replace hydraulic fluid in the closed circuit with that from the reservoir. When the hydraulic motor is operated under load, either in the clockwise or anti-clockwise direction, the flushing valve opens and takes a fixed flow of fluid through an orifice from the low pressure side of the circuit. This flow is then fed to the motor housing and back to the reservoir normally via a cooler. In order to charge the low pressure side of the circuit, cool fluid is drawn from the reservoir by the boost pump and is fed to the pump inlet through the check valve. Thus the flushing valve ensures a continuous renewal and cooling of the hydraulic fluid. The flushing feature incorporates a relief valve which is used to maintain a minimum boost pressure and operates at a standard setting of 14 bar (other options available on request). Different orifice sizes may be used to select varying flows of flushing fluid. The following table gives flushing rate values based on a boost/charge pressure of 25 bar.

▼ **Schematic**



Flushing flow rates

Flushing code	Orifice size [mm]	Flow [l/min] at 25 bar[1)]	
		min	max
F1	Ø1	2.2	2.7
F2	Ø1.5	5.0	6.1
F7	Ø1.7	6.4	7.8
F4	Ø2	8.2	10.7
F6	Ø2.3	8.8	11.4

1) 0.6 mm Shim (Standard), Cracking pressure = 11±3 bar

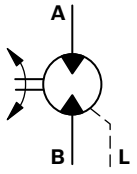
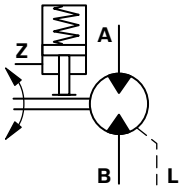
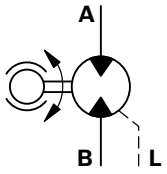
Holding brake (multi-disc brake)

Mounting
By way of rear housing (**2**) and brake shaft (**14**).

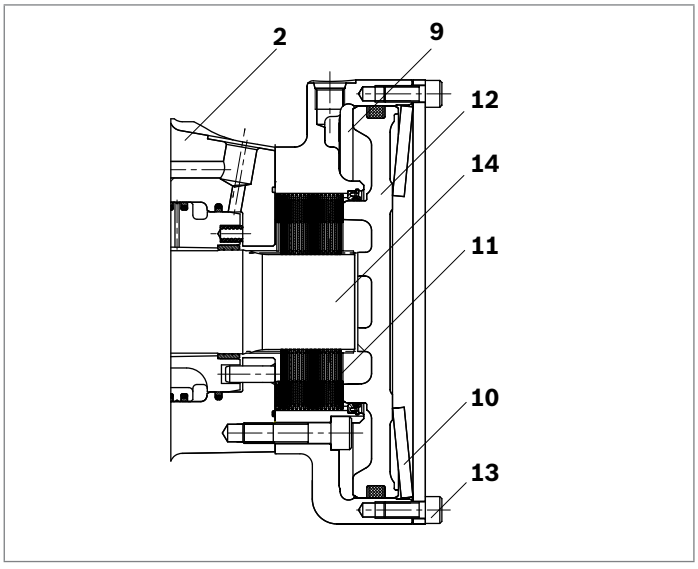
Brake application
As a safety requirement in mobile applications a parking brake may be provided to ensure that the motor cannot turn when the machine is not in use. The parking brake provides holding torque by means of discs (**11**) that are compressed by a disc spring (**10**). The brake is released when oil pressure is applied to brake port "**Z**" and the pressure in the annular area (**9**) compresses the disc spring using brake piston (**12**) thus allowing the brake discs (**11**) to turn independently.

Notice
Brakes not for dynamic use!

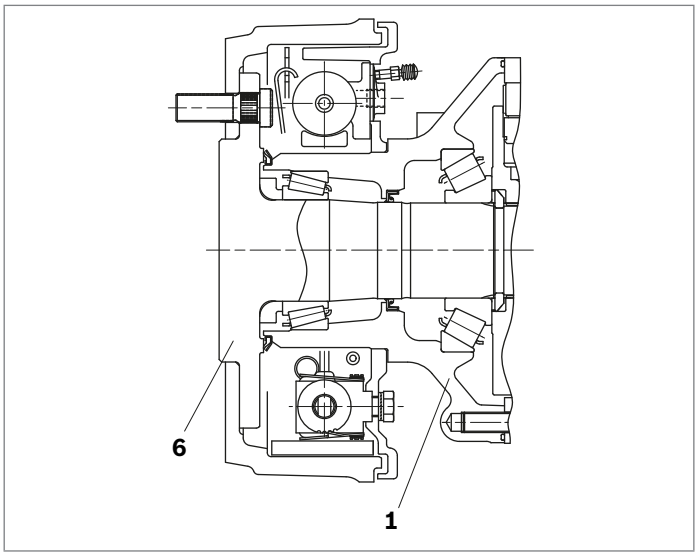
▼ **Schematic diagrams**

Motor without brake	Motor with holding brake	Motor with dynamic brake
		

Manual release of holding brake
The brake may also be released manually by loosening screws (**13**).



Dynamic brake
Where mechanical dynamic braking is required, a drum brake may be specified. The drum brake is mounted directly onto the drive shaft (**6**) and front housing (**1**). Braking torque is provided by brake shoes acting on the inside of the drum.
The drum brake can also provide mechanical park brake function by use of bowden cable.

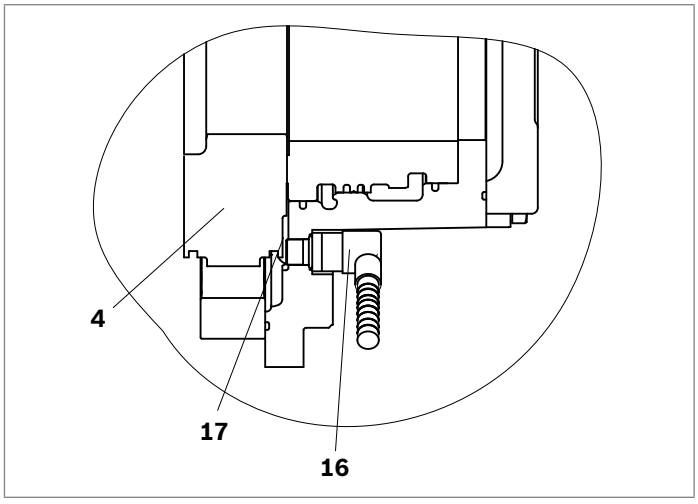


Speed sensor

A Hall-effect speed sensor (**16**) may be fitted as an option, giving a two-channel output of phase-displaced square waves, and enabling detection of speed and direction. A toothed target disc (**17**) is fitted to the motor cylinder block (**4**), and the sensor, fitted to a port in the rear case, produces a pulse on each channel as each tooth passes in front of it. The frequency of the pulses is proportional to the rotational speed.

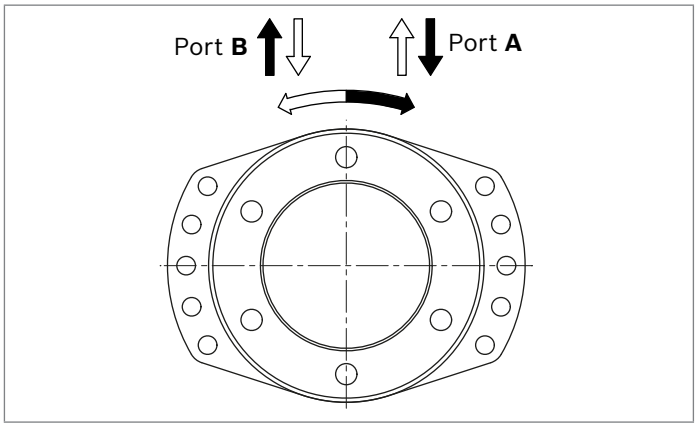
Versions are available for use with regulated supplies 10 V (Code P1) and for direct connection to a 12 V or 24 V unregulated supply (Code P2).

The motor can also be supplied fitted with a target disc and with a speed sensor port machined, but covered and sealed with a blanking plate (Code P0). These “sensor-ready” motors may be fitted with a sensor at a later date.



Direction of shaft rotation with flow

(viewed from drive shaft)



Ordering code

01	02	03	04	05	06		07	08	09	10	11	12	13	14	15	16
MCR		**F**			**Z**	**/**										

Radial piston motor

01	Radial-piston type, low-speed, high-torque motor	**MCR**

Frame size

02	Frame size	3	**3**
		5	**5**
		10	**10**
		15	**15**

Housing type

03	Rear case mounting flange	**F**

Nominal size, displacement V_g in cm³/rev

04	Frame size 3		**160**	**225**	**255**	**280**	**325**	**365**	**400**	
	Low displacement: motors use standard cylindrical pistons	LD	●	●	●	●	–	–	–	
	High displacement: motors use stepped pistons	HD	–	–	–	–	●	●	●	
	Frame size 5		**380**	**470**	**520**	**565**	**620**	**680**	**750**	**820**
	Low displacement: motors use standard cylindrical pistons	LD	●	●	●	●	–	–	–	–
	High displacement: motors use stepped pistons	HD	–	–	–	–	●	●	●	●
	Frame size 10		**780**	**860**	**940**	**1120**	**1250**	**1340**		
	Low displacement: motors use standard cylindrical pistons	LD	●	●	●	–	–	–		
	High displacement: motors use stepped pistons	HD	–	–	–	●	●	●		
	Frame size 15		**1130**	**1250**	**1500**	**1780**	**2150**			
	Low displacement: motors use standard cylindrical pistons	LD	●	●	●	–	–			
	High displacement: motors use stepped pistons	HD	–	–	–	●	●			

Drive shaft

		MCR3	**MCR5**	**MCR10**	**MCR15**	
05	With flange ø180 mm	●	●	–	–	**F180**
	With flange ø250 mm	–	●	●	–	**F250**
	With flange ø280 mm	–	–	–	●	**F280**

Rear shaft

06	Without rear shaft	**Z**

Series

07	Series 32	**32**
	Series 33	**33**

Brake

			MCR3	**MCR5**	**MCR10**	**MCR15**	
08	Without brake		●	●	●	●	**A0**
	Hydraulic release spring applied multi-disc holding brake	2200 Nm	●	●	–	–	**B2**
		4400 Nm	–	●	–	–	**B4**
		4400 Nm	–	–	●	–	**B5**
		7000 Nm	–	–	●	–	**B7**
		11000 Nm	–	–	–	●	**B11**
	Dynamic brake (drum-brake) with maximum torque	2900 Nm	●	–	–	–	**C2L/R**
		4000 Nm	–	●	–	–	**C4L/R**
		6400 Nm	–	–	●	–	**C7L/R**
		12000 Nm	–	–	–	●	**C12L/R**

● = Available – = Not available

01	02	03	04	05	06		07	08	09	10	11	12	13	14	15	16
MCR		**F**			**Z**	**/**										

Seals

09	NBR (nitrile rubber)	**M**
	FKM (fluoroelastomer / Viton)	**V**

Single/two-speed operation		**MCR3**	**MCR5**	**MCR10**	**MCR15**	
10	Single speed, standard direction of rotation	●	●	●	●	**1L**
	Bi-directional two speed, standard direction of rotation	●	●	●	–	**2WL**
	Switchable two speed, anti-clockwise direction of rotation	–	–	–	●	**2L**
	Switchable two speed, clockwise directon of rotation	–	–	–	●	**2R**

Ports		**MCR3**	**MCR5**	**MCR10**	**MCR15**	
11	Tapped with UNF thread (SAE J514)	●	●	–	–	**12**
	Tapped with UNF thread (SAE J514) (A and B ports SAE split flange metric bolt holes)	–	–	●	●	**42**

Studs

12	Without studs (no code)	
	With wheel studs and nuts	**S**
	With twice the normal number of wheel studs and nuts	**SS**

Speed sensor

13	Without sensor (no code)	
	Sensor ready	**P0**
	Sensor without regulator	**P1**
	Sensor with regulator	**P2**

Flushing

14	Without flushing (no code)	
	With flushing (see table on page 3)	**F1-F7**

Special order

15	Special feature	**SOXXX**

Other

16	Mark in text here	*

● = Available – = Not available

Technical data

Frame size			**MCR3**	**MCR5**	**MCR10**	**MCR15**				
Type of mounting			Flange mounting							
Pipe connections[1)2)]			Threaded per SAE J514; Flanged per SAE J518							
Shaft loading			see page 11							
Weight										
Single speed (1L)	m	kg	21	38	65	95				
Two speed (2WL, 2L and 2R)	m	kg	26	46	70	95				
Hydraulic fluid[3)]			Mineral oil type HLP/HLVP to DIN 51524							
Fluid cleaniness			ISO 4406, Class 20/18/15							
Fluid viscosity range	$v_{min/max}$	mm²/s	10 to 2000							
Fluid temperature range[4)]	$\theta_{min/max}$	°C	-20 to +85							
Pressure			Low displacement				High displacement			
Maximum differential pressure[5)6)]	Δp_{max}	bar	450				400			
Maximum pressure at port **A** or **B**[5)6)]	p_{max}	bar	470				420			
Maximum case drain pressure	$p_{case\ max}$	bar	10				10			
Motor performance MCR3										
Displacement	V_g	cm³/rev	160	225	255	280	325	365	400	
Specific torque		Nm/bar	3	4	4	4	5	6	6	
Maximum torque[5)]	T_{max}	Nm	1146	1611	1826	2005	2069	2324	2546	
Minimum speed for smooth running[7)]	n_{min}	rpm	0.5	0.5	0.5	0.5	0.5	0.5	0.5	
Maximum speed (1L)[8)9)]	n_{max}	rpm	670	475	420	385	330	295	270	
Maximum speed (2WL)[8)9)]	n_{max}	rpm	875	620	550	500	430	385	350	
Motor performance MCR5										
Displacement	V_g	cm³/rev	380	470	520	565	620	680	750	820
Specific torque		Nm/bar	6	7	8	9	10	11	12	13
Maximum torque[5)]	T_{max}	Nm	2722	3366	3724	4047	3947	4329	4775	5220
Minimum speed for smooth running[7)]	n_{min}	rpm	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Maximum speed (1L)[8)9)]	n_{max}	rpm	475	385	350	320	290	265	240	220
Maximum speed (2WL)[8)9)]	n_{max}	rpm	570	465	420	385	350	320	290	265
Motor performance MCR10										
Displacement	V_g	cm³/rev	780	860	940		1120	1250	1340	
Specific torque		Nm/bar	12	14	15		18	20	21	
Maximum torque[5)]	T_{max}	Nm	5586	6159	6732		7130	7958	8531	
Minimum speed for smooth running[7)]	n_{min}	rpm	0.5	0.5	0.5		0.5	0.5	0.5	
Maximum speed (1L and 2WL)[8)9)]	n_{max}	rpm	215	195	178		150	135	125	
Motor performance MCR15										
Displacement	V_g	cm³/rev	1130	1250	1500		1780	2150		
Specific torque		Nm/bar	18	20	24		28	34		
Maximum torque[5)]	T_{max}	Nm	8093	8952	10743		11332	13687		
Minimum speed for smooth running[7)]	n_{min}	rpm	0.5	0.5	0.5		0.5	0.5		
Maximum speed (1L, 2L and 2R)[8)9)]	n_{max}	rpm	145	130	110		90	75		

			MCR3		MCR5		MCR10		MCR15	
Holding brake (disc brake)			**B2**		**B2**	**B4**	**B5**	**B7**	**B11**	
Minimum holding torque	$t_{min/max}$	Nm	2200		2200	4400	4400	7000	11000	
Release pressure (min)	$p_{rel\ min}$	bar	11		11	11	11	11	12	
Release pressure (max)	$p_{rel\ max}$	bar	15		15	15	15	15	15	
Maximum pressure at brake port „**Z**“	p_{max}	bar	40		40	40	30	30	30	
Oil volume to operate brake	V_{rel}	cm^3	23		23	46	17	36	77	
			MCR3		**MCR5**		**MCR10**		**MCR15**	
Dynamic brake			**C2L/R**		**C4L/R**		**C7L/R**		**C12L/R**	
Braking torque	$t_{min/max}$	Nm	2000	2900	3000	4000	4700	6400	9000	12000
Brake cable tension		N	1000	1440	1270	1661	1755	2400	2580	3460
Brake port pressure	p_{max}	bar	82	117	73	97	89	120	84	112
Brake cylinder operating volume	V	cm^3	7	7	9	9	13	13	24.91	24.91

Notice

- Motor performance values are based on theoretical calculations.
- Efficiencies are not taken into consideration for theoretical calculations.
- Brake torque accounts for tolerances. Values are based when used with standard mineral oil (HLP).
- For MCR20 frame size, please refer MCR-C data sheet (15197).

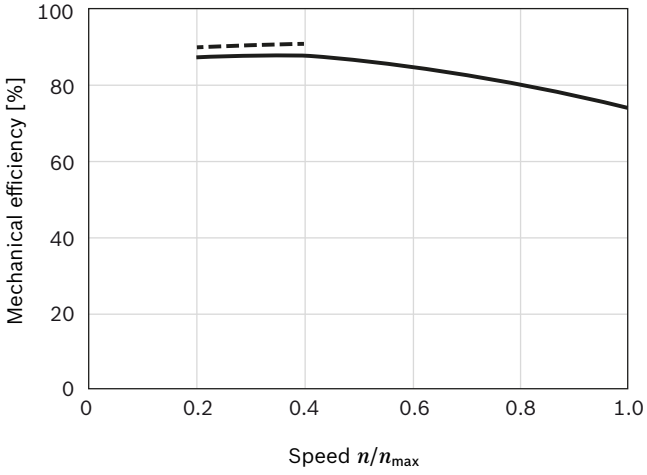
Please refer the related foot notes for more details.

Footer from page 8 and 9

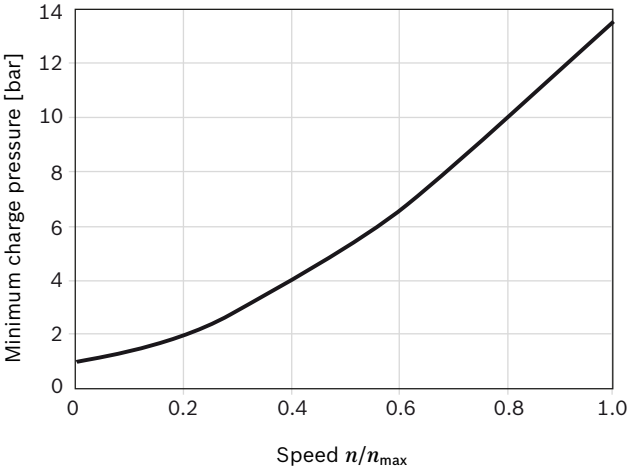
1) Ensure motor case is filled with oil prior to start-up. See instruction manual 15215-B.
2) For installation and maintenance details, please see instruction manual 15215-B.
3) For any other fluid type contact the Engineering Department at Bosch Rexroth, Glenrothes. For more information on hydraulic fluids, see datasheets 90220 and 90223.
4) Extension of the allowable temperature range may be possible depending on specification. Please consult Bosch Rexroth Engineering Department in Glenrothes for further details.
5) Maximum values should only be applied for a small portion of the duty cycle. Please consult Bosch Rexroth Engineering. Department in Glenrothes for motor life calculations based on particular operating cases.
6) When operating motors in series, please consult Bosch Rexroth Engineering Department in Glenrothes.
7) For continuous operation at speeds <5 rpm please consult Bosch Rexroth Engineering Department in Glenrothes.
8) Based on nominal no-load Δp of 20 bar in full-displacement mode.
9) Warning! During the running in period of the motor (min. 20 hrs) it should not be run unloaded at >100 rpm.

Efficiencies

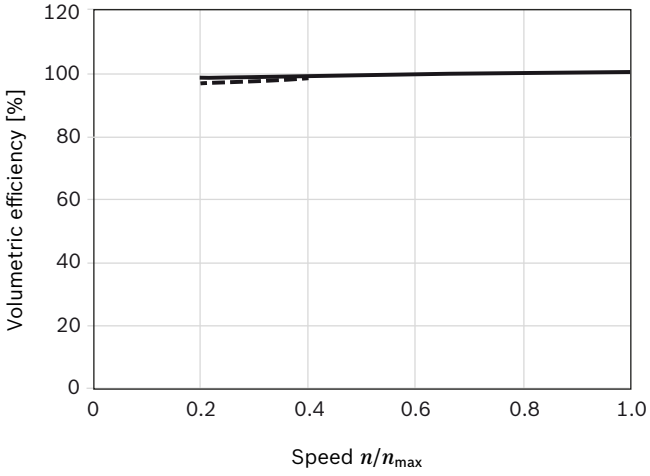
▼ **Mechanical efficiency**



▼ **Charge pressure**



▼ **Volumetric efficiency**



100 bar / 1450 psi
300 bar / 4350 psi

Notice

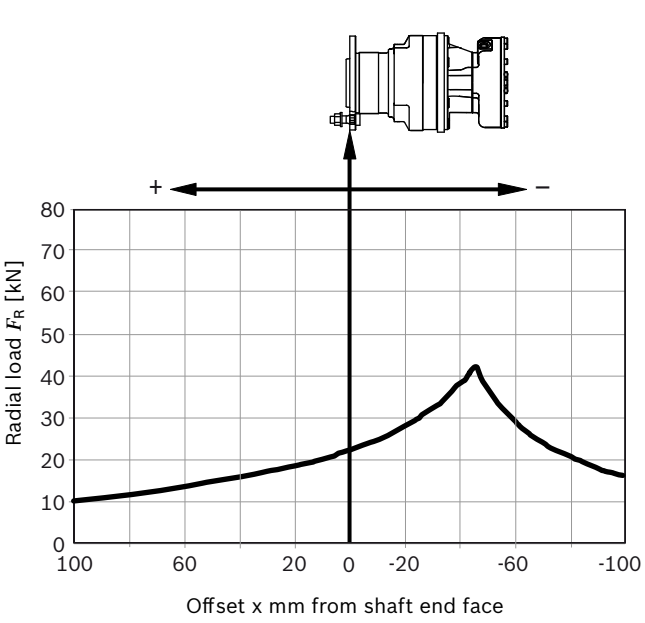
For specific performance information or operating conditions contact the Engineering Department at Bosch Rexroth, Glenrothes.

Permitted loading on drive shaft

(Speed n = 50 rpm, pressure differential Δp = 250 bar, 2000 hrs L10 life at 50 °C)

Drive shaft ...3F F180...

Maximum radial load $F_{R\,max}$ (with axial load F_{ax} = 0)



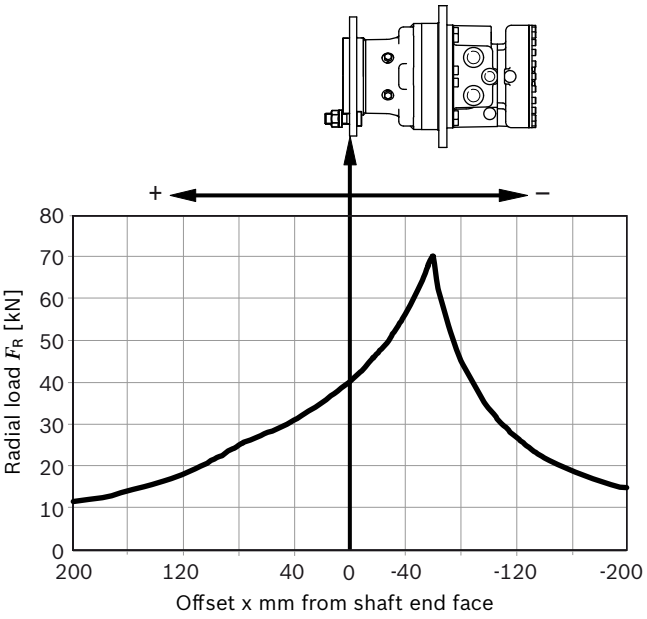
Maximum axial load $F_{ax\,max}$ (with radial load F_R = 0):

$F_{ax\,max}$ = 18300 N ← +

$F_{ax\,max}$ = 28000 N → –

Drive shaft ...5F F250...

Maximum radial load $F_{R\,max}$ (with axial load F_{ax} = 0)



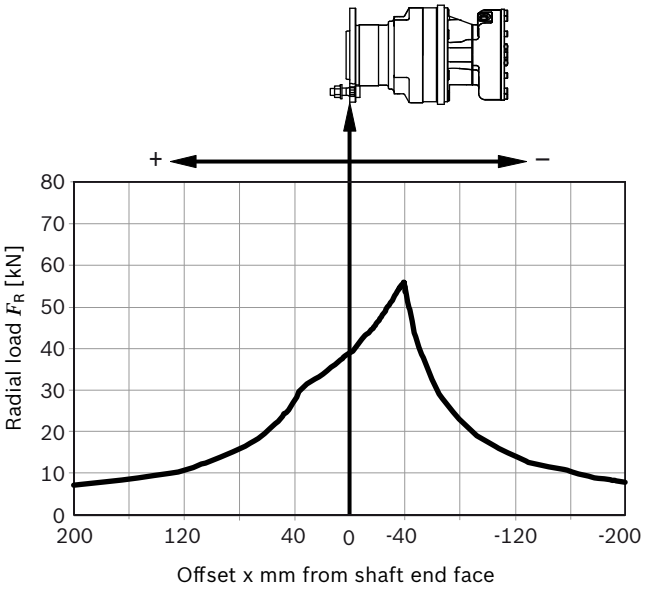
Maximum axial load $F_{ax\,max}$ (with radial load F_R = 0):

$F_{ax\,max}$ = 37500 N ← +

$F_{ax\,max}$ = 36800 N → –

Drive shaft ...5F F180...

Maximum radial load $F_{R\,max}$ (with axial load F_{ax} = 0)



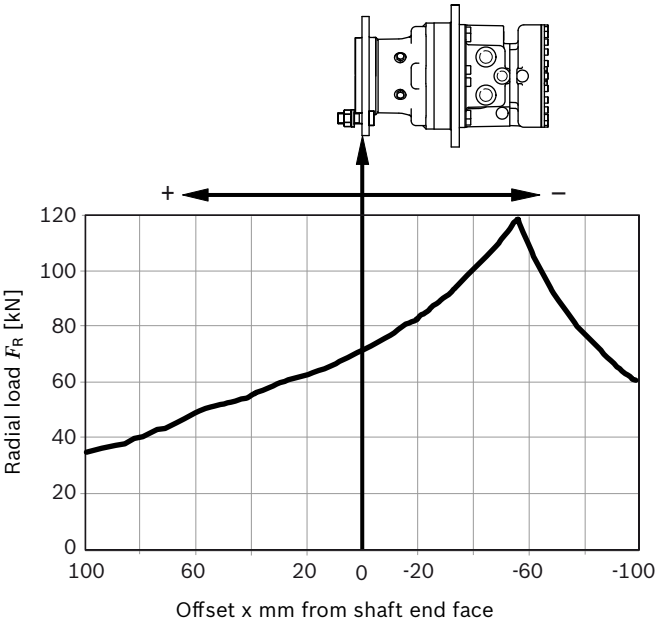
Maximum axial load $F_{ax\,max}$ (with radial load F_R = 0):

$F_{ax\,max}$ = 37500 N ← +

$F_{ax\,max}$ = 36800 N → –

Drive shaft ...10F F250...

Maximum radial load $F_{R\,max}$ (with axial load F_{ax} = 0)



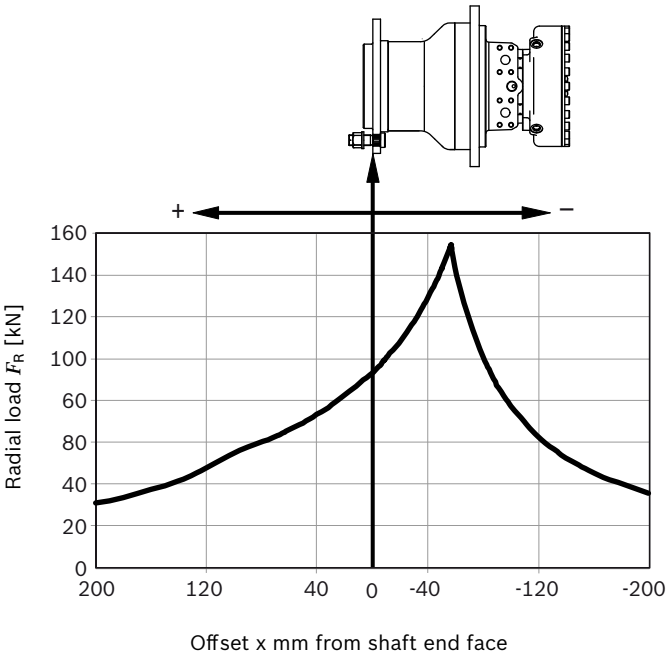
Maximum axial load $F_{ax\,max}$ (with radial load F_R = 0):

$F_{ax\,max}$ = 76100 N ← +

$F_{ax\,max}$ = 67400 N → –

Drive shaft ...15F F280...

Maximum radial load $F_{R\,max}$ (with axial load F_{ax} = 0)



Maximum axial load $F_{ax\,max}$ (with radial load F_R = 0):

$F_{ax\,max}$ = 95400 N ← +

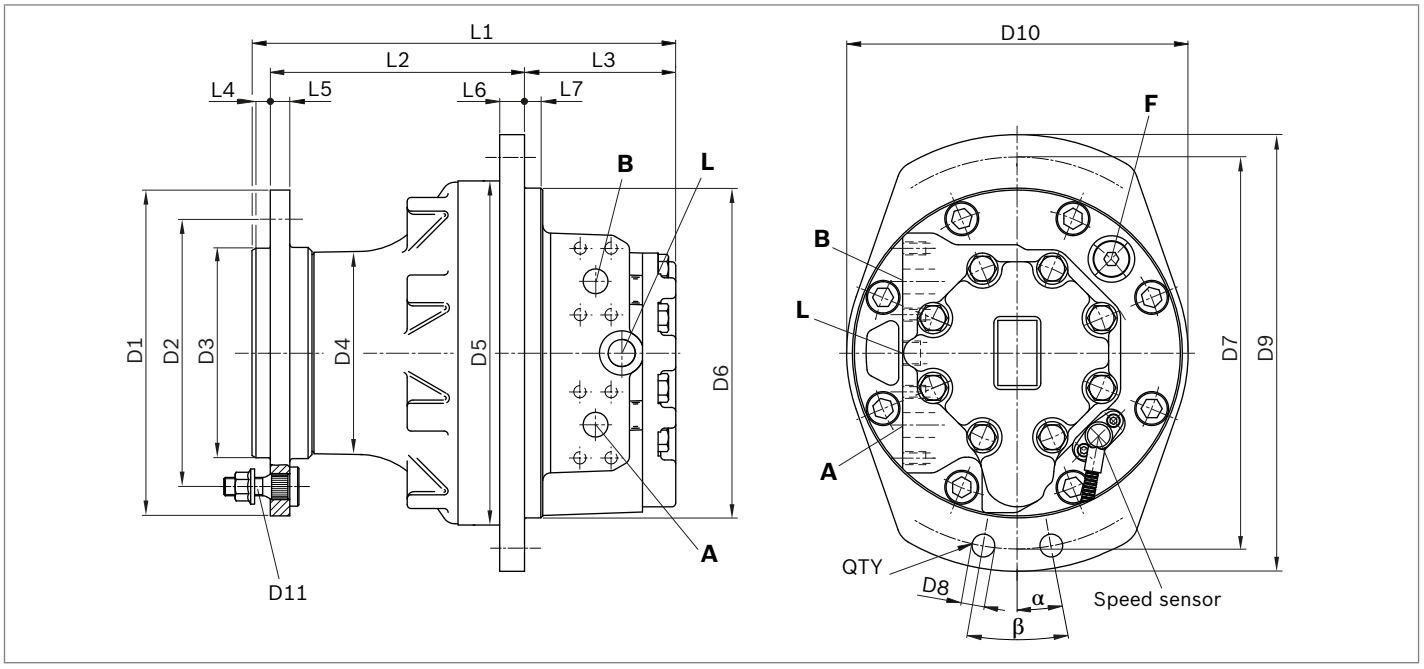
$F_{ax\,max}$ = 88700 N → –

Notice

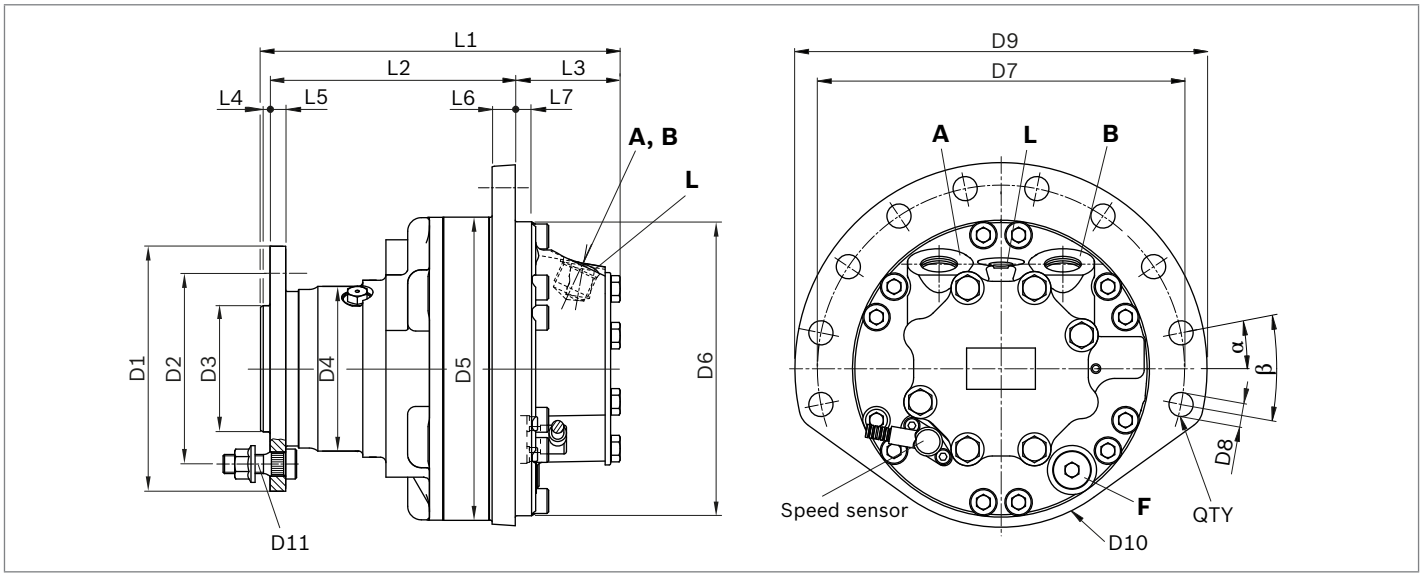
- These values and graphs are for initial guidance only
- For actual motor life calculations under typical or specified duty cycles, contact the Engineering Department at Bosch Rexroth, Glenrothes.
- For drum braked motors, the permitted loading varies depending on the offset.

Dimensions

MCR3F, MCR10F and MCR15F single speed (1L)



MCR5F single speed (1L)



Motor	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
MCR3	ø172.5	ø140	ø92.8	–	ø180	ø180	ø210	ø14	ø237	ø190	5×M14×1.5
MCR5	ø180	ø140	ø92.7	ø116.5	ø223	ø215.95	ø267	ø17.4	ø298	ø228	8×M20×1.5
MCR10	ø250	ø205	ø160	ø162	ø264	ø253	ø300	ø17.5	ø335	ø264	10×M22×1.5
MCR15	ø280	ø225	ø175.8	ø190	ø304	ø285	ø335	ø17.4	ø375	–	10×M22×1.5

Motor	L1	L2	L3	L4	L5	L6	L7	α	β	QTY
MCR3	217.5	143.5	67	6	12	13	6	0°	15°	10
MCR5	264.1	180	77	5	11.5	17	12	11.25°	22.5°	10
MCR10	325	195	116	14	15	19	12.5	0°	15°	10
MCR15	334.4	219.4	98.9	15	16	36.5	9	10°	20°	8

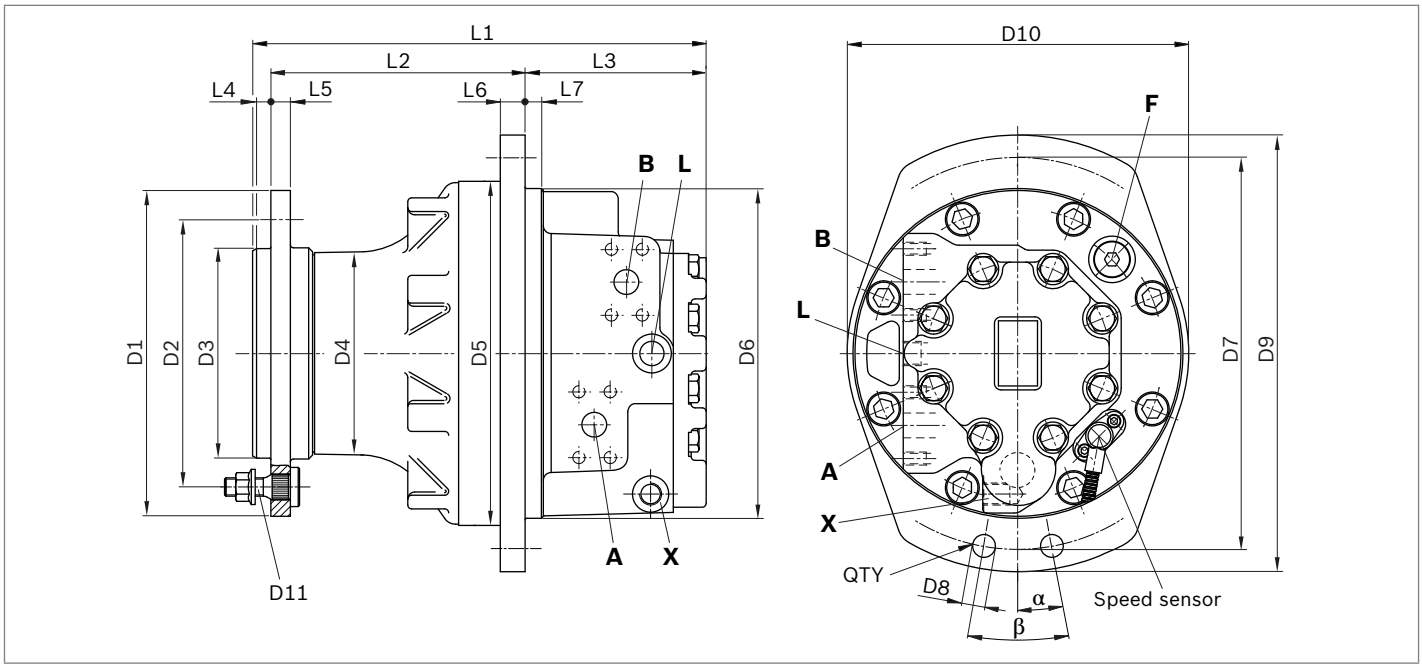
Before finalizing your design, request a binding installation drawing.

Ports

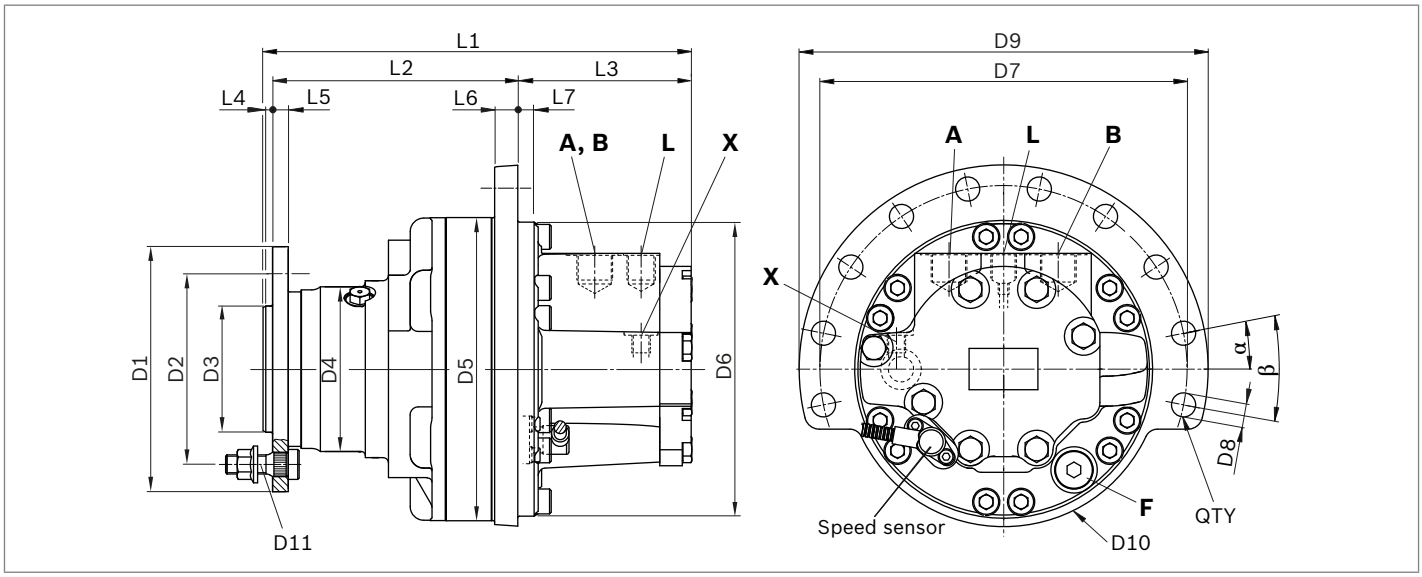
Motor	Designation	Port function	Code	Size	p_{max} [bar]	State[2)]
MCR3	**A, B**	Inlet, outlet	SAE J514	7/8-14 UNF	470/420[1)]	O
	L	Case drain	SAE J514	9/16-18 UNF	10	O
	F	Filler port	SAE J514	3/4-16 UNF	10	X
MCR5	**A, B**	Inlet, outlet	SAE J514	1 1/16-12 UNF	470/420[1)]	O
	L	Case drain	SAE J514	3/4-16 UNF	10	O
	F	Filler port	SAE J514	3/4-16 UNF	10	X
MCR10	**A, B**	Inlet, outlet	SAE J518[3)]	3/4 in	470/420[1)]	O
	L	Case drain	SAE J514	3/4-16 UNF	10	O
	F	Filler port	SAE J514	3/4-16 UNF	10	X
MCR15	**A, B**	Inlet, outlet	SAE J518[3)]	3/4 in	470/420[1)]	O
	L	Case drain	SAE J514	3/4-16 UNF	10	O
	F	Filler port	SAE J514	3/4-16 UNF	10	X

1) Depends on nominal size
2) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)
3) Dimensions according to SAE J518 (Code 62 - high pressure series)

MCR3F, MCR10F and MCR15F two speed (2WL, 2L and 2R)



MCR5F two speed (2WL, 2L and 2R)



Motor	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11
MCR3	ø172	ø140	ø92.7	–	ø180	ø180	ø210	ø14	ø237	ø190	5×M14×1.5
MCR5	ø180	ø140	ø92.7	ø116.5	ø223	ø215.96	ø267	ø17.4	ø298	ø228	10×M18×1.5
MCR10	ø250	ø205	ø160	ø162	ø264	ø253	ø300	ø17.5	ø330	ø262	8×M20×1.5
MCR15	ø280	ø225	ø175.8	ø190	ø304	ø285	ø335	ø22.4	ø375	–	10×M22×1.5

Motor	L1	L2	L3	L4	L5	L6	L7	α	β	QTY
MCR3	274.1	143.6	123.5	6	12	13	6	0°	15°	10
MCR5	313.8	180	126.7	7	11.5	17	12	11.25°	22.5°	10
MCR10	350	195	141	14	15	19	12.5	0°	15°	10
MCR15	334.4	219.5	98.9	14	16	36.5	9	10°	20°	8

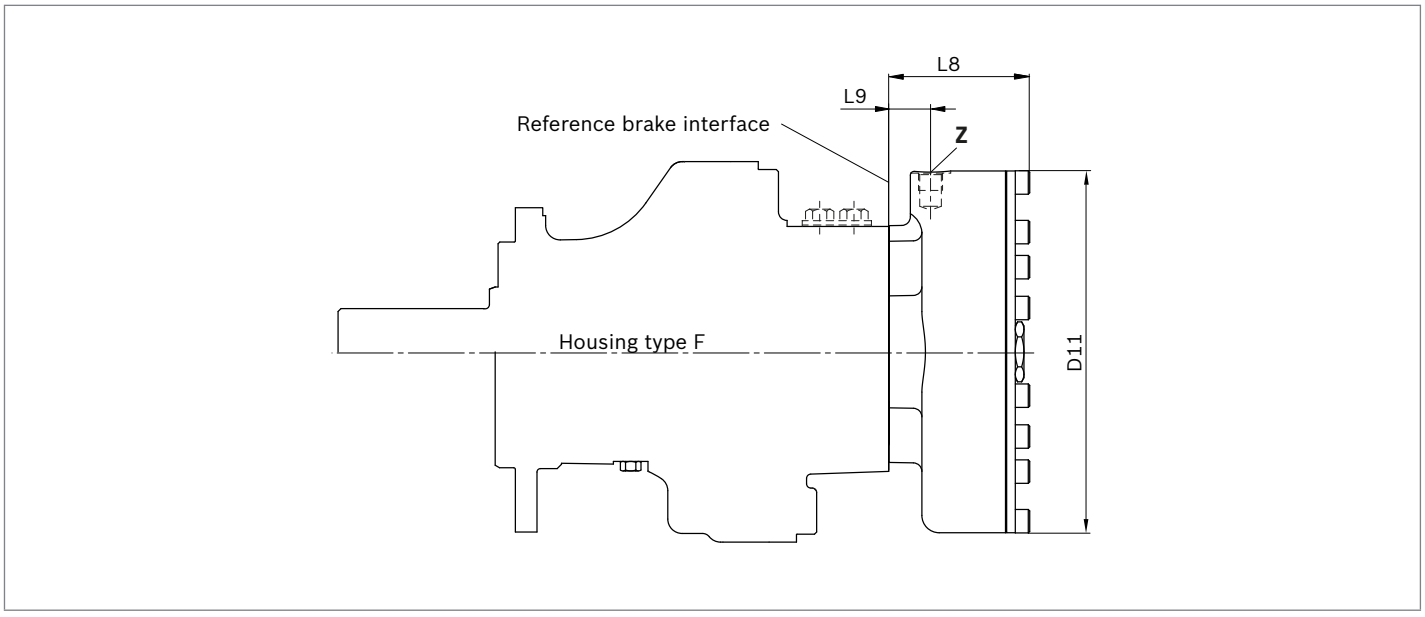
Before finalizing your design, request a binding installation drawing.

Ports

Motor	Designation	Port function	Code	Size	p_{max} [bar]	State[2)]
MCR3	**A, B**	Inlet, outlet	SAE J514	1 1/16-12 UNF	470/420[1)]	O
	L	Case drain	SAE J514	9/16-18 UNF	10	O
	F	Filler port	SAE J514	3/4-16 UNF	10	X
	X	2 speed port	SAE J514	9/16-18 UNF	35	O
MCR5	**A, B**	Inlet, outlet	SAE J514	1 1/16-12 UNF	470/420[1)]	O
	L	Case drain	SAE J514	3/4-16 UNF	10	O
	F	Filler port	SAE J514	3/4-16 UNF	10	X
	X	2 speed port	SAE J514	9/16-18 UNF	35	O
MCR10	**A, B**	Inlet, outlet	SAE J518[3)]	3/4 in	470/420[1)]	O
	L	Case drain	SAE J514	3/4-16 UNF	10	O
	F	Filler port	SAE J514	3/4-16 UNF	10	X
	X	2 speed port	SAE J514	9/16-18 UNF	35	O
MCR15	**A, B**	Inlet, outlet	SAE J518[3)]	3/4 in	470/420[1)]	O
	L	Case drain	SAE J514	3/4-16 UNF	10	O
	F	Filler port	SAE J514	3/4-16 UNF	10	X
	X	2 speed port	SAE J514	9/16-18 UNF	35	O

1) Depends on nominal size
2) O = Must be connected (plugged on delivery)
X = Plugged (in normal operation)
3) Dimensions according to SAE J518 (Code 62 - high pressure series)

Holding brake (multi-disc brake)



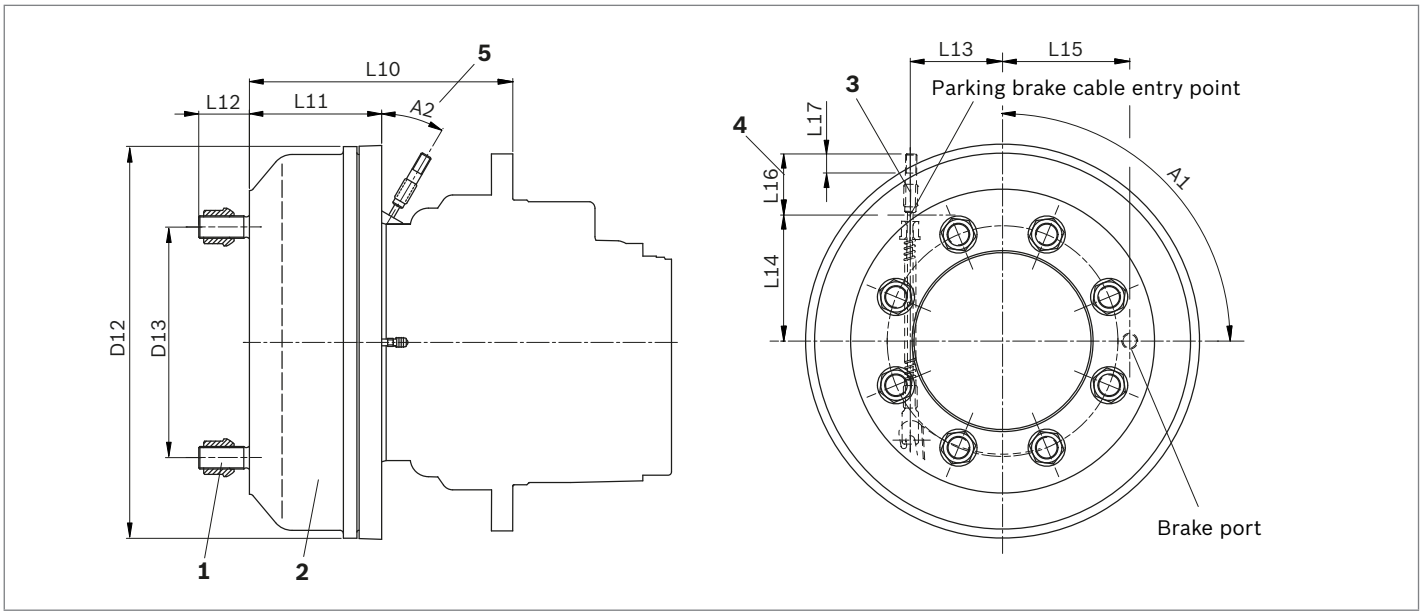
Motor	Brake	L8	L9	D11
MCR3	**B2**	67.3	22	ø174
MCR5	**B2**	67.3	22	ø174
	B4	80.7	26.5	ø215
MCR10	**B5**	84.7	26.5	ø215
	B7	97.8	29	ø251
MCR15	**B11**	102.3	33	ø282

Motor	Designation	Port function	Code	Size	p_{max} [bar]	State[1)]
MCR3	**Z**	Brake port	SAE J515	9/16-18 SAE	40	O
MCR5	**Z**	Brake port	SAE J515	9/16-18 SAE	40	O
MCR10	**Z**	Brake port	SAE J515	9/16-18 SAE	30	O
MCR15	**Z**	Brake Port	SAE J515	9/16-18 SAE	30	O

1) O = Must be connected (plugged on delivery)

Before finalizing your design, request a binding installation drawing.

Dynamic brake (drum brake)



Motor	Brake	L10	L11	L12	L13	L14	L15	L16	L17	D12	D13	A1	A2
MCR3	**C2**	193	94.75	34.5	45	82	68.5	55	19	ø222	ø140	90°	30°
MCR5	**C4**	192	95	32.5	65	86	89	83	19	ø272	ø140	30°	30°
MCR10	**C7**	234.1	117.5	45	82	–	113	54	17	ø348	ø205	90°	30°
MCR15	**C12**	294.6	132	36	80	–	120	40	17	ø365	ø225	90°	30°

1	**C2**	5 Studs M14x1.5 with spherical wheel nuts
	C4	10 Studs M18x1.5 with spherical wheel nuts
	C7	8 Studs M20x1.5 with spherical wheel nuts
	C12	10 Studs M22x1.5 with hexagonal wheel nuts
2	Dynamic drum brake for use with brake fluid DOT 3+5 or SAE JI 703. If brake is to be used with mineral oil a special order is to be made. Please state if seals for mineral oil are required when placing order.	
3	For use as a mechanical park brake a brake cable (Bowden cable) can be connected from right side for C*R and left side for C*L (left is s mirror image of the right type) (* = 2, 4, 7, 12). Mechanical brake cable is not supplied with the motor.	
4	Brake cable length.	
5	Angular position of brake cable.	

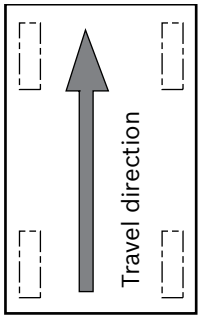
Before finalizing your design, request a binding installation drawing.

Dynamic drum brake run-in procedure

- Brake the machine hard in forward and reverse directions until the brake drum temperature reaches 200 °C.
- Allow the brake to cool.
- To remove residue, brake gently 2 times each in the forward and reverse directions.

Notice
The drum brake cylinder port must be oriented as instructed in the installation drawing. The drum brake also has an influence on permitted radial loading due to its offset.

Left side of vehicle
Ordering code C4L



Right side of vehicle
Ordering code C4R

Selection guide

Data sheet	Motor type Application		Frame size 3 160..400 cc	 5 380..820 cc	 6 820..920 cc	 10 780..1340 cc	 15 1130..2150 cc	 20 1750..3000 cc
15198	**MCR-F** Wheel drives		●	●	–	●	●	–
15200	**MCR-W** Heavy duty wheel drives		●	●	–	●	–	–
15195	**MCR-A** Frame integrated drives		●	●	–	●	●	–
15199	**MCR-H** Integrated drives		●	●	–	●	●	●
15221	**MCR-T** Track drives		–	●	●	●	–	–
15223	**MCR-R Series 41** Hydraulic drive assist		–	–	–	●	–	–
15214	**MCR-X** Slew drives		●	●	–	–	–	–
15197	**MCR-C** Compact drives		–	–	–	–	–	●
15196	**MCR-D** Industrial applications		●	●	–	●	–	–
	MCR-E Industrial applications		–	●	–	–	–	–

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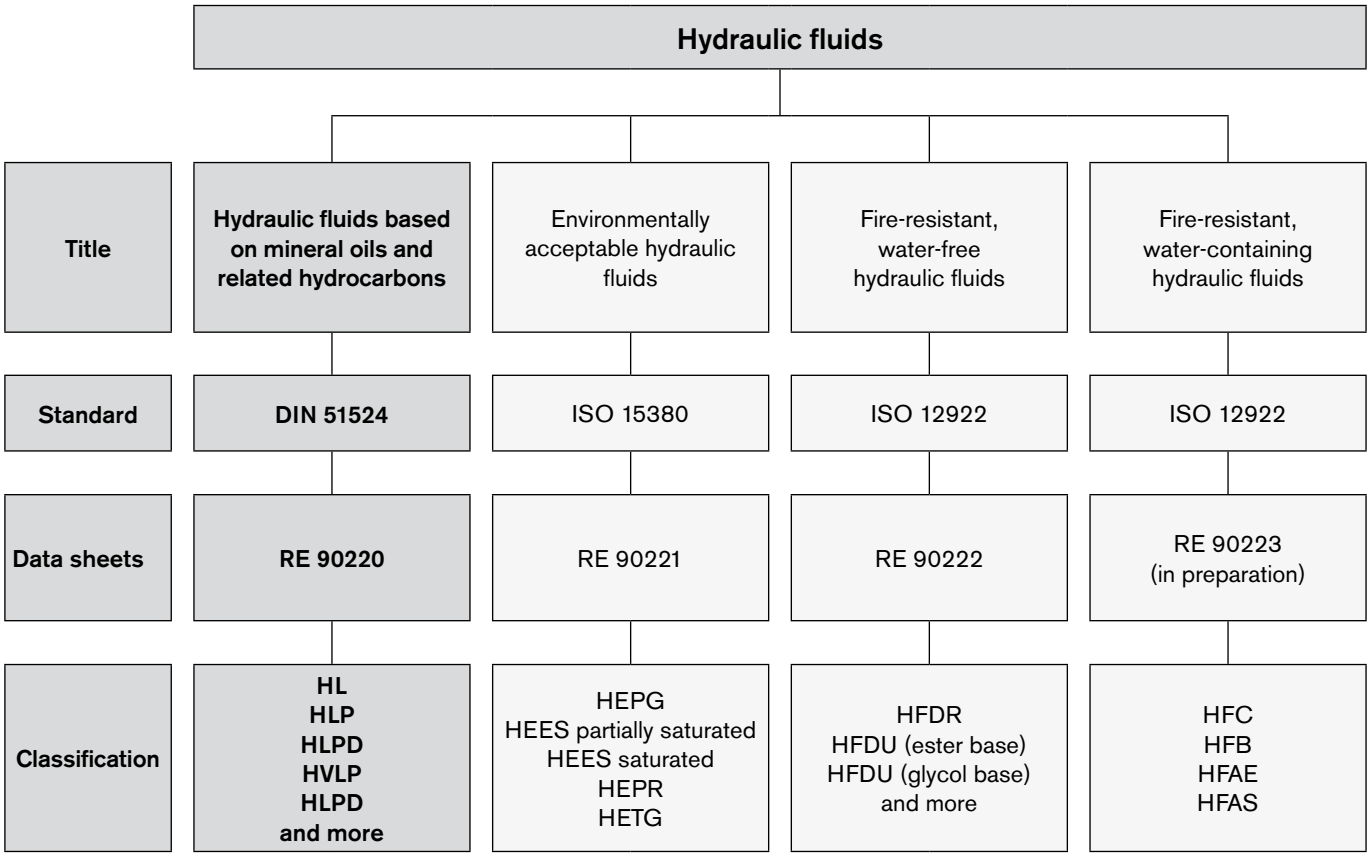
Rexroth
Bosch Group

Hydraulic fluids based on mineral oils and related hydrocarbons

RE 90220/05.12 **1**/16
Replaces: 05.10

Application notes and requirements for Rexroth hydraulic components



Contents

1 Basic information

1.1 General instructions

The hydraulic fluid is the common element in any hydraulic component and must be selected very carefully. Quality and cleanliness of the hydraulic fluid are decisive factors for the operational reliability, efficiency and service life of a system.

Hydraulic fluids must conform, be selected and used in accordance with the generally acknowledged rules of technology and safety provisions. Reference is made to the country-specific standards and directives (in Germany the directive of the Employer's Liability Insurance Association BGR 137).

This data sheet includes recommendations and regulations concerning the selection, operation and disposal of hydraulic fluids based on mineral oils and related hydrocarbons in the application of Rexroth hydraulic components.

The individual selection of hydraulic fluid or the choice of classification are the responsibility of the operator.

It is the responsibility of the user to ensure that appropriate measures are taken for safety and health protection and to ensure compliance with statutory regulations. The recommendations of the lubricant manufacturer and the specifications given in the safety data sheet are to be observed when using hydraulic fluid.

This data sheet does not absolve the operator from verifying the conformity and suitability of the respective hydraulic fluid for his system. He is to ensure that the selected fluid meets the minimum requirements of the relevant fluid standard during the whole of the period of use.

Other regulations and legal provisions may also apply. The operator is responsible for their observance, e.g. EU directive 2004/35/EG and their national implementations. In Germany the Water Resources Act (WHG) is also to be observed.

We recommend that you maintain constant, close contact with lubricant manufacturers to support you in the selection, maintenance, care and analyses.

When disposing of used hydraulic fluids, apply the same care as during use.

1.2 Scope

This data sheet must be observed when using hydraulic fluids based on mineral oils and related hydrocarbons in Bosch Rexroth hydraulic components.

Please note that the specifications of this data sheet may be restricted further by the specifications given in the product data sheets for the individual components.

The use of the individual hydraulic fluids in accordance with the intended purpose can be found in the safety data sheets or other product description documents of the lubricant manufacturers. In addition, each use is to be individually considered.

Rexroth hydraulic components may only be operated with hydraulic fluids based on mineral oils and related hydrocarbons according to DIN 51524 if specified in the respective component data sheet or if Rexroth approval for use is furnished.

Notes:
In the market overview RE 90220-01, hydraulic fluid based on mineral oil are described which, according to the information of the lubricant manufacturer, feature the respective parameters of the current requirements standard DIN 51524 and other parameters which are of relevance for suitability in connection with Rexroth components.

These specifications are not checked or monitored by Bosch Rexroth. The list in the market overview does not therefore represent a recommendation on the part of Rexroth or approval of the respective hydraulic fluid for use with Rexroth components and does not release the operator from his responsibility regarding selection of the hydraulic fluid.

Bosch Rexroth will accept no liability for its components for any damage resulting from failure to comply with the notes below.

1.3 Safety instructions

Hydraulic fluids can constitute a risk for persons and the environment. These risks are described in the hydraulic fluid safety data sheets. The operator is to ensure that a current safety data sheet for the hydraulic fluid used is available and that the measures stipulated therein are complied with.

2 Solid particle contamination and cleanliness levels

Solid particle contamination is the major reason for faults occurring in hydraulic systems. It may lead to a number of effects in the hydraulic system. Firstly, single large solid particles may lead directly to a system malfunction, and secondly small particles cause continuous elevated wear.

For hydraulic fluids, the cleanliness level is given as a three-digit numerical code in accordance with ISO 4406. This numerical code denotes the number of particles present in a hydraulic fluid for a defined quantity. Moreover, foreign solid matter is not to exceed a mass of 50 mg/kg (gravimetric examination according to ISO 4405).

In general, compliance with a minimum cleanliness level of 20/18/15 in accordance with ISO 4406 or better is to be maintained in operation. Special servo valves demand improved cleanliness levels of at least 18/16/13. A reduction in cleanliness level by one level means half of the quantity of particles and thus greater cleanliness. Lower numbers in cleanliness levels should always be striven for and extend the service life of hydraulic components. The component with the highest cleanliness requirements determines the required cleanliness of the overall system. Please also observe the specifications in table 1: "Cleanliness levels according to ISO 4406" and in the respective data sheets of the various hydraulic components.

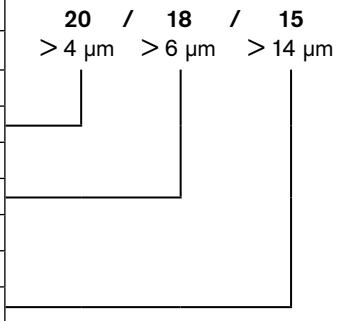
Hydraulic fluids frequently fail to meet these cleanliness requirements on delivery. Careful filtering is therefore required during operation and in particular, during filling in order to ensure the required cleanliness levels. Your lubricant manufacturer can tell you the cleanliness level of hydraulic fluids as delivered. To maintain the required cleanliness level over the operating period, you must use a reservoir breather filter. If the environment is humid, take appropriate measures, such as a breather filter with air drying or permanent off-line water separation.

Note: the specifications of the lubricant manufacturer relating to cleanliness levels are based on the time at which the container concerned is filled and not on the conditions during transport and storage.

Further information about contamination with solid matter and cleanliness levels can be found in brochure RE 08016.

Table 1: Cleanliness levels according to ISO 4406

Particles per 100 ml		Scale number
More than	Up to and including	
8,000,000	16,000,000	24
4,000,000	8,000,000	23
2,000,000	4,000,000	22
1,000,000	2,000,000	21
500,000	1,000,000	20
250,000	500,000	19
130,000	250,000	18
64000	130,000	17
32000	64000	16
16000	32000	15
8000	16000	14
4000	8000	13
2000	4000	12
1000	2000	11
500	1000	10
250	500	9
130	250	8
64	130	7
32	64	6



3 Selection of the hydraulic fluid

The use of hydraulic fluids based on mineral oils for Rexroth hydraulic components is based on compliance with the minimum requirements of DIN 51524.

3.1 Selection criteria for the hydraulic fluid

The specified limit values for all components employed in the hydraulic system, for example viscosity and cleanliness level, must be observed with the hydraulic fluid used, taking into account the specified operating conditions.

Hydraulic fluid suitability depends, amongst others, on the following factors:

3.1.1 Viscosity

Viscosity is a basic property of hydraulic fluids. The permissible viscosity range of complete systems needs to be determined taking account of the permissible viscosity of all components and it is to be observed for each individual component.

The viscosity at operating temperature determines the response characteristics of closed control loops, stability and damping of systems, the efficiency factor and the degree of wear.

We recommend that the optimum operating viscosity range of each component be kept within the permissible temperature range. This usually requires either cooling or heating, or both. The permissible viscosity range and the necessary cleanliness level can be found in the product data sheet for the component concerned.

If the viscosity of a hydraulic fluid used is above the permitted operating viscosity, this will result in increased hydraulic-mechanical losses. In return, there will be lower internal leakage losses. If the pressure level is lower, lubrication gaps may not be filled up, which can lead to increased wear. For hydraulic pumps, the permitted suction pressure may not be reached, which may lead to cavitation damage.

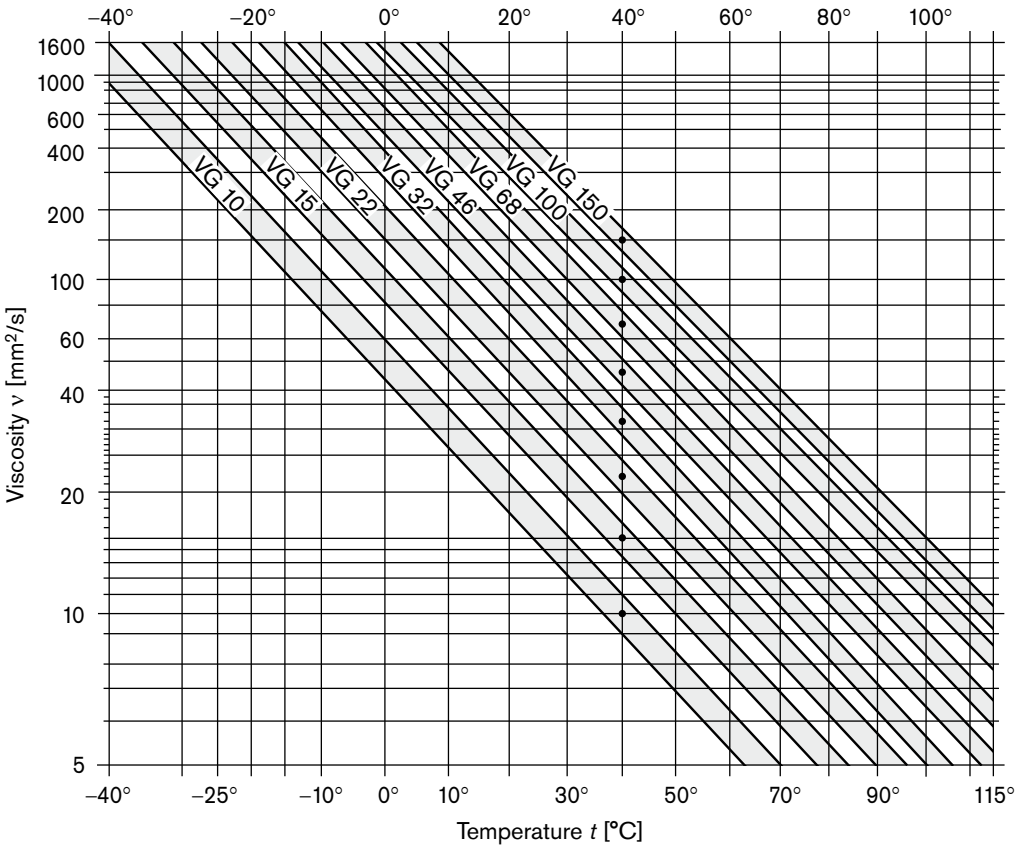
If the viscosity of a hydraulic fluid is below the permitted operating viscosity, increased leakage, wear, susceptibility to contamination and a shorter component life cycle will result.

3.1.2 Viscosity-temperature behavior

For hydraulic fluids, the viscosity temperature behavior (V-T behavior) is of particular importance. Viscosity is characterized in that it drops when the temperature increases and rises when the temperature drops; see Fig. 1 "Viscosity temperature chart for HL, HLP, HLPD (VI 100)". The interrelation between viscosity and temperature is described by the viscosity index (VI).

The viscosity temperature diagram in Fig. 1 is extrapolated in the < 40 °C range. This idealized diagram is for reference purposes only. Measured values can be obtained from your lubricant manufacturer and are to be preferred for design purposes.

Fig. 1: Viscosity-temperature chart for HL, HLP, HLPD (VI 100, double logarithmic representation)



3.1.3 Wear protection capability

Wear protection capability describes the property of hydraulic fluids to prevent or minimize wear within the components. The wear protection capability is described in DIN 51524-2,-3 via test procedures "FZG gear test rig" (ISO 14635-1) and "Mechanical test in the vane pump" (ISO 20763). From ISO VG 32 DIN 51524-2,-3 prescribes a rating of at least 10 (FZG test). At present, the FZG test cannot be applied to viscosity classes < ISO VG 32.

3.1.4 Material compatibility

The hydraulic fluid must not negatively affect the materials used in the components. Compatibility with coatings, seals, hoses, metals and plastics is to be observed in particular. The fluid classifications specified in the respective component data sheets are tested by the manufacturer with regard to material compatibility. Parts and components not supplied by us are to be checked by the user.

Table 2: Known material incompatibilities

Classification	Incompatible with:
HLxx classifications	with EPDM seals
Zinc- and ash/free hydraulic fluids	with bronze-filled PTFE seals

3.1.5 Aging resistance

The way a hydraulic fluid ages depends on the thermal, chemical and mechanical stress to which it is subjected. Aging resistance can be greatly influenced by the chemical composition of the hydraulic fluids.

High fluid temperatures (e.g. over 80 °C) result in a approximate halving of the fluid service life for every 10 °C temperature increase and should therefore by avoided. The halving of the fluid service life results from the application of the Arrhenius equation (see Glossary).

Table 3: Reference values for temperature-dependent aging of the hydraulic fluid

Reservoir temperature	Fluid life cycle
80 °C	100 %
90 °C	50 %
100 °C	25 %

Hydraulic fluids based on mineral oils and related hydrocarbons are tested with 20% water additive during testing of aging resistance according to ISO 4263-1.

The calculated fluid service life is derived from the results of tests in which the long-term characteristics are simulated in a short period of time by applying more arduous conditions (condensed testing). This calculated fluid service life is not to be equated to the fluid service life in real-life applications.

Table 3 is a practical indicator for hydraulic fluids with water content < 0.1%, cf. chapter 4.10. "Water".

3.1.6 Air separation ability (ASA)

The air separation ability (ASA) describes the property of a hydraulic fluid to separate undissolved air. Hydraulic fluids contain approx. 7 to 13 percent by volume of dissolved air (with atmospheric pressure and 50 °C). Hydraulic fluids always contain dissolved air. During operation, dissolved air may be transformed into undissolved air, leading to cavitation damages. Fluid classification, fluid product, reservoir size and design must be coordinated to take into account the dwell time and ASA value of the hydraulic fluid. The air separation capacity depends on the viscosity, temperature, basic fluid and aging.
It cannot be improved by additives.

According to DIN 51524 for instance, an ASA value ≤ 10 minutes is required for viscosity class ISO VG 46,
6 minutes are typical, lower values are preferable.

3.1.7 Demulsifying ability and water solubility

The capacity of a hydraulic fluid to separate water at a defined temperature is known as the demulsifying ability. ISO 6614 defines the demulsifying properties of hydraulic fluids.

For larger systems with permanent monitoring, a demulsifying fluid with good water separation capability (WSC) is recommended. The water can be drained from the bottom of the reservoir. In smaller systems (e.g. in mobile machines), whose fluid is less closely monitored and where water contamination into the hydraulic fluid, for instance through air condensation, cannot be ruled out completely, an HLPD fluid is recommended.

The demulsifying ability up to ISO-VG 100 is given at 54 °C, and at 82 °C for fluids with higher viscosity.

Water emulsifying HLPD hydraulic fluids have no, or a very poor, demulsifying ability.

3.1.8 Filterability

Filterability describes the ability of a hydraulic fluid to pass through a filter, removing solid contaminants. The hydraulic fluids used require a good filterability, not just when new, but also during the whole of their service life. Depending on the basic fluid used and the additives (VI enhancers) there are great differences here.

The filterability is a basic prerequisite for cleanliness, servicing and filtration of hydraulic fluids. Filterability is tested with the new hydraulic fluid and after the addition of 0.2 % water. The underlying standard (ISO 13357-1/-2) stipulates that filterability must have no negative effects on the filters or the hydraulic fluid, see chapter 4 "Hydraulic fluids in operation".

3.1.9 Corrosion protection

Hydraulic fluids should not just prevent corrosion formation on steel components, they must also be compatible with non-ferrous metals and alloys. Corrosion protection tests on different metals and metal alloys are described in DIN 51524. Hydraulic fluids that are not compatible with the materials listed above must not be used, even if they are compliant with ISO 51524.

Rexroth components are usually tested with HLP hydraulic fluids or corrosion protection oils based on mineral oils before they are delivered.

3.1.10 Additivation

The properties described above can be modified with the help of suitable additives. A general distinction is made for fluids between heavy metal-free and heavy metal-containing (generally zinc) additive systems. Both additive systems are most often incompatible with each other. The mixing of these fluids must be avoided even if the mixing ratio is very low. See chapter 4, "Hydraulic fluids in operation".

Increasing additivation generally leads to deteriorated air separation ability (ASA) and water separation capability (WSC) of the hydraulic fluid. According to the present state of knowledge, all hydraulic fluids described in this document, independently of the actual additivation, can be filtered using all filter materials with all known filtration ratings ≥ 1 µm without filtering out effective additives at the same time.

Bosch Rexroth does not prescribe any specific additive system.

3.2 Classification and fields of application

Table 4: Classification and fields of application

Classification	Features	Typical field of application	Notes
HL fluids according to DIN 51524-1 VI = 100	Hydraulic fluids predominantly only with additives for oxidation and corrosion protection, but no specific additives for wear protection in case of mixed friction	HL fluids can be used in hydraulic systems that do not pose any requirements as to wear protection.	HL fluids may be used only for components whose product data sheet specifically allows HL fluids. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. Hydraulic fluids that only comply with the requirements of classes HL and HR in accordance with ISO 11158 without proving that DIN 51524-1 is also met may be used only with written approval of Bosch Rexroth AG. Observe restrictions as to pressure, rotation speed etc.
HLP fluids according to DIN 51524-2 VI = 100	Hydraulic fluid with corrosion, oxidation and verified wear protection additives	HLP fluids are suitable for most fields of application and components provided the temperature and viscosity provisions are observed.	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. For the viscosity classes VG10, VG15 and VG22, DIN 51524 defines no requirements as to wear protection (DIN 51354 part 2 and DIN 51389 part 2). Beyond the requirements of DIN 51524 part 2, we require the same base oil type, identical refining procedure, identical additivation and identical additivation level across all viscosity classes.

Continued on page 8

Table 4: Classification and fields of application (continued from page 7)

Classification	Features	Typical field of application	Notes
HVLP fluids according to DIN 51524-3 VI > 140	HLP hydraulic fluid with additional improved viscosity temperature behavior	HVLP fluids are used in systems operated over a wide temperature range.	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. The same notes and restrictions as defined for HLP fluids apply accordingly. The effect on Rexroth components (e.g. compatibility with material seals, wear resistance capacity) may differ when using related hydrocarbons instead of mineral oils, cf. Table 6, line 8. When using HVLP fluids, the viscosity may change on account of the shear of the long-chain VI enhancers. The viscosity index, high at the start, decreases during operation. This needs to be taken into account when selecting the hydraulic fluid. The only value at present that can be used to assess viscosity changes in operation is the result of the test in accordance with DIN 51350 part 6. Please note that there are practical applications that create a much higher shear load on such fluids than can be achieved by this test. Up to VI < 160, we recommend a maximum permitted viscosity drop of 15 %, viscosity at 100 °C. The viscosity limits given by Bosch Rexroth for its components are to be observed for all operating conditions, even after the hydraulic fluids have sheared. HVLP fluids should be used only if required by the temperature ranges of the application.
HLPD fluids according to DIN 51524-2, HVLPD fluids in accordance with DIN 51524-3	HLP and HVLP hydraulic fluid with additional detergent and or dispersant additives	HLPD and HVLPD fluids are used in systems where deposits as well as solid or liquid contamination need to be kept temporarily suspended	For information on approved components, please refer to the respective product data sheet. For components which have not been approved according to the product data sheet, please consult your Bosch Rexroth sales partner. Some of these fluids are able to absorb significant quantities of water (> 0.1 %). This may have negative implications for the wear protection and the aging properties of the fluid. The wetting ability of these fluids varies largely depending on the product. Therefore it is not correct to say that they are generally all very well able to prevent stick-slip. In individual cases where higher water contamination is to be expected (such as in steelworks or under humid conditions), the use of HLPD/HVLPD fluids cannot be recommended as the emulsified water does not settle in the reservoir but is evaporated in heavily loaded positions. For such cases, we recommend using HLP hydraulic fluids with particularly good demulsifying ability. The water collected at the reservoir bottom is to be drained regularly. If HLPD/HVLPD fluids are used, contamination does not settle. It rather remains suspended and needs to be filtered out or removed by appropriate draining systems. For this reason, the filter area must be increased. HLPD/HVLPD fluids may contain additives that in the long run are incompatible with plastics, elastomers and non-ferrous metals. Furthermore, these additives may lead to the premature clogging of hydraulic filters. Therefore, test the filterability and the selection of the filter material in consultation with the filter manufacturer.

4 Hydraulic fluids in operation

4.1 General

The properties of hydraulic fluids can change continually during storage and operation.

Please note that the fluid standard DIN 51524 merely describes minimum requirements for hydraulic fluids in new condition at the time of filling into the bins. The operator of a hydraulic system must ensure that the hydraulic fluid remains in a utilizable condition throughout its entire period of use.

Deviations from the characteristic values are to be clarified with the lubricant manufacturer, the test labs or Bosch Rexroth.

Please note the following aspects in operation.

4.2 Storage and handling

Hydraulic fluids must be stored correctly in accordance with the instructions of the lubricant manufacturer. Avoid exposing the containers to lengthy periods of direct heat. Containers are to be stored in such a way that the risk of any foreign liquid or solid matter (e.g. water, foreign fluids or dust) ingression into the inside of the container can be ruled out. After taking hydraulic fluids from the containers, these are immediately to be properly resealed.

Recommendation:

- Store containers in a dry, roofed place
- Store barrels on their sides
- Clean reservoir systems and machine reservoirs regularly

4.3 Filling of new systems

Usually, the cleanliness levels of the hydraulic fluids as delivered do not meet the requirements of our components. Hydraulic fluids must be filtered using an appropriate filter system to minimize solid particle contamination and water in the system.

As early as possible during test operation, new systems should be filled with the selected hydraulic fluid so as to reduce the risk of accidentally mixing the fluids (see chapter 4.5 "Mixing and compatibility of different hydraulic fluids"). Changing the hydraulic medium at a later point represents significant additional costs (see following chapter).

4.4 Hydraulic fluid changeover

Changeovers, in particular between hydraulic fluids with heavy metal-free and heavy metal-containing (generally zinc) additives, frequently lead to malfunctions, see chapter 3.1.10 "Additivation".

In the case of changeovers of the fluid in hydraulic systems, it is important to ensure compatibility of the new hydraulic fluid with the remainder of the previous hydraulic fluid. We recommend obtaining a written performance guarantee from the manufacturer or supplier of the new hydraulic fluid. The quantity of old fluid remaining should be minimized. Mixing hydraulic fluids should be avoided, see following chapter.

For information on changing over hydraulic fluids with different classifications please refer to VDMA 24314, VDMA 24569 and ISO 15380 appendix A.

Bosch Rexroth will not accept liability for any damage to its components resulting from inadequate hydraulic fluid changeovers!

4.5 Mixing and compatibility of different hydraulic fluids

If hydraulic fluids from different manufacturers or different types from the same manufacturer are mixed, gelling, silting and deposits may occur. These, in turn, may cause foaming, impaired air separation ability, malfunctions and damage to the hydraulic system.

If the fluid contains more than 2 % of another fluid then it is considered to be a mixture. Exceptions apply for water, see chapter 4.10 "Water".

Mixing with other hydraulic fluids is not generally permitted. This also includes hydraulic fluids with the same classification and from the market overview RE 90220-01. If individual lubricant manufacturers advertise miscibility and/or compatibility, this is entirely the responsibility of the lubricant manufacturer.

Bosch Rexroth customarily tests all components with mineral oil HLP before they are delivered.

Note: With connectible accessory units and mobile filtering systems, there is a considerable risk of non-permitted mixing of the hydraulic fluids!

Rexroth will not accept liability for any damage to its components resulting from mixing hydraulic fluids!

4.6 Re-additivation

Additives added at a later point in time such as colors, wear reducers, VI enhancers or anti-foam additives, may negatively affect the performance properties of the hydraulic fluid and the compatibility with our components and therefore are not permissible.

Rexroth will not accept liability for any damage to its components resulting from re-additivation!

4.7 Foaming behavior

Foam is created by rising air bubbles at the surface of hydraulic fluids in the reservoir. Foam that develops should collapse as quickly as possible.

Common hydraulic fluids in accordance with DIN 51524 are sufficiently inhibited against foam formation in new condition. On account of aging and adsorption onto surfaces, the defoamer concentration may decrease over time, leading to a stable foam.

Defoamers may be re-dosed only after consultation with the lubricant manufacturer and with his written approval.

Defoamers may affect the air separation ability.

4.8 Corrosion

The hydraulic fluid is to guarantee sufficient corrosion protection of components under all operating conditions, even in the event of impermissible water contamination.

During storage and operation, hydraulic fluid based on mineral oils with anti-corrosion additives protect components against water and "acidic" oil degradation products.

4.9 Air

Under atmospheric conditions, the hydraulic fluid contains dissolved air. In the negative pressure range, for instance in the suction pipe of the pump or downstream of control edges, this dissolved air may transform into undissolved air. The undissolved air content represents a risk of cavitation and of the diesel effect. This results in material erosion of components and increased hydraulic fluid aging.

With the correct measures, such as suction pipe and reservoir design, and an appropriate hydraulic fluid, air intake and separation can be positively influenced.

See also chapter 3.1.7 "Air separation ability (ASA)".

4.10 Water

Water contamination in hydraulic fluids can result from direct ingress or indirectly through condensation of water from the air due to temperature variations.

Water in the hydraulic fluid may result in wear or direct failure of hydraulic components. Furthermore, a high water content in the hydraulic fluid negatively affects aging and filterability and increases susceptibility to cavitation.

Undissolved water can be drained from the bottom of the reservoir. Dissolved water can be removed only by using appropriate measures. If the hydraulic system is used in humid conditions, preventive measures need to be taken, such as an air dehumidifier at the reservoir vent. During operation, the water content in all hydraulic fluids, determined according to the "Karl Fischer method" (see chapter 6 "Glossary") for all hydraulic fluids must constantly be kept below 0.1% (1000 ppm). To ensure a long service life of both hydraulic fluids and components, Bosch Rexroth recommends that values below 0.05% (500 ppm) are permanently maintained.

To ensure a long service life for the hydraulic fluids and the components, we recommend that values below 0.05 % (500 ppm) are permanently maintained. Detergent and or dispersant hydraulic fluids (HLPD / HVLPD) are able to absorb (and keep suspended) more water. Prior to using these hydraulic fluids, please contact the lubricant manufacturer.

4.11 Fluid servicing, fluid analysis and filtration

Air, water, operating temperature influences and solid matter contamination will change the performance characteristics of hydraulic fluids and cause them to age.

To preserve the usage properties and ensure a long service life for hydraulic fluid and components, the monitoring of the fluid condition and a filtration adapted to the application requirements (draining and degassing if required) are indispensable.

The effort is higher in the case of unfavorable usage conditions, increased stress for the hydraulic system or high expectations as to availability and service life, see chapter 2 "Solid particle contamination and cleanliness level".

When commissioning a system, please note that the required minimum cleanliness level can frequently be attained only by flushing the system. Due to severe start-up contamination, it may be possible that a fluid and/or filter replacement becomes necessary after a short operating period (< 50 operating hours).

The hydraulic fluid must be replaced in regular intervals and tested by the lubricant manufacturer or recognized, accredited test labs. **We recommend a reference analysis after commissioning.**

The minimum data to be tested for analyses are:

- Viscosity at 40 °C and 100 °C
- Neutralization number NN (acid number AN)
- Water content (Karl-Fischer method)
- Particle measurement with evaluation according to ISO 4406 or mass of solid foreign substances with evaluation to EN 12662
- Element analysis (RFA (EDX) / ICP, specify test method)
- Comparison with new product or available trend analyses
- Assessment / evaluation for further use
- Also recommended: IR spectrum

Compared to the pure unused hydraulic fluid, the changed neutralization number NN (acid number AN) indicates how many aging products are contained in the hydraulic fluid. This value must be kept as low as possible. As soon as the trend analysis notes a significant increase in the acid number, the lubricant manufacturer should be contacted.

In case of warranty, liability or guarantee claims to Bosch Rexroth, service verification and/or the results of fluid analyses are to be provided.

5 Disposal and environmental protection

Hydraulic fluids based on mineral oil and related hydrocarbons are hazardous for the environment. They are subject to a special disposal obligation.

The respective lubricant manufacturers provide specifications on environmentally acceptable handling and storage. Please ensure that spilt or splashed fluids are absorbed with appropriate adsorbents or by a technique that prevents it contaminating water courses, the ground or sewerage systems.

It is also not permitted to mix fluids when disposing of hydraulic fluids. Regulations governing the handing of used oils stipulate that used oils are not to mixed with other products, e.g. substances containing halogen. Non-compliance will increase disposal costs. Comply with the national legal provisions concerning the disposal of the corresponding hydraulic fluid. Comply with the local safety data sheet of the lubricant manufacturer for the country concerned.

6 Other hydraulic fluids based on mineral oil and related hydrocarbons

Table 6: Other hydraulic fluids based on mineral oils and related hydrocarbons

Serial number	Hydraulic fluids	Features / Typical field of application / Notes
1	Hydraulic fluids with classification HL, HM, HV according to ISO 11158	– Can be used without confirmation provided they are listed in the respective product data sheet and are compliant with DIN 51524. Conformity with DIN 51524 must be verified in the technical data sheet of the fluid concerned. For classification see Table 4: "Hydraulic fluid classification". – Fluids **only** classified in accordance with ISO 11158 may be used only with prior written approval of Bosch Rexroth AG.
2	Hydraulic fluids with classification HH, HR, HS, HG according to ISO 11158	– May not be used.
3	Hydraulic fluids with classification HL, HLP, HLPD, HVLP, HVLPD to DIN 51502	– DIN 51502 merely describes how fluids are classified / designated on a national level. – It contains no information on minimum requirements for hydraulic fluids. – Hydraulic fluids standardized according to DIN 51502 can be used without confirmation provided they are listed in the respective product data sheet and are compliant with DIN 51524. Conformity with DIN 51524 must be verified in the technical data sheet of the fluid concerned. For classification see Table 4: "Hydraulic fluid classification".
4	Hydraulic fluids with classification HH, HL, HM, HR, HV, HS, HG according to ISO 6743-4	– ISO 6743-4 merely describes how fluids are classified / designated on an international level. It contains no information on minimum requirements for hydraulic fluids. – Hydraulic fluids standardized according to ISO 6743 -4 can be used without confirmation provided they are listed in the respective product data sheet and are compliant with DIN 51524. Conformity with DIN 51524 must be verified in the technical data sheet of the fluid concerned. For classification see table 4: "Classification and fields of application".
5	Lubricants and regulator fluids for turbines to DIN 51515-1 and -2	– Turbine oils can be used after confirmation and with limited performance data. – They usually offer lower wear protection than mineral oil HLP. Classification of turbine oils to DIN 51515-1 comparable to HL, turbine oils to DIN 51515-2 comparable to HLP. – Particular attention must be paid to material compatibility!
6	Lube oils C, CL, CLP in accordance with DIN 51517	– Lube oils in acc. with DIN 51517 can be used after confirmation and with limited performance data. They are mostly higher-viscosity fluids with low wear protection. Classification: CL similar to HL fluids and CLP similar to HLP fluids. – Particular attention must be paid to material compatibility, specifically with non-ferrous metals!
7	Fluids to be used in pharmaceutical and foodstuff industries, in acc. with FDA / USDA / NSF H1	– There are medical white oils and synthetic hydrocarbons (PAO). – Can only be used after consultation and approval for use in the specific application, even if they are compliant with DIN 51524. – May be used only with FKM seals. – Other fluids used in pharmaceutical and foodstuff industries may be used only after confirmation. – Attention is to be paid to material compatibility in accordance with the applicable food law. **Caution!** Fluids used in pharmaceutical and foodstuff industries should not be confused with environmentally acceptable fluids!

Continued on page 13

Table 6: Other hydraulic fluids based on mineral oils and related hydrocarbons
(continued from page 12)

Serial number	Hydraulic fluids	Features / Typical field of application / Notes
8	Hydraulic fluids of classes HVLP and HVLPD based on related hydrocarbons	– Can only be used after consultation and approval for use in the specific application, even if they are compliant with DIN 51524. – Lower pour point than HLP – Other wetting (polarity)
9	Automatic Transmission Fluids (ATF)	– ATF are operating fluids for automatic gearboxes in vehicles and machines. In special cases, ATFs are also used for certain synchronous gearboxes and hydraulic systems comprising gearboxes. – To be used only after confirmation! – Some of these fluids have poor air separation abilities and modified wear properties. – Check material compatibility and filterability!
10	Multi-purpose oil (MFO) – Industry	– Multi-purpose oils (industry) combine at least two requirements for a fluid, for instance metal machining and hydraulics. – To be used only after confirmation! – Please pay particular attention to air separation ability, modified wear properties and the reduced material life cycle. – Check material compatibility and filterability!
11	Multi-purpose oils (MFO) – Mobil UTTO, STOU	– Multi-purpose oils combine requirements for wet brakes, gearboxes, motor oil (STOU only) and hydraulics. – Fluids of the types: – UTTO (= universal tractor transmission oil) and – STOU (= Super Tractor super tractor universal oil) – To be used only after confirmation! – Please pay particular attention to shear stability, air separation ability and modified wear properties. – Check material compatibility and filterability!
12	Single-grade engine oils 10W, 20W, 30W	– To be used only after confirmation! – Please pay particular attention to the air separation ability and filtering ability.
13	Multi-grade engine oils 0Wx-30Wx	– To be used only after confirmation! – Please pay particular attention to air separation ability, changes in wear protection capability, viscosity changes during operation, material compatibility, dispersant and detergent properties and filterability. **Caution!** Multi-grade engine oils have been adapted to specific requirements in combustion engines and are suitable for use in hydraulic systems only to a limited extent.
14	Motor vehicle transmission oils	– Motor vehicle transmission oil can be used after confirmation and with limited performance data. – Pay particular attention to wear protection, material compatibility, specifically with non-ferrous metals, as well as viscosity!
15	Diesel, test diesel in acc. with DIN 4113	– Diesel / test diesel has poorer wear protection capabilities and a very low viscosity (< 3 mm^2/s). – May be used only with FKM seals – Please note their low flash point! – To be used only after confirmation and with limited performance data!

Continued on page 14

Table 6: Other hydraulic fluids based on mineral oils and related hydrocarbons
(continued from page 13)

Serial number	Hydraulic fluids	Features / Typical field of application / Notes
16	Hydraulic fluids for roller processes	– Hydraulic fluids for roller processes have lower wear protection capabilities than mineral oil HLP and a lower viscosity – Please note their low flash point! – Hydraulic fluids for roller processes with limited performance data can be used only after confirmation.
17	Fluids for power steering, hydro-pneumatic suspension, active chassis etc.	– Can only be used after consultation and approval for use in the specific application, even if they are compliant with DIN 51524. – Please note the low viscosity! – In most cases they have poor water separation capability – Check the material compatibility!

7 Glossary

Additivation
Additives are chemical substances added to the basic fluids to achieve or improve specific properties.

Aging
Hydraulic fluids age due to oxidation (see chapter 3.1.5 "Aging resistance"). Liquid and solid contamination acts as a catalyzer for aging, meaning that it needs to be minimized as far as possible by careful filtration.

API classification
Classification of basic fluids by the **A**merican **P**etroleum **I**nstitute (API) – the largest association representing the US oil and gas industry.

Arrhenius equation
The quantitative relation between reaction rate and temperature is described by an exponential function, the Arrhenius equation. This function is usually visualized within the typical temperature range of the hydraulic system. For a practical example, see chapter 3.1.5 "Aging resistance".

Related hydrocarbons
Related hydrocarbons are hydrocarbon compounds that are not classified as API class 1, 2 or 5.

Basic fluids
In general, a hydraulic fluid is made up of a basic fluid, or base oil, and chemical substances, the so-called additives. The proportion of basic fluid is generally greater than 90%.

Demulsifying
Ability of a fluid to separate water contamination quickly; achieved with careful selection of base oil and additives.

Detergent
Ability of certain additives to emulsify part of the water contamination in the oil or to hold it in suspension until it has evaporated with increasing temperature. Larger water quantities, in contrast (above approx. 2 %), are separated immediately.

Dispersant
Ability of certain additives to keep insoluble liquid and solid contamination in suspension in the fluid.

Diesel effect
If hydraulic fluid that contains air bubbles is compressed quickly, the bubbles are heated to such a degree that a self-ignition of the air-gas mix may occur. The resultant temperature increase may lead to seal damage and increased aging of the hydraulic fluid.

Hydraulic fluids based on mineral oils
Hydraulic fluids based on mineral oils are made from petroleum (crude oil).

ICP (atomic emission spectroscopy)
The ICP procedure can be used to determine various wear metals, contamination types and additives. Practically all elements in the periodic system can be detected with this method.

Karl Fischer method
Method to determine the water content in fluids. Indirect coulometric determination procedure in accordance with DIN EN ISO 12937 in connection with DIN 51777-2. Only the combination of both standards will assure adequately accurate measured values.

Cavitation
Cavitation is the creation of cavities in fluids due to pressure reduction below the saturated vapour pressure and subsequent implosion when the pressure increases. When the cavities implode, extremely high acceleration, temperatures and pressure may occur temporarily, which may damage the component surfaces.

Neutralization number (NN)
The neutralization number (NN) or acid number (AN) specifies the amount of caustic potash required to neutralize the acid contained in one gram of fluid.

Pour point
The lowest temperature at which the fluid still just flows when cooled down under set conditions. The pour point is specified in the lubricant manufacturers' technical data sheets as a reference value for achieving this flow limit.

RFA (wavelength dispersive x-ray fluorescence analysis)
Is a procedure to determine nearly all elements in liquid and solid samples with nearly any composition. This analysis method is suitable for examining additives and contamination, delivering fast results.

Shearing/shear loss
Shearing of molecule chains during operation can change the viscosity of hydraulic fluids with long chain VI enhancers. The initially high viscosity index drops. This needs to be taken into account when selecting the hydraulic fluid.

The only value at present that can be used to assess viscosity changes in operation is the result of the test in accordance with DIN 51350 part -6. Please note that there are practical applications that create a much higher shear load on such hydraulic fluids than can be achieved by this test.

Stick-slip effect (sliding)
Interaction between a resilient mass system involving friction (such as cylinder + oil column + load) and the pressure increase at very low sliding speeds. The static friction of the system is a decisive value here. The lower it is, the lower the speed that can still be maintained without sticking. Depending on the tribologic system, the stick-slip effect may lead to vibrations generated and sometimes also to significant noise emission. In many cases, the effect can be attenuated by replacing the lubricant.

Viscosity
Viscosity is the measure of the internal friction of a fluid to flow. It is defined as the property of a substance to flow under tension. Viscosity is the most important characteristic for describing the load-bearing capacity of a hydraulic fluid.

Kinematic viscosity is the ratio of the dynamic viscosity and the density of the fluid; the unit is mm^2/s. Hydraulic fluids are classified by their kinematic viscosity into ISO viscosity classes. The reference temperature for this is 40 °C.

Viscosity index (VI)
Refers to the viscosity temperature behavior of a fluid.
The lower the change of viscosity in relation the temperature, the higher the VI.

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G8K Spiral Wire Hose
Ultra High Pressure

(Meets Flame Resistance Acceptance Designation "MSHA 2G")

Recommended For: Ultra high–pressure, high–impulse applications such as hydrostatic transmissions, for use in the construction, agriculture, forestry, underground or open pit mining, or other industries on applications where extremely high pressure capability is required. G8K hose and couplings offer industry–leading bend radius capability, which leads to ease of routing and installation, longer hose life in flexing applications, and fewer bent tube fitting requirements.

Tube: Black, oil–resistant Neoprene Type A tube material allows for the high pressure, high temperature performance required in these demanding applications. See Hose Stock Characteristics.

Reinforcement: Six alternating layers of high tensile steel wire spiral construction.

Cover: Black, oil resistant, synthetic rubber (Neoprene – Type A), with color coded layline.

Temperature Range: –40°F to +250°F (–40°C to +121°C). For water emulsions see Temperature Limits Table.

Coupling Recommendation (See Crimp Data Manual 428-7365 or E-Crimp):
G8K Couplings (G19) Section D

Part No.	Description	Product No.	Standard Pack					
71096	12G8KXCTN	4651-1639	100	3/4	1.36	8000	32000	9.5
71097	16G8KXCTN	4651-1631	100	1	1.66	8000	32000	12.0

EFG6K Spiral Wire Hose - SAE 100R15
Extremely High Pressure

(Meets Flame Resistance Acceptance Designation "MSHA 2G")
For Biodegradable Hydraulic Fluids

Recommended For: Extremely high–pressure, high–impulse applications such as hydrostatic transmissions. EFG6K is designed to meet or exceed all requirements of SAE 100R15 specifications and performance requirements of EN 856 4SP (–6, –8, –10 and –12), EN 856 4SH (–12, –16, and –20), and ISO 3862 Type R15 (–6, –8, –10, –12, –16, –24). Compatible with biodegradable hydraulic fluids like polyolester, polyglycol and vegetable oil as well as standard petroleum–based fluids. Available in 121' through 200' continuous lengths.

Tube: Black, oil resistant, synthetic rubber (Nitrile – Type C). See Hose Stock Characteristics.

Reinforcement: Four (six for –20, –24 and –32) alternating layers of spiraled, high–tensile steel.

Cover: Black, oil resistant, synthetic rubber (Neoprene – Type A). Color coded layline. Also available with unique abrasion resistant MegaTuff® cover. See Hose Stock Characteristics.

Temperature Range: –40°F to +250°F (–40°C to +121°C). For water emulsions see Temperature Limits Table.

Coupling Recommendation (See Crimp Data Manual 428-7365 or E-Crimp):
GlobalSpiral™ Couplings (–6 through –20) (G20) Section E
GlobalSpiral™ MAX Pressure Couplings (–24 G24), (–32 G23) Section E
Stainless Steel Spiral Couplings (G18) Section F

Part No.	Description	Product No.	Standard Pack					
70163	6EFG6K X REEL	4651-0123	300	3/8	.80	6000	24000	2.5
85465	6EFG6K X25FT	4651-4032	1	3/8	.80	6000	24000	2.5
70866	6EFG6KXCTN	4651-1396	100	3/8	.80	6000	24000	2.5
70164	8EFG6K X REEL	4651-0124	230	1/2	.95	6000	24000	3.5
85466	8EFG6K X25FT	4651-4033	1	1/2	.95	6000	24000	3.5
70865	8EFG6KXCTN	4651-1371	100	1/2	.95	6000	24000	3.5
70978	8EFG6KXLL	4651-1613	200	1/2	.95	6000	24000	3.5
70165	10EFG6K X REEL	4651-0125	200	5/8	1.09	6000	24000	4.0
85467	10EFG6K X25FT	4651-4034	1	5/8	1.09	6000	24000	4.0
70815	10EFG6KXCTN	4651-1368	100	5/8	1.09	6000	24000	4.0
70735	10EFG6KXLL	4651-1397	200	5/8	1.09	6000	24000	4.0
70168	12EFG6K X REEL	4651-0128	200	3/4	1.24	6000	24000	4.7
85468	12EFG6K X25FT	4651-4035	1	3/4	1.24	6000	24000	4.7
70839	12EFG6KXCTN	4651-1288	100	3/4	1.24	6000	24000	4.7
70736	12EFG6KXLL	4651-1398	200	3/4	1.24	6000	24000	4.7

EFG6K Spiral Wire Hose - SAE 100R15
Extremely High Pressure

Continued

Part No.	Description	Product No.	Standard Pack					
85469	16EFG6K X25FT	4651-4036	1	1	1.53	6000	24000	6.0
70836	16EFG6KXCTN	4651-1289	100	1	1.53	6000	24000	6.0
70737	16EFG6KXLL	4651-1399	200	1	1.53	6000	24000	6.0
85470	20EFG6K X25FT	4651-4037	1	1 1/4	1.97	6000	24000	8.2
70837	20EFG6KXCTN	4651-1290	50	1 1/4	1.97	6000	24000	8.2
70738	20EFG6KXLL	4651-1400	200	1 1/4	1.97	6000	24000	8.2
85426	24EFG6K X25FT	4651-1574	1	1 1/2	2.26	6000	24000	10.0
71065	24EFG6KXCTN	4651-1531	50	1 1/2	2.26	6000	24000	10.0
71100	32EFG6KXCTN	4651-1759	50	2	2.80	6000	24000	25.0
71099	32EFG6KXLL	4651-1758	200	2	2.80	6000	24000	25.0

EFG6K Spiral Wire Hose - SAE 100R15 - MegaTuff® Cover
Extremely High Pressure

(Meets Flame Resistance Acceptance Designation "MSHA 2G")
For Biodegradable Hydraulic Fluids
MegaTuff® hose lasts up to 300 times longer than standard hose during hose–to–hose and hose–to–metal abrasion tests per ISO 6945.

Recommended For: Extremely high–pressure, high–impulse applications such as hydrostatic transmissions. EFG6K is designed to meet or exceed all requirements of SAE 100R15 specifications and performance requirements of EN 856 4SP (–6, –8, –10 and –12), EN 856 4SH (–12, –16, and –20), and ISO 3862 Type R15 (–6, –8, –10, –12, –16, –24). Compatible with biodegradable hydraulic fluids like polyolester, polyglycol and vegetable oil as well as standard petroleum–based fluids. Available in 121' through 200' continuous lengths.

Tube: Black, oil resistant, synthetic rubber (Nitrile – Type C). See Hose Stock Characteristics.

Reinforcement: Four (six for –20, –24 and –32) alternating layers of spiraled, high–tensile steel.

Cover: Black, oil, abrasion and weather resistant MegaTuff® cover with synthetic rubber (Neoprene – Type A) base, with color coded layline. Also available in Standard cover. See Hose Stock Characteristics.

Temperature Range: –40°F to +250°F (–40°C to +121°C). For water emulsions see Temperature Limits Table.

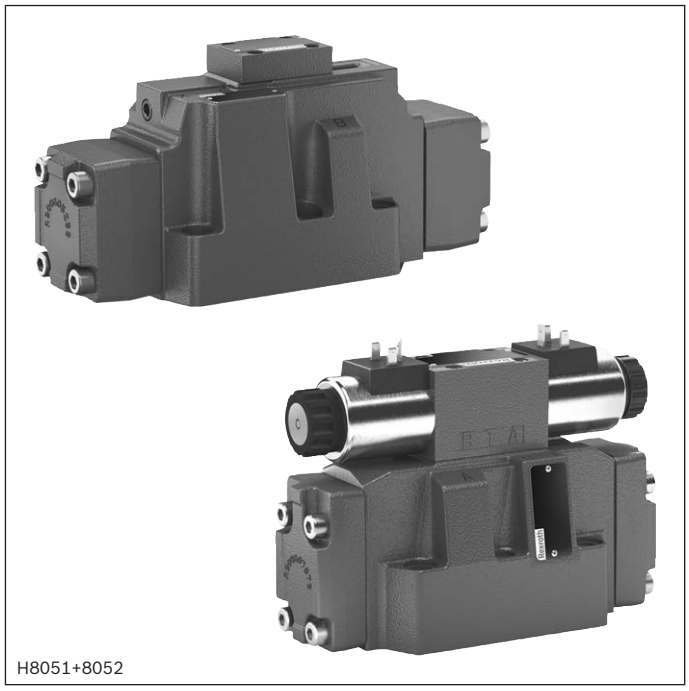
Coupling Recommendation (See Crimp Data Manual 428-7365 or E-Crimp):
GlobalSpiral™ Couplings (–6 through –20) (G20) Section E
GlobalSpiral™ MAX Pressure Couplings (–24 G24), (–32 G23) Section E
Stainless Steel Spiral Couplings (G18) Section F

Part No.	Description	Product No.	Standard Pack					
85471	6EFG6K-MTF X25FT	4651-4038	1	3/8	.80	6000	24000	2.5
70849	6EFG6K-MTFXCTN	4651-1435	100	3/8	.80	6000	24000	2.5
85472	8EFG6K-MTF X25FT	4651-4039	1	1/2	.95	6000	24000	3.5
70867	8EFG6K-MTFXCTN	4651-1609	100	1/2	.95	6000	24000	3.5
85473	10EFG6K-MTF X25FT	4651-4040	1	5/8	1.09	6000	24000	4.0
70880	10EFG6K-MTFXCTN	4651-1416	100	5/8	1.09	6000	24000	4.0
85474	12EFG6K-MTF X25FT	4651-4041	1	3/4	1.24	6000	24000	4.7
70868	12EFG6K-MTFXCTN	4651-1606	100	3/4	1.24	6000	24000	4.7
85475	16EFG6K-MTF X25FT	4651-4042	1	1	1.53	6000	24000	6.0
70869	16EFG6K-MTFXCTN	4651-1604	100	1	1.53	6000	24000	6.0
85476	20EFG6K-MTF X25FT	4651-4043	1	1 1/4	1.97	6000	24000	8.2
70870	20EFG6K-MTFXCTN	4651-1601	50	1 1/4	1.97	6000	24000	8.2
70991	24EFG6K-MTFXCTN	4651-1754	50	1 1/2	2.26	6000	24000	10.0
71098	32EFG6K-MTFXCTN	4651-1757	50	2	2.80	6000	24000	25.0

Directional spool valves, pilot-operated, with hydraulic or electro-hydraulic actuation

WEH and WH

RE 24751
Edition: 2016-06
Replaces: 08.08



H8051+8052

- Size 10 ... 32
- Component series 4X; 6X; 7X
- Maximum operating pressure 350bar *[5076psi]*
- Maximum flow 1100 l/min *[290 US gpm]*

Features

- 4/3-, 4/2- or 3/2-way version
- Types of actuation (internal or external pilot control):
  - Electro-hydraulic (type WEH)
  - Hydraulic (type WH)
- For subplate mounting
- Porting pattern according to ISO 4401 and NFPA T3.5.1 R2
- Spring or pressure centering, spring end position or hydraulic end position
- Wet-pin DC or AC solenoids, optional
- Electrical connection as individual or central connection
- Optional versions:
  - Manual override
  - Switching time adjustment
  - Preload valve in channel P of the main valve
  - Stroke setting and/or spool position monitoring

Contents

Ordering code

01	02	03	04	05	06	07		08	09	10	11	12	13	14	15	16		17	18	19	20	21	22
							/										/						*

01	Up to 280 bar	**no code**
	Up to 350 bar	**H –**

02	3-way version	**3**
	4-way version	**4**

Types of actuation

03	Electro-hydraulic	**WEH**
	Hydraulic	**WH**

Size

04	NG10	**10**
	NG16	**16**
	NG25 (version "W.H 22")	**22**
	NG25 (version "W.H 25")	**25**
	NG32	**32**

Spool return in the main valve

05	By means of springs	**no code**
	Hydraulic [1)]	**H**

06	For symbols, see page 5 and 6	

07	Component series 40 ... 49 (40 ... 49: unchanged installation and connection dimension) – NG10	**4X**
	Component series 60 ... 69 (60 ... 69: unchanged installation and connection dimension) – NG25 ("W.H 25") and NG32	**6X**
	Component series 70 ... 79 (70 ... 79: unchanged installation and connection dimension) – NG16 (from series 72) and NG25 ("W.H 22")	**7X**

Control spool return in the pilot control valve with 2 spool positions and 2 solenoids
(only possible with symbols C, D, K, Z and hydraulic control spool return in the main valve)

08	**With** spring return	**no code**
	Without spring return	**O**
	Without spring return with detent [2)]	**OF**

Pilot control valve [(2)]

09	High-power valve (data sheet 23178)	**6E**

10	Direct voltage 24 V [2)]	**G24**
	Alternating voltage 230 V 50/60 Hz [2)]	**W230**
	For other voltages, frequencies and electric data, see data sheet 23178	

11	**Without** manual override	**no code**
	With manual override	**N**
	With concealed manual override	**N9**

Pilot oil flow

12	External pilot oil supply, external pilot oil return [3)]	**no code**
	Internal pilot oil supply, external pilot oil return [3; 4)]	**E**
	Internal pilot oil supply, internal pilot oil return [4)]	**ET**
	External pilot oil supply, internal pilot oil return [3)]	**T**
	(For type WH... **only "no code"**; version "ET" and "T" with 3-spool position valve, pressure-centered **only** possible if $p_{pilot} \geq 2 \times p_{tank} + p_{pilot\ min}$!)	

Ordering code

01	02	03	04	05	06	07		08	09	10	11	12	13	14	15	16		17	18	19	20	21	22
							/										/						*

Switching time adjustment

13	**Without** switching time adjustment	**no code**
	Switching time adjustment as supply control	**S**
	Switching time adjustment as discharge control	**S2**

Corrosion resistance (outside)

14	None (valve housing primed)	**no code**
	Improved corrosion protection (240 h salt spray test according to EN ISO 9227)	**J3**

Electrical connection [2)]

15	**Individual connection**	
	Without mating connector; connector DIN EN 175301-803	**K4** [6)]
	For further electrical connections, see data sheet 23178 and 08010	

Spool position monitoring

16	**Without** position switch	**no code**
	Monitored spool position "a"	**QMAG24**
	Monitored spool position "b"	**QMBG24**
	Monitored spool position "a" and "b"	**QMABG24**
	Monitored rest position	**QM0G24**
	For more information, see data sheet 24830	

Stroke setting

17	For ordering code, see page 36 and 37	

Throttle insert [2)]

18	**Without** throttle insert	**no code**
	Throttle Ø 0.8 mm *[0.0315 inch]*	**B08**
	Throttle Ø 1.0 mm *[0.0394 inch]*	**B10**
	Throttle Ø 1.2 mm *[0.0472 inch]*	**B12**
	Throttle Ø 1.5 mm *[0.0591 inch]*	**B15**
	Throttle Ø 2.0 mm *[0.0787 inch]*	**B20**
	Throttle Ø 2.5 mm *[0.0984 inch]*	**B25**

Preload valve (not for NG10) [2)]

19	**Without** preload valve	**no code**
	With preload valve (p_c = 4.5 bar *[65 psi]*)	**P4,5**

20	**Without** pressure reducing valve	**no code**
	With pressure reducing valve	**D3** [5)]

Seal material

21	NBR seals	**no code**
	FKM seals	**V**
	Observe compatibility of seals with hydraulic fluid used. (other seals on request)	

22	For further information, see the plain text	*

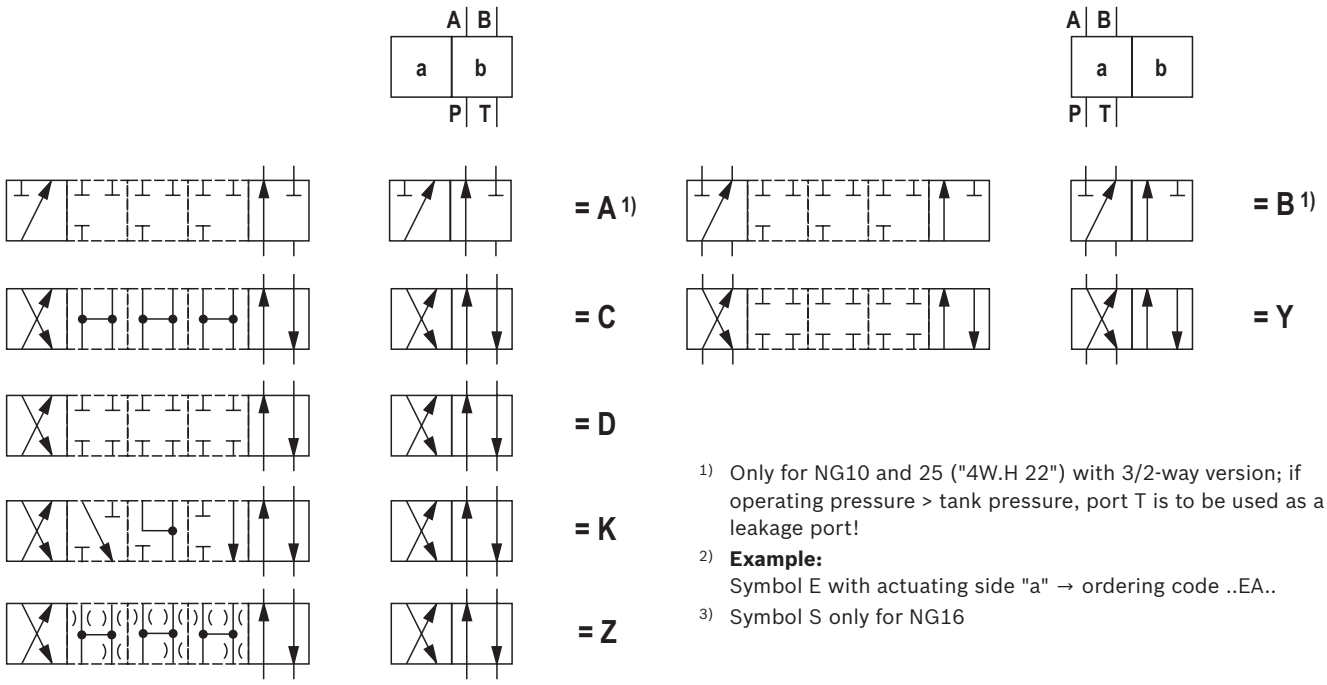
p_{pilot} = pilot pressure
$p_{pilot\ min}$ = minimum pilot pressure
p_{tank} = tank pressure
p_c = cracking pressure

Explanation of the footnotes, see page 4.

Ordering code

1) ▶ 2 spool positions (hydraulic end position): only symbols C, D, K, Z, Y
   ▶ 3 switching positions (hydraulically centered): only NG16, NG25 ("4W.H **25**") and NG32
2) Only with electro-hydraulic actuation (type WEH)
3) Pilot oil supply X or return Y **external**:
   ▶ The maximum admissible operating parameters of the pilot control valve must be observed (see data sheet 23178)!
   ▶ Minimum pilot pressure: please observe page 16!
   ▶ Maximum pilot pressure: please observe page 16!
4) Pilot oil supply **internal** (version "ET" and "E"):
   ▶ Minimum pilot pressure: please observe page 16!
   ▶ Maximum pilot pressure: please observe page 16!
   With a higher pilot pressure, use of a **pressure reducing valve "D3"** is required (if it is not used pilot pressure = operating pressure at the port!).
   ▶ In order to prevent inadmissibly high pressure peaks, a **"B10" throttle insert** has to be provided in port P of the pilot control valve (see page 14).
   ▶ In connection with version "H", the **pressure reducing valve "D3"** is also required.
5) Only in connection with the **"B10"** throttle insert
6) Mating connectors, separate order, see data sheet 23178

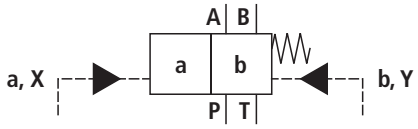
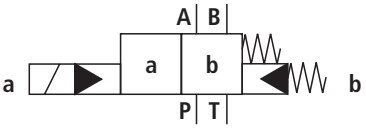
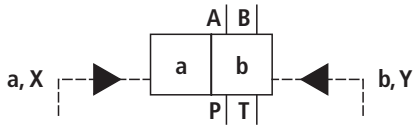
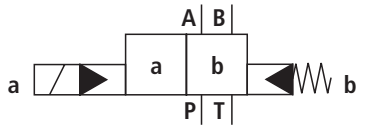
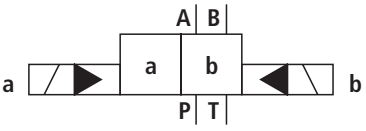
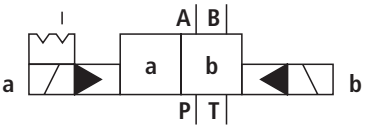
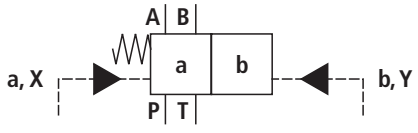
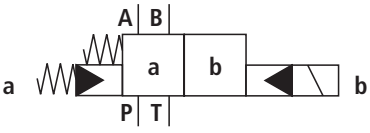
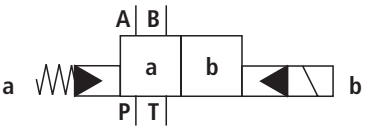
Symbols: 2 spool positions



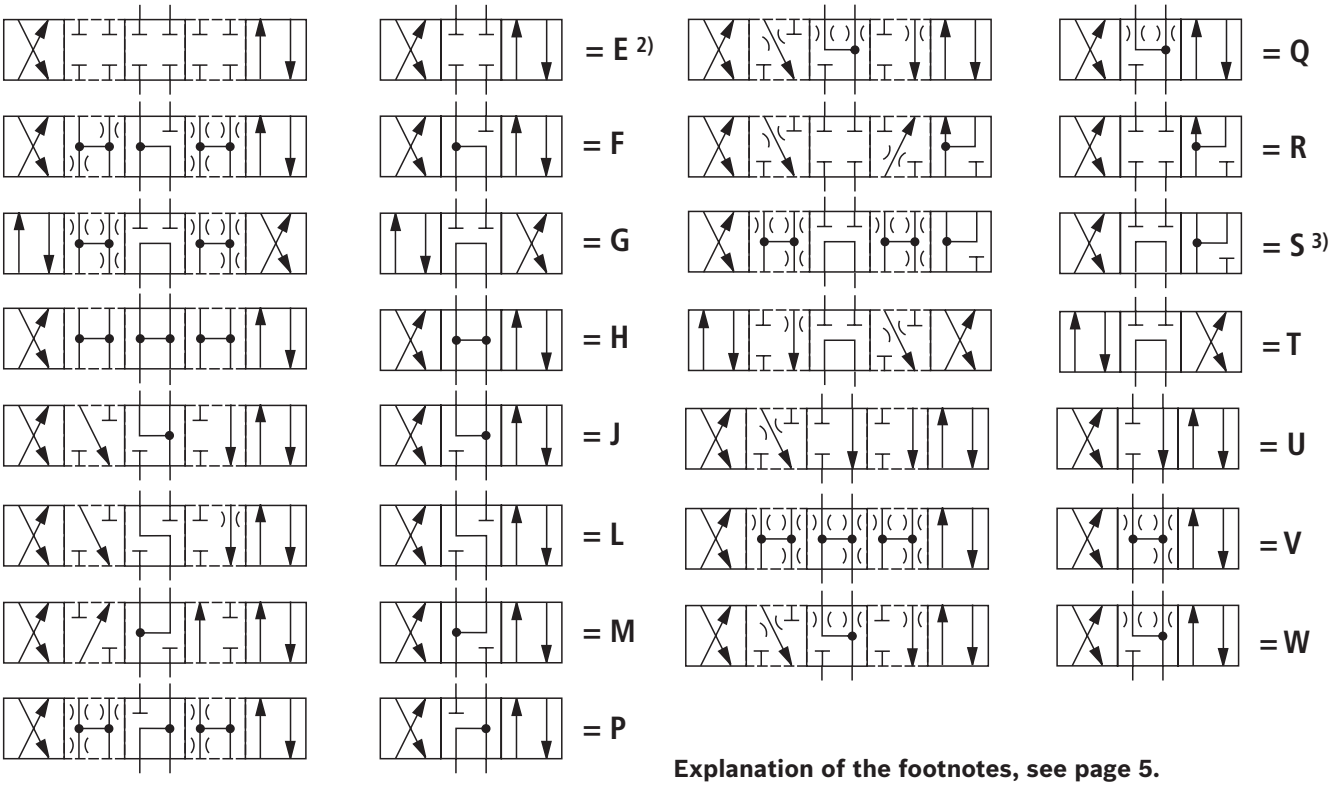
1) Only for NG10 and 25 ("4W.H 22") with 3/2-way version; if operating pressure > tank pressure, port T is to be used as a leakage port!

2) **Example:**
Symbol E with actuating side "a" → ordering code ..EA..

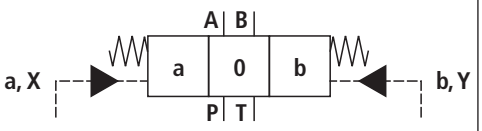
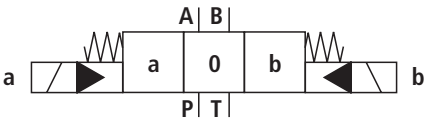
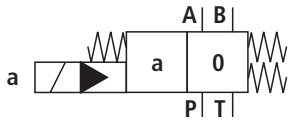
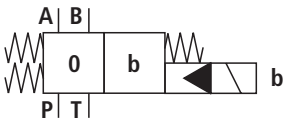
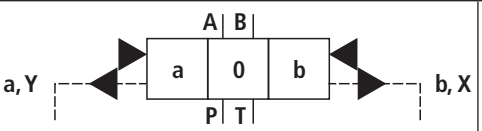
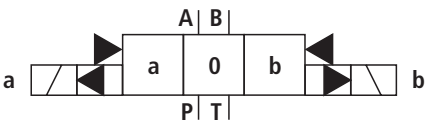
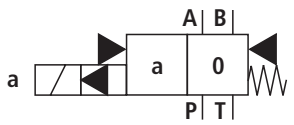
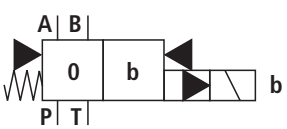
3) Symbol S only for NG16

Ordering code		Type of actuation	
Symbol	**Spool return**	**Type WH** (hydraulic)	**Type WEH** (electro-hydraulic)
A 1), **C, D, K, Z**	**../..**		
	..H../..		
	..H../O		
	..H../OF		
B 1), **Y**	**../..**		
	..H../..		

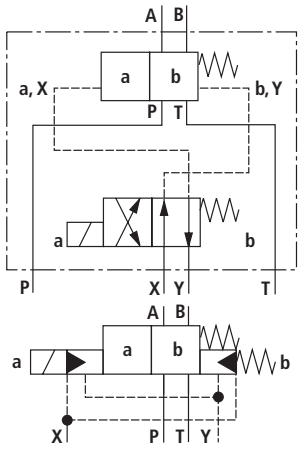
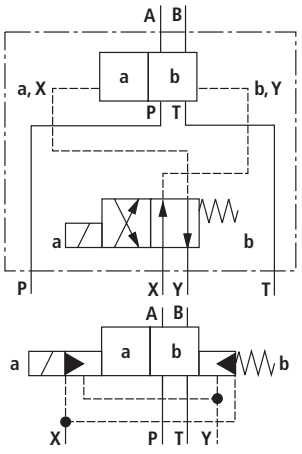
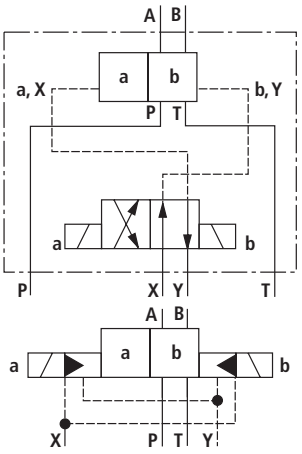
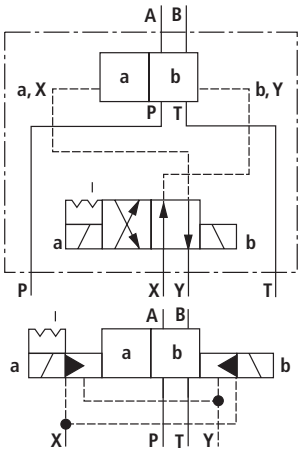
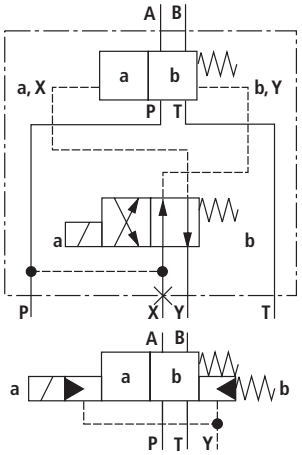
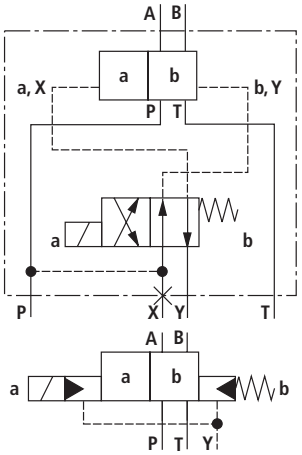
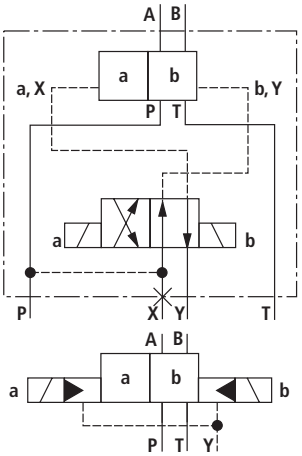
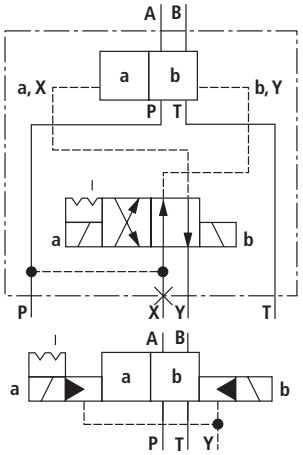
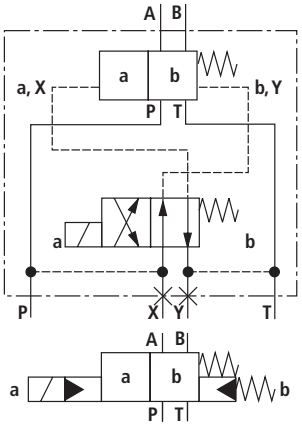
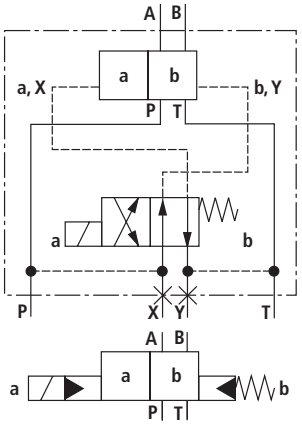
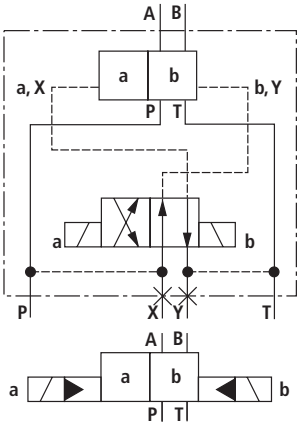
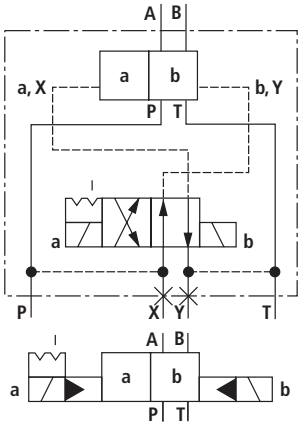
Symbols: 3 spool positions



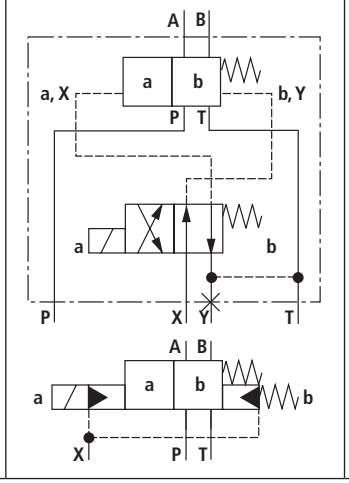
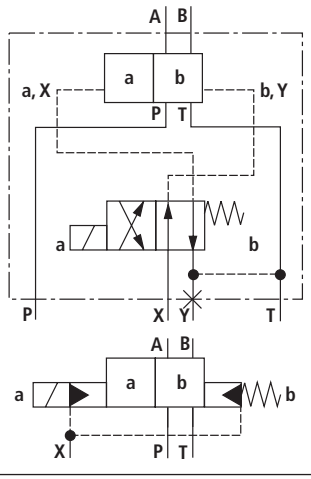
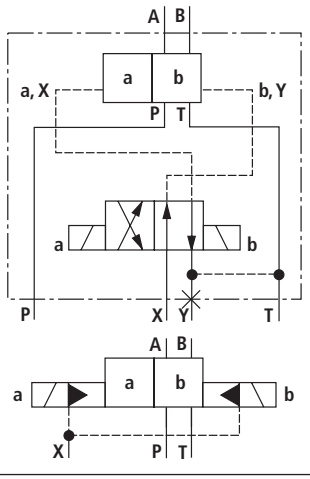
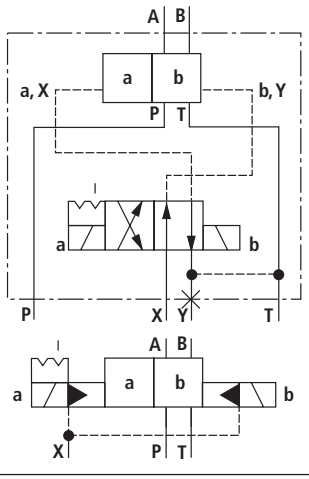
Explanation of the footnotes, see page 5.

Ordering code			Type of actuation	
Symbol	Actuating side	Spool return	**Type WH** (hydraulic)	**Type WEH** (electro-hydraulic)
E, F, G, H, J, L, M, P, Q, R, S, T, U, V, W		../..		
	.A			
	.B			
		..H../..		
	H.A			
	H.B			

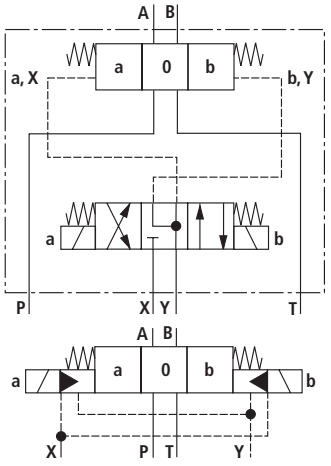
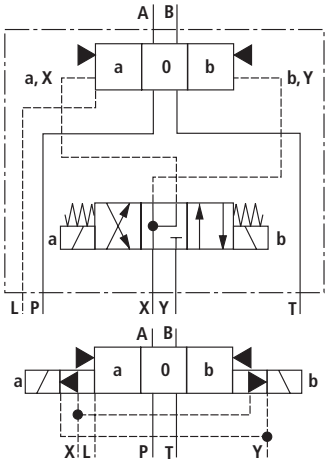
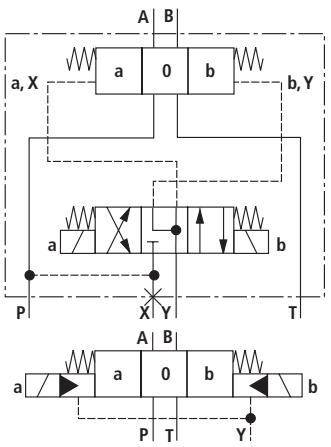
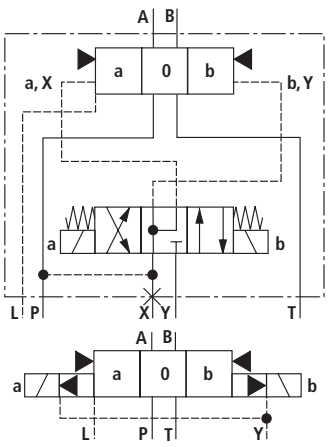
Symbols for valves with 2 spool positions

	Valve with spring end position	Valve with hydraulic end position		
	Type WEH.../..	Type WEH . H../...	Type WEH . H../O...	Type WEH . H../OF...
X = external; **Y** = external				
	Type WEH.../...E...	Type WEH . H../...E...	Type WEH . H../O...E...	Type WEH . H../OF...E...
X = internal; **Y** = external				
	Type WEH.../...ET...	Type WEH . H../...ET...	Type WEH . H../O...ET...	Type WEH . H../OF...ET...
X = internal; **Y** = internal				

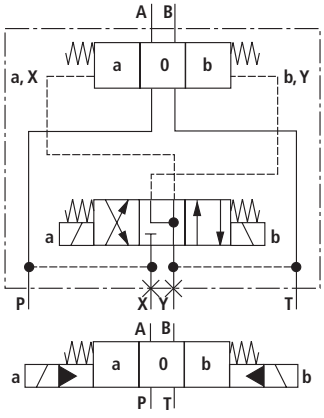
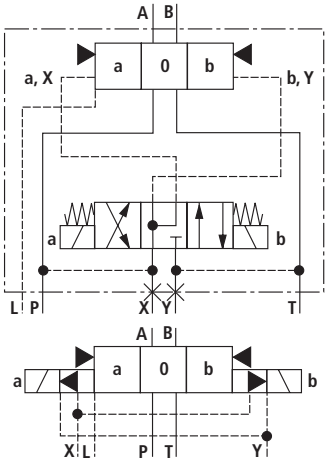
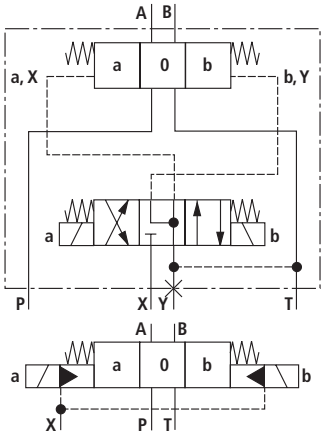
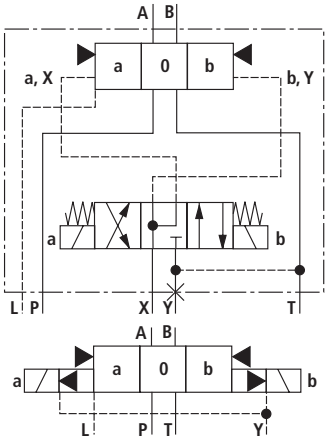
Symbols for valves with 2 spool positions

	Valve with spring end position	Valve with hydraulic end position		
	Type WEH.../...T...	Type WEH . H../...T...	Type WEH . H../O...T...	Type WEH . H../OF...T...
X = external; **Y** = internal				

Symbols for valves with 3 spool positions

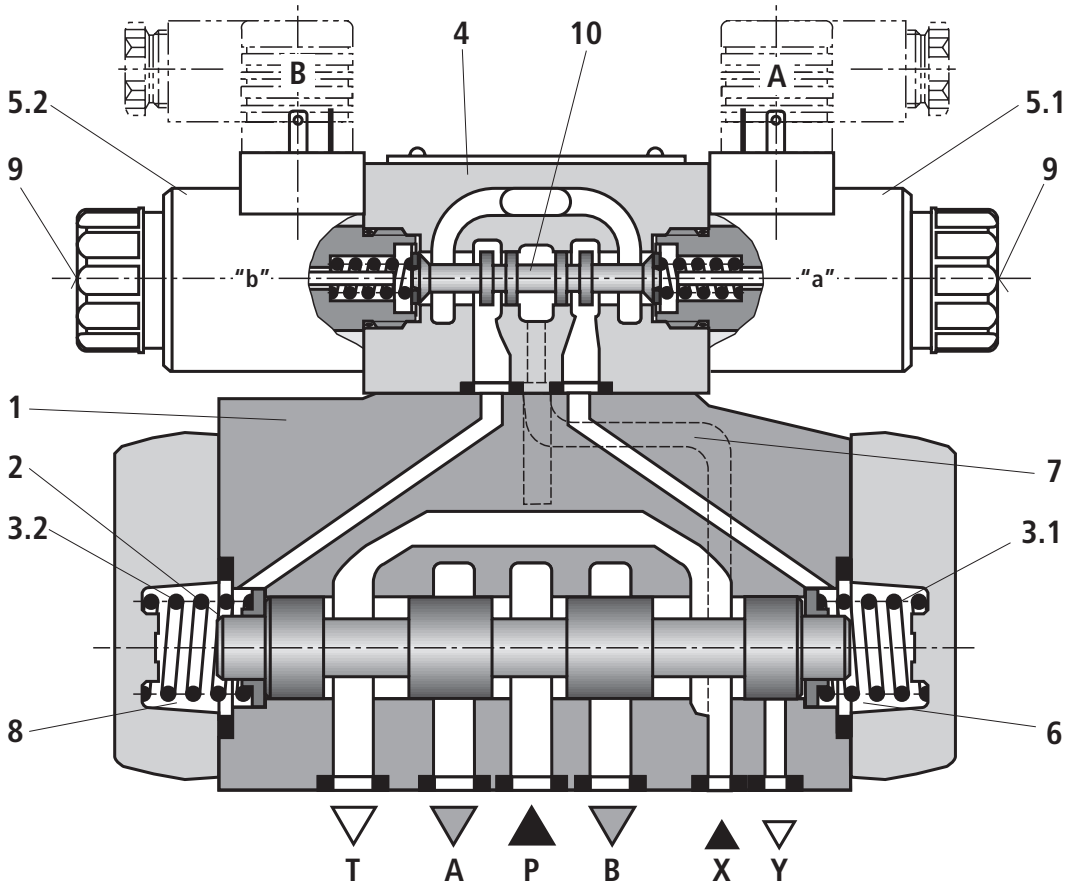
	Valve with spring-centered zero position	Valve with pressure-centered zero position only NG16, 25 ("W.H **25**") and 32
	Type WEH.../...	Type WEH . H../...
X = external; **Y** = external		
	Type WEH.../...E...	Type WEH . H../...E...
X = internal; **Y** = external		

Symbols for valves with 3 spool positions

	Valve with spring-centered zero position	**Valve with pressure-centered zero position** only NG16, 25 ("W.H **25**") and 32
X = internal; **Y** = internal	**Type WEH.../...ET...** 	**Type WEH . H../...ET...** 
X = external; **Y** = internal	**Type WEH.../...T...** 	**Type WEH . H../...T...** 

☞ **Notice:**
3-spool position valves, pressure-centered, preferably with external pilot oil supply and/or return ("no code", "E")
For preconditions for internal pilot oil supply and/or return ("ET", "T"), see page 4 and 15.

Function, section: Type WEH



Directional valves type WEH...

The valve type WEH is a directional spool valve with electro-hydraulic actuation. It controls the start, stop and direction of a flow.

The directional valve basically consists of the main valve with housing (1), the main control spool (2), one or two return springs (3.1) and (3.2), as well as the pilot control valve (4) with one or two solenoids "a" (5.1) and/or "b" (5.2).

The main control spool (2) in the main valve is held in the zero or initial position by the springs or by means of pressurization. In the initial position, the two spring chambers (6) and (8) are connected with the tank in a depressurized form via the pilot control valve (4). Via the control line (7), the pilot control valve is supplied with pilot oil. Supply can be implemented internally or externally (externally via port X). Upon actuation of the pilot control valve, e.g. solenoid "a", the pilot control spool (10) is moved to the left and thus, the spring chamber (8) is pressurized with pilot pressure. The spring chamber (6) remains depressurized.

The pilot pressure acts on the left side of the main control spool (2) and moves it against the spring (3.1). This connects port P with B and A with T in the main valve.

On switching off of solenoid, the pilot control spool (10) returns to its initial position (except impulse spool). The spring chamber (8) is unloaded to the tank.

The pilot oil return is implemented internally (via channel T) or externally (via channel Y).

An optional manual override (9) allows for moving of the pilot control spool (10) without solenoid energization.

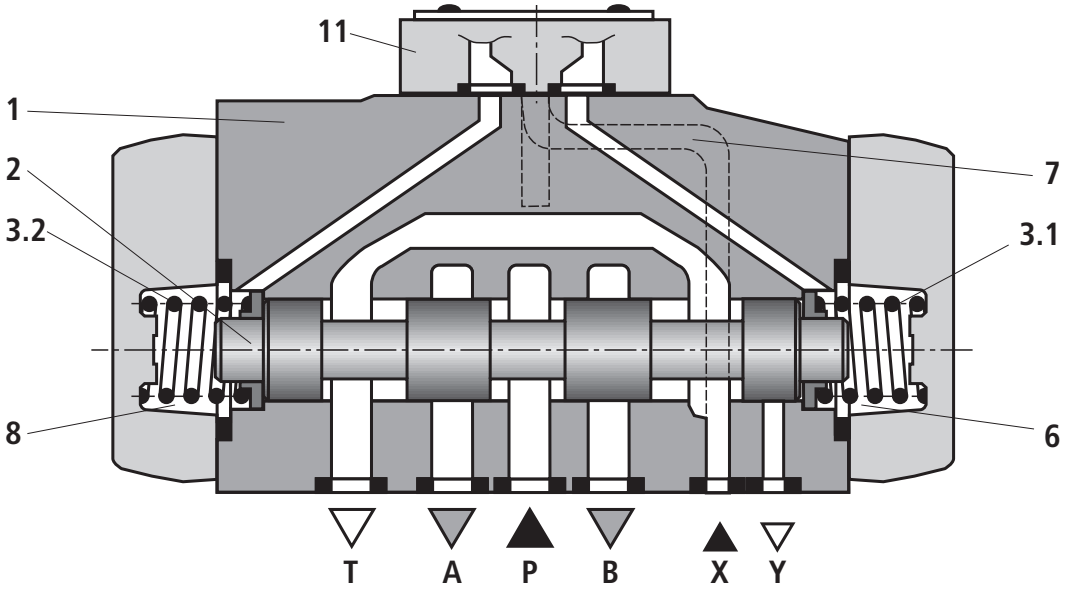
☞ **Notices:**

The return springs (3.1) and (3.2) in the spring chambers (6) and (8) hold the main control spool (2) in central position without pilot pressure even with, for example, vertical valve positioning.

Due to the design principle, internal leakage is inherent to the valves, which may increase over the life cycle.

For pilot oil supply, see page 13 and 14.

Function, section: Type WH

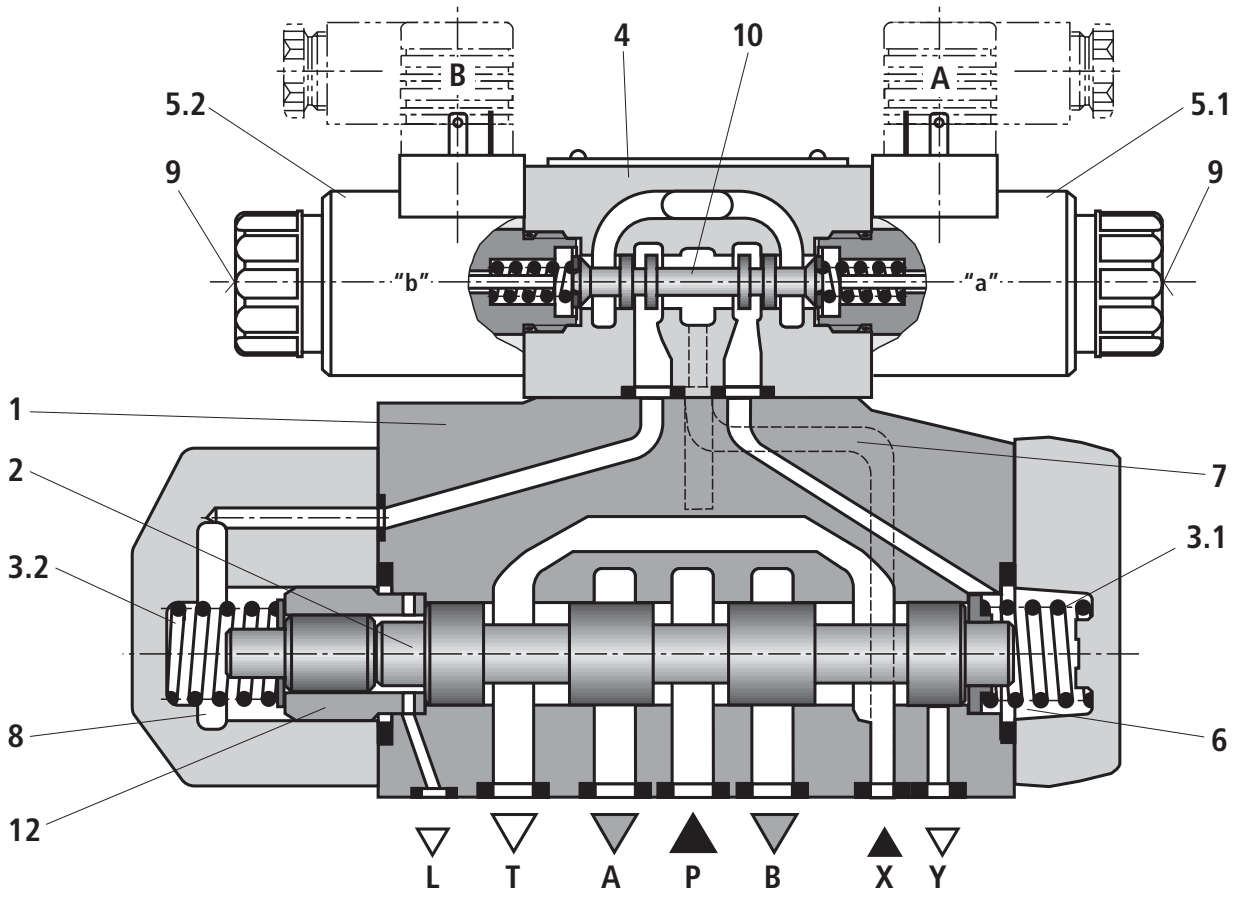


Directional valves type WH...
Valve type WH is a directional spool valve with hydraulic actuation. It controls the start, stop and direction of a flow.
The directional valve basically consists of the valve housing (1), the main control spool (2), one or two return springs (3.1) and (3.2) at valves with spring return or spring centering as well as the diversion plate (11).
The main control spool (2) is actuated directly by pressurization.
The main control spool (2) is held in zero or initial position by springs or pressurization. Pilot oil supply and return are external (see page 13).

4/3 directional valve with spring centering of the control spool
With this version, the main control spool (2) is held in zero position by two return springs (3.1) and (3.2). The two spring chambers (6) and (8) are connected to ports X and Y via the diversion plate (11).
With pilot pressure loading of one of the two front sides of the main control spool (2), the spool is moved to the switching position. In the valve, the required ports are connected in this way.
The spring on the opposite side returns the spool to the zero or initial position at pressure relief of the pressurized control spool area.

For pilot oil supply, see page 13 and 14.

Function, section: Type WEH...H



4/3 directional valve with pressure centering of the main control spool, type WEH...H

The main control spool (2) in the main valve is kept in the zero position by pressurization of the two front faces. One centering bush (12) rests on the housing and fixes the control spool position.

By pressure relief of one front face, the main control spool (2) is moved to the switching position.

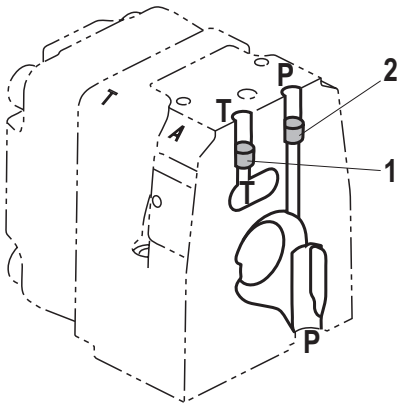
The unloaded control spool face displaces the returning pilot oil into channel Y (external) via the pilot control valve.

☞ **Notices:**

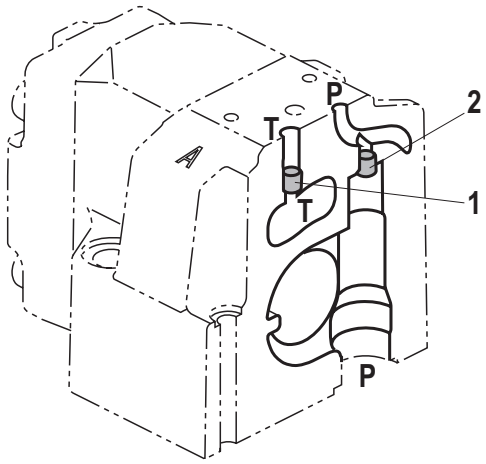
The springs (3.1) and (3.2) do not have a return function in this version. They hold the main control spool (2) in central position in the depressurized condition and with horizontal installation.

Pilot oil supply (schematic illustration)

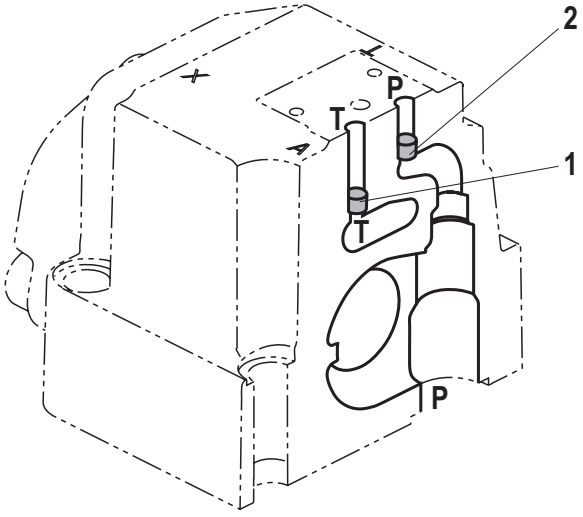
NG10



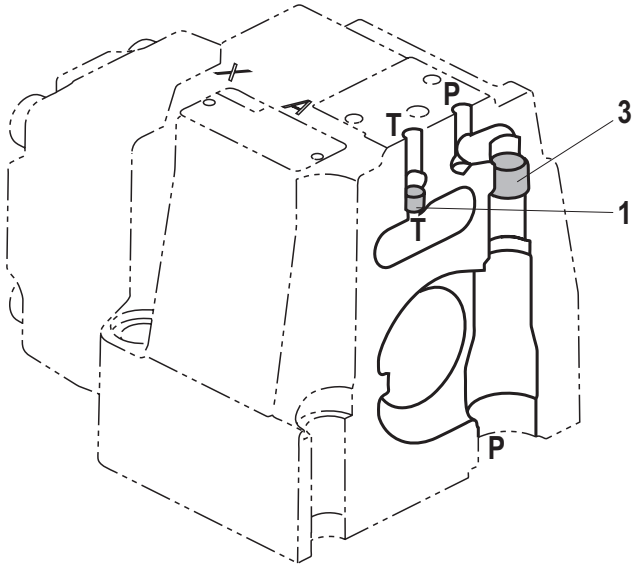
NG16



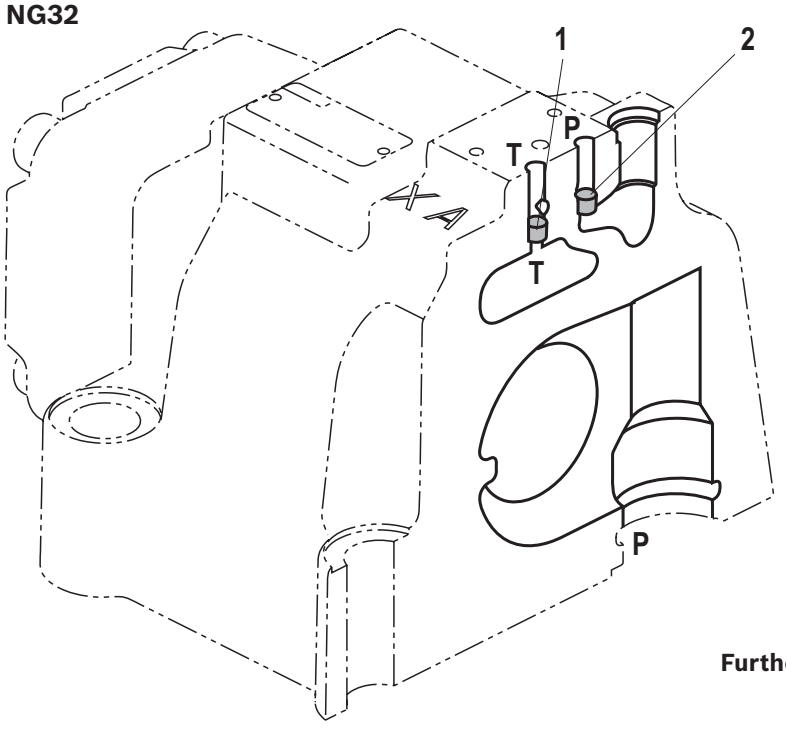
NG25 ("W.H **22**")



NG25 ("W.H **25**")



NG32



1 Plug screw M6 according to DIN 906, wrench size 3 – pilot oil return

2 Plug screw M6 according to DIN 906, wrench size 3 – pilot oil supply

9 Plug screw M12 x 1.5 according DIN 906, wrench size 6 – pilot oil supply

Pilot oil supply
external: **2, 3** closed
internal: **2, 3** open

Pilot oil return
external: **1** closed
internal: **1** open

Further explanations on page 14.

Pilot oil supply

Type WH...
The pilot oil supply and return is implemented **externally** via channel X and Y.

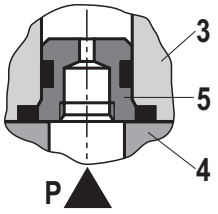
Type WEH...
The pilot oil supply is implemented **externally** - via channel X - from a separate pressure supply.
The pilot oil return is implemented **externally** - via channel Y - into the tank.

Type WEH...E...
The pilot oil supply is implemented **internally** from channel P of the main valve. (see page 15, footnotes [5] and [6])
The pilot oil return is implemented **externally** - via channel Y - into the tank. In the subplate, port X is closed.

Type WEH...ET...
The pilot oil supply is implemented **internally** from channel P of the main valve.
The pilot oil return is implemented **internally** - via channel T - into the tank. In the subplate, ports X and Y are closed.

Type WEH...T...
The pilot oil supply is implemented **externally** - via channel X - from a separate pressure supply.
The pilot oil return is implemented **internally** - via channel T - into the tank. In the subplate, port Y is closed.

Throttle insert
Use of the throttle insert (5) is necessary if the pilot oil supply in channel P of the pilot control valve is to be limited (see below).
The throttle insert (5) is inserted in channel P of the pilot control valve.



☞ **Notices:**
The modification of the pilot oil supply may only be performed by authorized specialists or at the factory!
- Pilot oil supply X or return Y **external**:
  - The maximum admissible operating parameters of the pilot control valve must be observed (see data sheet 23178)!
  - Maximum pilot pressure: please observe page 16!
- Pilot oil supply **internal** (version "ET" and "E"):
  - Minimum pilot pressure: please observe page 15!
  - In order to prevent inadmissibly high pressure peaks, a **"B10" throttle insert** has to be provided in port P of the pilot control valve (see above).
  - In connection with version "H", the **pressure reducing valve "D3"** (see page 38) is also required.

3 Pilot control valve
4 Main valve
5 Throttle insert

Technical data
(For application outside these values, please consult us!)

general							
Sizes		NG	**10**	**16**	**25** "W.H **22**"	**25** "W.H **25**"	**32**
Weight, approx.	▶ Valve with one solenoid	kg *[lbs]*	6.4 *[14.1]*	8.5 *[18.7]*	11.5 *[25.3]*	17.6 *[38.8]*	17.6 *[38.8]*
	▶ Valve with two solenoids, spring-centered	kg *[lbs]*	6.8 *[15.0]*	8.9 *[19.6]*	11.9 *[26.2]*	19.0 *[41.9]*	41.0 *[90.4]*
	▶ Valve with two solenoids, pressure-centered	kg *[lbs]*	6.8 *[15.0]*	8.9 *[19.6]*	11.9 *[26.2]*	19.0 *[41.9]*	41.0 *[90.4]*
	▶ Valve witch hydraulic actuation (type WH...)	kg *[lbs]*	5.5 *[12.1]*	7.3 *[16.1]*	10.5 *[23.1]*	16.5 *[36.4]*	39.5 *[87.1]*
	▶ Switching time adjustment "S" and "S2"	kg *[lbs]*	0.8 *[1.8]*	0.8 *[1.8]*	0.8 *[1.8]*	0.8 *[1.8]*	0.8 *[1.8]*
	▶ Pressure reducing valve "D3"	kg *[lbs]*	0.4 *[0.9]*	0.4 *[0.9]*	0.4 *[0.9]*	0.4 *[0.9]*	0.4 *[0.9]*
Installation position			Any; horizontal with valves with hydraulic control spool return "H" and symbol A, B, C, D, K, Z, Y. With suspended installation, higher sensitivity to contamination – horizontal is recommended.				
Ambient temperature range	▶ Standard version	°C *[°F]*	–20 ... +70 *[–4 ... +158]* (NBR seals) –15 ... +70 *[+5 ... +158]* (FKM seals)				
	▶ Version for HFC hydraulic fluid	°C *[°F]*	–20 ... +50 *[–4 ... +122]*				
Storage temperature range		°C *[°F]*	+5 ... +40 *[+41 ... +104]*				
Surface protection (valve body)			Coating, layer thickness max. 100 µm				
$MTTF_d$ values according to EN ISO 13849		Years	100 (type WEH), 150 (type WH) (for further details, see data sheet 08012)				

hydraulic								
Maximum operating pressure								
▶ Port P, A, B		Type W.H	bar *[psi]*	280 *[4061]*	280 *[4061]*	280 *[4061]*	280 *[4061]*	280 *[4061]*
		Type H-W.H	bar *[psi]*	350 *[5076]*	350 *[5076]*	350 *[5076]*	350 *[5076]*	350 *[5076]*
▶ Port T	External pilot oil return Y	Type W.H	bar *[psi]*	280 *[4061]*	250 *[3626]*	250 *[3626]*	250 *[3626]*	250 *[3626]*
		Type H-W.H		315 *[4568]*	250 *[3626]*	250 *[3626]*	250 *[3626]*	250 *[3626]*
	Internal pilot oil return Y [1]	Type H-WEH, WEH	bar *[psi]*	210 *[3046]* with direct voltage 160 *[2320]* with alternating voltage				
▶ Port Y	External pilot oil return	Type H-WEH, WEH	bar *[psi]*	210 *[3046]* with direct voltage 160 *[2320]* with alternating voltage				
		Type WH, H-WH	bar *[psi]*	250 *[3626]*	250 *[3626]*	210 *[3046]*	250 *[3626]*	250 *[3626]*
Hydraulic fluid				see table on page 15				
Hydraulic fluid temperature range (at the valve working ports) [3]			°C *[°F]*	–20 ... +80 *[–4 ... +176]* (NBR seals) –15 ... +80 *[+5 ... +176]* (FKM seals) –20 ... +50 *[–4 ... +122]* (HFC hydraulic fluid)				
Viscosity range			mm^2/s *[SUS]*	2.8 ... 500 *[35 ... 2320]*				
Maximum admissible degree of contamination of the hydraulic fluid Cleanliness class according to ISO 4406 (c)				Class 20/18/15 [2]				

1) As a 3-spool position valve, pressure-centered only possible if $p_{pilot} \geq 2 \times p_{tank} + p_{pilot\ min}$.

2) The cleanliness classes specified for the components must be adhered to in hydraulic systems. Effective filtration prevents faults and simultaneously increases the life cycle of the components.
For selecting the filters, see www.boschrexroth.com/filter.

3) If type WH is used in potentially explosion-proof areas, see data sheet 07011.

Technical data
(For applications outside these parameters, please consult us!)

hydraulic							
Size		NG	**10**	**16**	**25** "W.H **22**"	**25** "W.H **25**"	**32**
Maximum pilot pressure [4]		bar *[psi]*	250 *[3626]*	250 *[3626]*	210 *[3046]*	250 *[3626]*	250 *[3626]*
Minimum pilot pressure							
▶ External pilot oil supply X (all symbols), internal pilot oil supply (only symbols D, K, E, J, L, M, Q, R, U, W)							
3-spool position valve, spring-centered	Type H-.W.H...	bar *[psi]*	12 *[174]*	14 *[203]*	12.5 *[181]*	13 *[188]*	8.5 *[123]*
	Type W.H...	bar *[psi]*	12 *[174]*	14 *[203]*	10.5 *[152]*	13 *[188]*	8.5 *[123]*
3-spool position valve, pressure-centered		bar *[psi]*	–	14 *[203]*	–	18 *[261]*	8.5 *[123]*
2-spool position valve with spring end position	Type H-W.H...	bar *[psi]*	10 *[145]*	14 *[203]*	14 *[203]*	13 *[188]*	10 *[145]*
	Type W.H...	bar *[psi]*	10 *[145]*	14 *[203]*	11 *[159]*	13 *[188]*	10 *[145]*
2-spool position valve with hydraulic end position		bar *[psi]*	7 *[101]*	14 *[203]*	8 *[116]*	8 *[116]*	5 *[72]*
▶ Internal pilot oil supply X (only type WEH) (with symbols C, F, G, H, P, T, V, Z, S [5])		bar *[psi]*	7.5 *[109]* [6]	4.5 *[65]* [7]	4.5 *[65]* [7]	4.5 *[65]* [7]	4.5 *[65]* [7]
Free flow cross-sections in zero position with symbols Q, V and W							
Symbol **Q**	A – T; B – T	mm² *[inch²]*	13 *[0.02]*	32 *[0.05]*	78 *[0.121]*	83 *[0.129]*	78 *[0.121]*
Symbol **V**	P – A; P – B	mm² *[inch²]*	13 *[0.02]*	32 *[0.05]*	73 *[0.113]*	83 *[0.129]*	73 *[0.113]*
	A – T; B – T	mm² *[inch²]*	13 *[0.02]*	32 *[0.05]*	84 *[0.13]*	83 *[0.129]*	84 *[0.13]*
Symbol **W**	A – T; B – T	mm² *[inch²]*	2.4 *[0.004]*	6 *[0.009]*	10 *[0.015]*	14 *[0.022]*	20 *[0.031]*

[4] ▶ **Internal** pilot oil supply:
- With a higher pilot pressure, use of a **pressure reducing valve "D3"** is required (if it is not used pilot pressure = operating pressure at the port).
- In connection with version "H", the **pressure reducing valve "D3"** is also required.

▶ **External** pilot oil supply:
- In connection with version "H-", compliance with the maximum pilot pressure must be ensured by appropriate measures (e. g. protection of the separate pilot oil circuit by means of a pressure relief valve)!

[5] Symbol S only for NG16

[6] For symbols C, F, G, H, P, T, V, Z, an internal pilot oil supply is only possible if the flow from P to T in the central position (for 3-spool position valve) or while crossing the central position (for 2-spool position valve) is so large that the pressure differential of P to T reaches a value of at least 7.5 bar *[109 psi]* and the pilot oil return Y is implemented externally.

[7] For symbols C, F, G, J, H, P, T, V, Z, S [5] – by means of preload valve (not NG10) or correspondingly high flow. (Determination of the required flow, see "Preload valve" characteristic curves on page 39.) For NG10, a check valve with a cracking pressure of 7.5 bar *[109 psi]* is to be provided in the return line to the tank. The pilot oil return Y must be implemented externally.

Technical data
(For application outside these values, please consult us!)

hydraulic							
Size		NG	**10**	**16**	**25** "W.H **22**"	**25** "W.H **25**"	**32**
Pilot volume for switching process							
▶ 3-spool position valve, spring-centered		cm³ *[inch³]*	2.04 *[0.124]*	5.72 *[0.349]*	7.64 *[0.466]*	14.2 *[0.866]*	29.4 *[1.794]*
▶ 2-spool position valve		cm³ *[inch³]*	4.08 *[0.249]*	11.45 *[0.699]*	15.28 *[0.932]*	28.4 *[1.733]*	58.8 *[3.588]*
▶ 3-spool position valve, pressure-centered							
from zero position in switching position "a"	Type WH	cm³ *[inch³]*	–	2.83 *[0.173]*	–	7.15 *[0.436]*	14.4 *[0.879]*
	Type WEH	cm³ *[inch³]*	–	2.83 *[0.173]*	–	7.15 *[0.436]*	14.4 *[0.879]*
from switching position "a" in zero position	Type WH	cm³ *[inch³]*	–	5.72 *[0.349]*	–	14.18 *[0.865]*	29.4 *[1.794]*
	Type WEH	cm³ *[inch³]*	–	2.9 *[0.177]*	–	7.0 *[0.427]*	15.1 *[0.921]*
from zero position in switching position "b"	Type WH	cm³ *[inch³]*	–	5.72 *[0.349]*	–	14.18 *[0.865]*	29.4 *[1.794]*
	Type WEH	cm³ *[inch³]*	–	5.72 *[0.349]*	–	14.15 *[0.863]*	29.4 *[1.794]*
from switching position "b" in zero position	Type WH	cm³ *[inch³]*	–	8.55 *[0.522]*	–	19.88 *[1.213]*	43.8 *[2.673]*
	Type WEH	cm³ *[inch³]*	–	2.83 *[0.173]*	–	5.73 *[0.349]*	14.4 *[0.879]*
Pilot flow for shortest switching time, approx.		l/min *[US gpm]*	35 *[9.2]*	35 *[9.2]*	35 *[9.2]*	35 *[9.2]*	45 *[11.9]*

Hydraulic fluid		**Classification**	**Suitable sealing materials**	**Standards**	**Data sheet**
Mineral oils		HL, HLP, HLPD, HVLP, HVLPD	NBR, FKM	DIN 51524	90220
Bio-degradable [1]	▶ Insoluble in water	HETG	FKM	ISO 15380	90221
		HEES	FKM		
	▶ Soluble in water	HEPG	FKM	ISO 15380	
Flame-resistant	▶ Water-free	HFDU (glycol base)	FKM	ISO 12922	90222
		HFDU (ester base) [1]	FKM		
	▶ Containing water [1]	HFC (Fuchs Hydrotherm 46M, Petrofer Ultra Safe 620)	NBR	ISO 12922	90223

☞ **Important notice on hydraulic fluids:**
- ▶ For more information and data on the use of other hydraulic fluids, please refer to the data sheets above or contact us.
- ▶ There may be limitations regarding the technical valve data (temperature, pressure range, life cycle, maintenance intervals, etc.).
- ▶ The ignition temperature of the hydraulic fluid used must be 50 K higher than the maximum solenoid surface temperature.
- ▶ **Flame-resistant – containing water**:
  - – Maximum pressure differential per control edge 50 bar
  - – Pressure pre-loading at the tank port >20% of the pressure differential, otherwise increased cavitation erosion
  - – Life cycle as compared to operation with mineral oil HL, HLP 30 ... 100%
- ▶ **Bio-degradable and flame-resistant:** If these hydraulic fluids are used, small amounts of dissolved zinc may get into the hydraulic system. (700 mg zinc per pole tube).

[1] Not recommended for corrosion-protected version "J3" (contains zinc)

Switching times

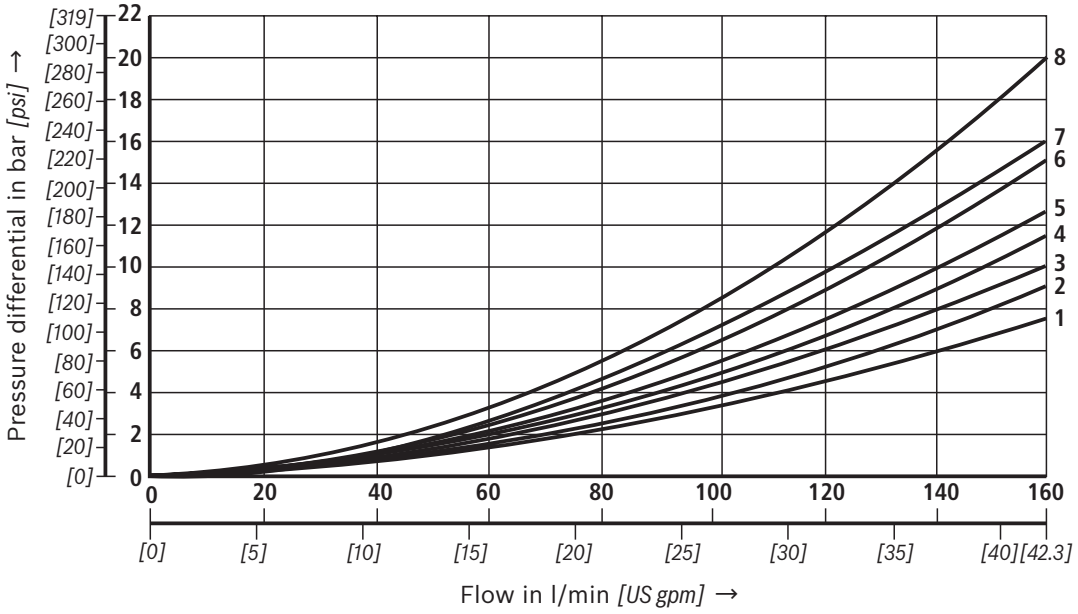
Pilot pressure		bar *[psi]*	70 *[1015]*	210 *[3046]*	250 *[3626]*	Spring
			ON			OFF
NG10	▶ Without throttle insert	ms	40 ... 60	–	40 ... 60	20 ... 30
	▶ With throttle insert	ms	60 ... 90	–	50 ... 70	20 ... 30
NG16	▶ Without throttle insert	ms	50 ... 80	–	40 ... 60	50 ... 80
	▶ With throttle insert	ms	110 ... 130	–	80 ... 100	50 ... 80
NG25 ("4W.H **22**")	▶ Without throttle insert	ms	40 ... 70	40 ... 60	–	50 ... 70
	▶ With throttle insert	ms	140 ... 160	80 ... 110	–	50 ... 70
NG25 ("4W.H **25**")	▶ Without throttle insert	ms	70 ... 100	–	50 ... 70	100 ... 130
	▶ With throttle insert	ms	200 ... 250	–	120 ... 150	100 ... 130
NG32	▶ Without throttle insert	ms	80 ... 130	–	70 ... 100	140 ... 160
	▶ With throttle insert	ms	420 ... 560	–	230 ... 350	140 ... 160

☞ **Notices:**

- Switching times = Contacting at the pilot control valve until start of opening of the control edge in the main valve and change in the control spool stroke by 95%)
- The switching times are measured according to ISO 6403 with HLP46, ϑ_{oil} = 40 °C ± 5 °C *[104 °F ±9 °F]*.
  With different oil temperatures, variations are possible!
- The switching times were determined using DC solenoids. They decrease by approx. 20 ms if AC solenoids are used.
- The shut-off of the solenoids creates voltage peaks, which can be reduced by the use of suitable diodes.
- The switching times increase by approx. 30 ms if the pressure reducing valve "D3" is used.
- The switching times have been determined under ideal conditions and may differ in the system, depending on the application conditions.

Characteristic curves: NG10
(measured with HLP46, ϑ_{Oil} = 40 ±5°C *[104 ±9°F]*)

***Δp-q*$_V$ characteristic curves**



Symbol	Spool position				Zero position		
	P – A	P – B	A – T [1]	B – T [1]	A – T	B – T	P – T
E, Y, D, Q, V, W, Z	1	1	3	5			
F	1	3	1	4	3	–	6
G, T	4	2	4	7	–	–	8
H, C	3	3	1	7	1	5	5
J, K	1	2	1	6			
L	2	2	1	4	2	–	–
M	3	3	2	5			
P	3	1	2	7	–	5	7
R	1	2	3	–			
U	2	2	3	6	–	6	–
A, B	1	1	–	–			

[1] The pressure differential refers to the use of port T. If port T1 is additionally used, the pressure differential may be lower. If only port T1 is used, the relations A – T and B – T may be reversed.

Performance limits: NG10
(measured with HLP46, ϑ_{Oil} = 40 ±5°C *[104 ±9°F]*)

2-spool position valves – $q_{V\,max}$ in l/min *[US gpm]*

Symbol	Operating pressure p_{max} in bar *[psi]*				
	70 *[1015]*	**140** *[2030]*	**210** *[3046]*	**280** *[4061]*	**350** *[5076]*
X external – spring end position in the main valve [1] (with $p_{pilot\,min}$ = 12 bar *[174 psi]*)					
C, D, K, Y, Z	160 *[42]*	160 *[42]*	160 *[42]*	160 *[42]*	160 *[42]*
X external – hydraulic end position in the main valve					
HC, HD, HK, HZ, HY	160 *[42]*	160 *[42]*	160 *[42]*	160 *[42]*	160 *[42]*

[1] If the pilot pressure fails, the function of the return spring is no longer guaranteed with the specified flow values!

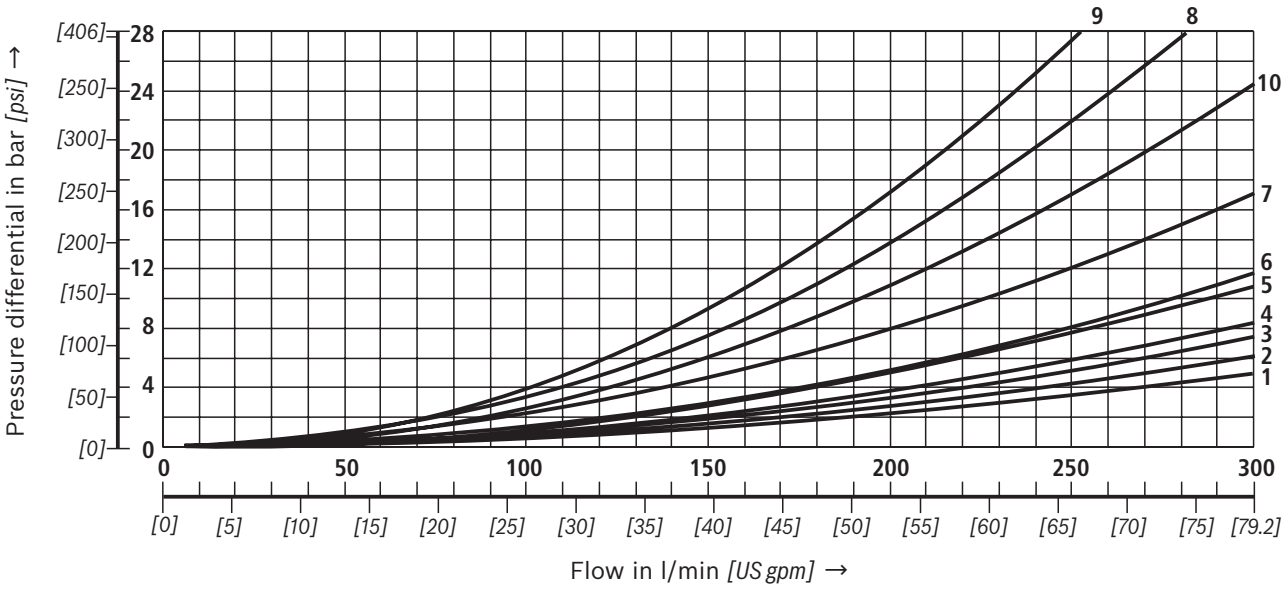
3-spool position valves – $q_{V\,max}$ in l/min *[US gpm]*

Symbol	Operating pressure p_{max} in bar *[psi]*				
	70 *[1015]*	**140** *[2030]*	**210** *[3046]*	**280** *[4061]*	**350** *[5076]*
X external – spring-centered					
E, J, L, M, Q, U, V, W, R	160 *[42]*	160 *[42]*	160 *[42]*	160 *[42]*	160 *[42]*
F, P	160 *[42]*	120 *[32]*	100 *[26]*	90 *[20]*	90 *[20]*
G, T	160 *[42]*	160 *[42]*	160 *[42]*	130 *[34]*	120 *[32]*
H	160 *[42]*	160 *[42]*	120 *[32]*	110 *[29]*	100 *[26]*

☞ **Important notices see page 28.**

Characteristic curves: NG16
(measured with HLP46, ϑ_{Oil} = 40 ±5 °C *[104 ±9 °F]*)

***Δp-q*V characteristic curves**



Symbol	Spool position				Zero position		
	P – A	P – B	A – T	B – T	P – T	A – T	B – T
D, E, Y	1	1	3	3			
F	1	2	5	5	4	3	–
G	4	1	5	5	7	–	–
C, H	1	1	5	6	2	4	4
K, J	2	2	6	6	–	3	–
L	2	2	5	4	–	3	–
M	1	1	3	4			
P	2	1	3	6	5	–	–

Symbol	Spool position				Zero position		
	P – A	P – B	A – T	B – T	P – T	A – T	B – T
Q	1	1	6	6			
R	2	4	7	–			
S	3	3	3	–	9	–	–
T	4	1	5	5	7	–	–
U	2	2	3	4			6
V, Z	1	1	6	6	10	8	8
W	1	1	3	4			

Performance limits: NG16
(measured with HLP46, ϑ_{Oil} = 40 ±5 °C *[104 ±9 °F]*)

2-spool position valves – $q_{V\,max}$ in l/min *[US gpm]*					
Symbol	**Operating pressure p_{max} in bar** *[psi]*				
	70 *[1015]*	**140** *[2030]*	**210** *[3046]*	**280** *[4061]*	**350** *[5076]*
X external – spring end position in the main valve (with $p_{pilot\,min}$ = 12 bar *[174 psi]*)					
C, D, K, Y, Z	300 *[79]*	300 *[79]*	300 *[79]*	300 *[79]*	300 *[79]*
X external – spring end position in the main valve [1]					
C	300 *[79]*	300 *[79]*	300 *[79]*	300 *[79]*	300 *[79]*
D, Y	300 *[79]*	270 *[71]*	260 *[68]*	250 *[66]*	230 *[60]*
K	300 *[79]*	250 *[66]*	240 *[63]*	230 *[60]*	210 *[55]*
Z	300 *[79]*	260 *[68]*	190 *[50]*	180 *[47]*	160 *[42]*
X external – hydraulic end position in the main valve					
HC, HD, HK, HZ, HY	300 *[79]*	300 *[79]*	300 *[79]*	300 *[79]*	300 *[79]*

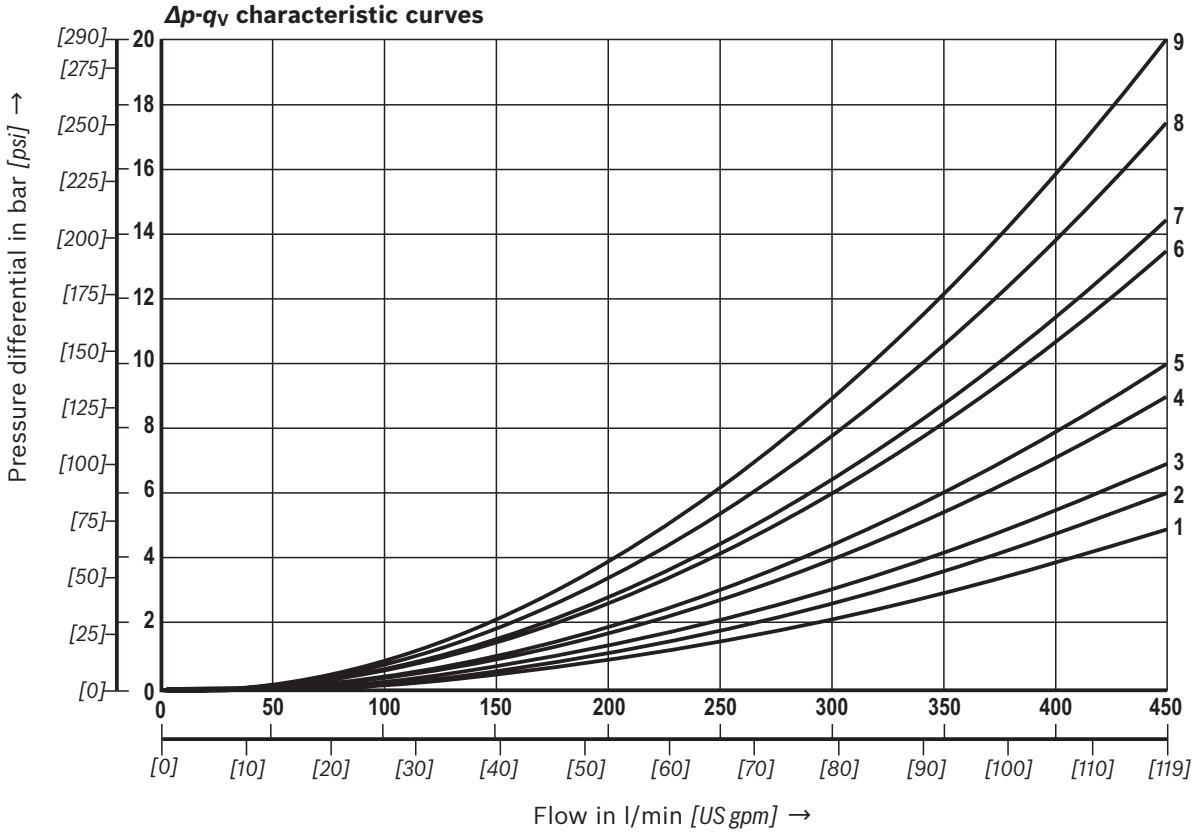
3-spool position valves – $q_{V\,max}$ in l/min *[US gpm]*					
Symbol	**Operating pressure p_{max} in bar** *[psi]*				
	70 *[1015]*	**140** *[2030]*	**210** *[3046]*	**280** *[4061]*	**350** *[5076]*
X external – spring-centered					
E, H, J, L, M, Q, U, W, R	300 *[79]*	300 *[79]*	300 *[79]*	300 *[79]*	300 *[79]*
F, P	300 *[79]*	250 *[66]*	180 *[47]*	170 *[45]*	150 *[39]*
G, T	300 *[79]*	300 *[79]*	240 *[63]*	210 *[55]*	190 *[50]*
S	300 *[79]*	300 *[79]*	300 *[79]*	250 *[66]*	220 *[58]*
V	300 *[79]*	250 *[66]*	210 *[55]*	200 *[53]*	180 *[47]*
X external – pressure-centered (at minimum pilot pressure of 16 bar *[232 psi]*)					
all symbols [2]	300 *[79]*	300 *[79]*	300 *[79]*	300 *[79]*	300 *[79]*

1) If the specified flow values are exceeded, the function of the return spring is no longer guaranteed if the pilot pressure fails!

2) With symbol V, the pilot control valve is not required for flows >160 l/min *[42 US gpm]*.

☞ **Important notices see page 28.**

Characteristic curves: NG25 ("W.H **22**")
(measured with HLP46, ϑ_{Oil} = 40 ±5 °C *[104 ±9 °F]*)



Symbol	Spool position				
	P – A	P – B	A – T	B – T	B – A
E, D	2	2	3	5	–
J, Q, K	2	2	4	6	-
M, W	1	1	3	5	–
H, V, C, Z	1	1	4	6	–
F	1	2	4	5	–
G	3	4	5	6	–
R	1	2	2	–	–
L	2	2	4	5	–
U	2	2	2	6	–
P	2	2	2	7	–
T	4	4	5	6	–

Symbol	Zero position		
	A – T	B – T	P – T
F	2	–	4
G, T	–	–	9
H	–	–	3
L	7	–	–
U	–	6	–
J	8	8	–
P	–	4	6
V, Z	–	–	8

Performance limits: NG25 ("W.H **22**")
(measured with HLP46, ϑ_{Oil} = 40 ±5 °C *[104 ±9 °F]*)

2-spool position valves – $q_{V\,max}$ in l/min *[US gpm]*

Symbol	Operating pressure p_{max} in bar *[psi]*				
	70 *[1015]*	**140** *[2030]*	**210** *[3046]*	**280** *[4061]*	**350** *[5076]*
X external – spring end position in the main valve (with $p_{pilot\ min}$ = 11 bar / 14 bar *[159 / 203 psi]*)					
C, D, K, Y, Z	450 *[119]*	450 *[119]*	450 *[119]*	450 *[119]*	450 *[119]*
X external – spring end position in the main valve [1]					
C	450 *[119]*	450 *[119]*	320 *[84]*	250 *[66]*	200 *[53]*
D, Y	450 *[119]*	450 *[119]*	450 *[119]*	400 *[105]*	320 *[84]*
K	450 *[119]*	215 *[57]*	150 *[39]*	120 *[32]*	100 *[26]*
Z	350 *[92]*	300 *[79]*	290 *[76]*	260 *[68]*	160 *[42]*
X external – hydraulic end position in the main valve					
HC, HD, HK, HZ, HY	450 *[119]*	450 *[119]*	450 *[119]*	450 *[119]*	450 *[119]*
HC./O..., HD./O..., HK./O..., HZ./O...	450 *[119]*	450 *[119]*	450 *[119]*	450 *[119]*	450 *[119]*
HC./OF..., HD./OF..., HK./OF..., HZ./OF...	450 *[119]*	450 *[119]*	450 *[119]*	450 *[119]*	450 *[119]*

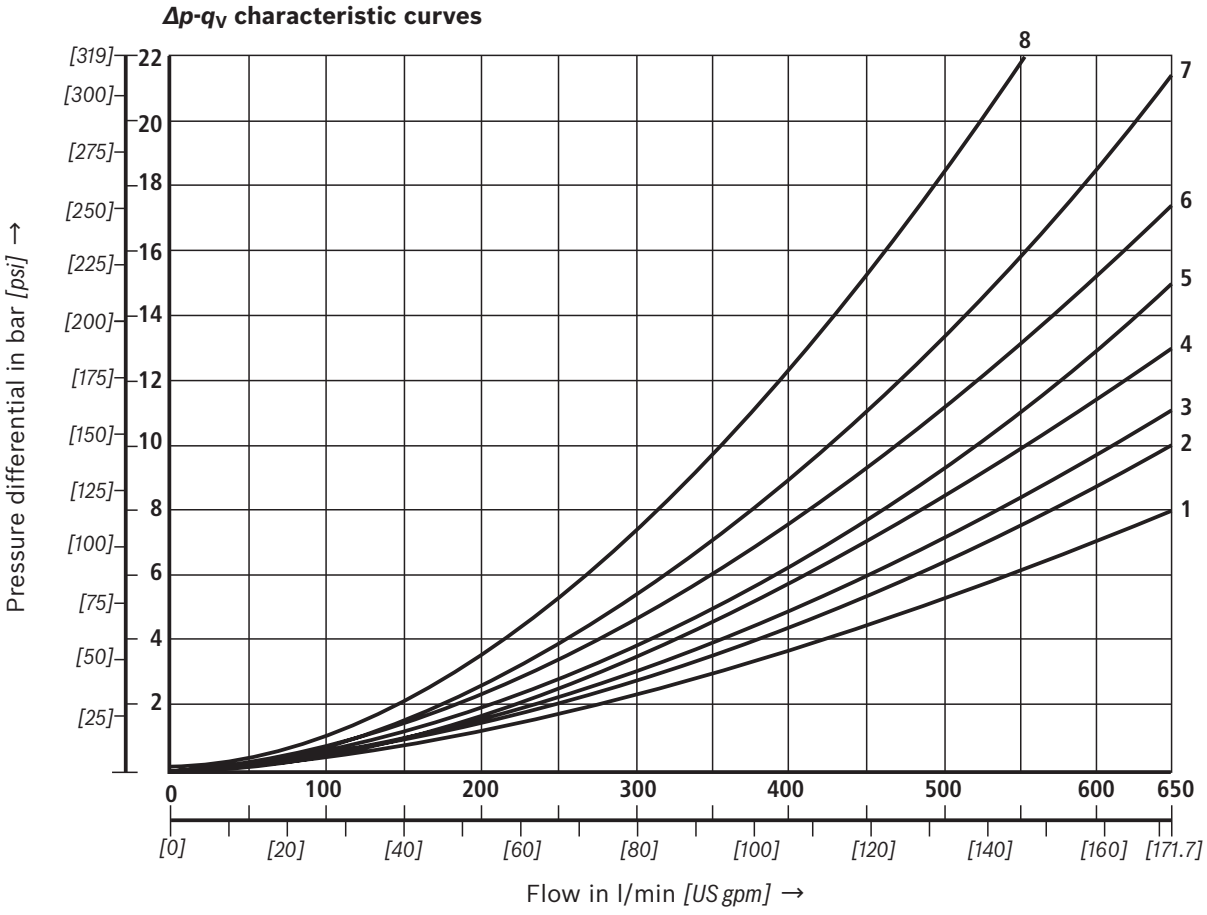
[1] If the specified flow values are exceeded, the function of the return spring is no longer guaranteed if the pilot pressure fails!

3-spool position valves – $q_{V\,max}$ in l/min *[US gpm]*

Symbol	Operating pressure p_{max} in bar *[psi]*				
	70 *[1015]*	**140** *[2030]*	**210** *[3046]*	**280** *[4061]*	**350** *[5076]*
X external – spring-centered					
E, J, L, M, Q, U, W, R	450 *[119]*	450 *[119]*	450 *[119]*	450 *[119]*	450 *[119]*
H	450 *[119]*	450 *[119]*	300 *[79]*	260 *[68]*	230 *[61]*
G	400 *[105]*	350 *[92]*	250 *[66]*	200 *[53]*	180 *[47]*
F	450 *[119]*	270 *[71]*	175 *[46]*	130 *[34]*	110 *[29]*
V	450 *[119]*	300 *[79]*	240 *[63]*	220 *[58]*	160 *[42]*
T	400 *[105]*	300 *[79]*	240 *[63]*	200 *[53]*	160 *[42]*
P	450 *[119]*	270 *[71]*	180 *[47]*	170 *[45]*	110 *[29]*

☞ **Important notices see page 28.**

Characteristic curves: NG25 ("W.H **25**")
(measured with HLP46, ϑ_{Oil} = 40 ±5 °C *[104 ±9 °F]*)



Symbol	Spool position				Zero position		
	P – A	P – B	A – T [1)]	B – T [1)]	A – T	B – T	P – T
E, Y, D	1	1	3	4			
F	1	1	2	4	2	–	5
G, T	1	1	2	5	–	–	7
H	1	1	2	5	2	2	4
C	1	1	2	5			
J	1	1	2	5	6	5	–
K	1	1	2	5			
L	1	1	2	4	5	–	–
M	1	1	3	4			
P	1	1	3	5	–	3	5
Q	1	1	2	3			
R	1	1	3	–			
U	1	1	2	5	–	5	–
V	1	1	2	5	8	7	–
Z	1	1	2	5			
W	1	1	3	4			

8 Symbol R, spool position B – A

Performance limits: NG25 ("W.H **25**")
(measured with HLP46, ϑ_{Oil} = 40 ±5 °C *[104 ±9 °F]*)

2-spool position valves – $q_{V\,max}$ in l/min *[US gpm]*					
Symbol	**Operating pressure p_{max} in bar** *[psi]*				
	70 *[1015]*	**140** *[2030]*	**210** *[3046]*	**280** *[4061]*	**350** *[5076]*
X external – spring end position in the main valve (with $p_{pilot\,min}$ = 13 bar *[188 psi]*)					
C, D, K, Y, Z	700 *[185]*	700 *[185]*	700 *[185]*	700 *[185]*	650 *[172]*
X external – spring end position in the main valve [1]					
C	700 *[185]*	700 *[185]*	700 *[185]*	700 *[185]*	650 *[172]*
D, Y	700 *[185]*	650 *[172]*	400 *[105]*	350 *[92]*	300 *[79]*
K	700 *[185]*	650 *[172]*	420 *[111]*	370 *[98]*	320 *[84]*
Z	700 *[185]*	700 *[185]*	650 *[172]*	480 *[127]*	400 *[105]*
X external – hydraulic end position in the main valve					
HC, HD, HK, HZ, HY	700 *[185]*	700 *[185]*	700 *[185]*	700 *[185]*	700 *[185]*
HC./O..., HD./O..., HK./O..., HZ./O...	700 *[185]*	700 *[185]*	700 *[185]*	700 *[185]*	700 *[185]*
HC./OF..., HD./OF..., HK./OF..., HZ./OF...	700 *[185]*	700 *[185]*	700 *[185]*	700 *[185]*	700 *[185]*

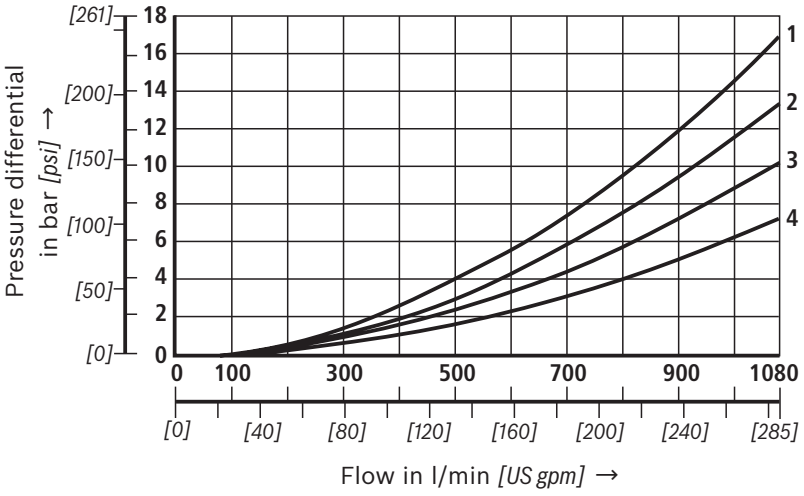
[1] If the specified flow values are exceeded, the function of the return spring is no longer guaranteed if the pilot pressure fails!

3-spool position valves – $q_{V\,max}$ in l/min *[US gpm]*					
Symbol	**Operating pressure p_{max} in bar** *[psi]*				
	70 *[1015]*	**140** *[2030]*	**210** *[3046]*	**280** *[4061]*	**350** *[5076]*
X external – spring-centered					
E, L, M, Q, U, W	700 *[185]*	700 *[185]*	700 *[185]*	700 *[185]*	650 *[172]*
G, T	400 *[105]*	400 *[105]*	400 *[105]*	400 *[105]*	400 *[105]*
F	650 *[172]*	550 *[145]*	430 *[113]*	330 *[87]*	300 *[79]*
H	700 *[185]*	650 *[172]*	550 *[145]*	400 *[105]*	360 *[95]*
J	700 *[185]*	700 *[185]*	650 *[172]*	600 *[158]*	520 *[137]*
P	650 *[172]*	550 *[145]*	430 *[113]*	330 *[87]*	300 *[79]*
V	650 *[172]*	550 *[145]*	400 *[105]*	350 *[92]*	310 *[82]*
R	700 *[185]*	700 *[185]*	700 *[185]*	650 *[172]*	580 *[153]*
X external – pressure-centered (at minimum pilot pressure of 18 bar *[261 psi]*)					
E, F, H, J, L, M, P, Q, R, U, V, W	700 *[185]*	700 *[185]*	700 *[185]*	700 *[185]*	650 *[172]*
G, T	400 *[105]*	400 *[105]*	400 *[105]*	400 *[105]*	400 *[105]*
X external – pressure-centered (with pilot pressure > 30 bar *[435 psi]*)					
G, T	700 *[185]*	700 *[185]*	700 *[185]*	700 *[185]*	650 *[172]*

☞ **Important notices see page 28.**

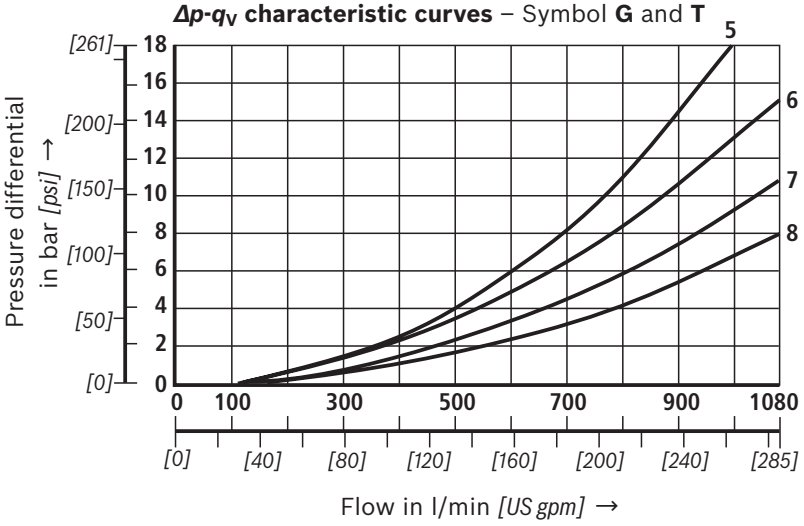
Characteristic curves: NG32
(measured with HLP46, ϑ_{Oil} = 40 ±5 °C *[104 ±9 °F]*)

Δp-q_V-characteristic curves – Symbol **E**, **R** and **W**



Symbol	Spool position				
	P – A	P – B	A – T	B – T	B – A
E	4	4	3	2	–
R	4	4	3	–	1
W	4	4	3	2	–

Δp-q_V characteristic curves – Symbol **G** and **T**



Symbol	Spool position				
	P – A	P – B	A – T	B – T	P – T
G	7	8	7	5	6
T	7	8	7	5	6

Performance limits: NG32
(measured with HLP46, ϑ_{Oil} = 40 ±5 °C *[104 ±9 °F]*)

2-spool position valves – $q_{V\,max}$ in l/min *[US gpm]*					
Symbol	**Operating pressure** p_{max} in bar *[psi]*				
	70 *[1015]*	**140** *[2030]*	**210** *[3046]*	**280** *[4061]*	**350** *[5076]*
X external – spring end position in the main valve (with $p_{pilot\,min}$ = 10 bar *[145 psi]*)					
C, D, K, Y, Z	1100 *[290]*	1040 *[275]*	860 *[227]*	750 *[198]*	680 *[179]*
X external – spring end position in the main valve [1]					
C	1100 *[290]*	1040 *[275]*	860 *[227]*	800 *[211]*	700 *[185]*
D, Y	1100 *[290]*	1040 *[275]*	540 *[142]*	480 *[127]*	420 *[111]*
K	1100 *[290]*	1040 *[275]*	860 *[227]*	500 *[132]*	450 *[119]*
Z	1100 *[290]*	1040 *[275]*	860 *[227]*	700 *[185]*	650 *[172]*
X external – hydraulic end position in the main valve					
HC, HD, HK, HZ, HY	1100 *[290]*	1040 *[275]*	860 *[227]*	750 *[198]*	680 *[179]*

[1] If the specified flow values are exceeded, the function of the return spring is no longer guaranteed if the pilot pressure fails!

3-spool position valves – $q_{V\,max}$ in l/min *[US gpm]*					
Symbol	**Operating pressure** p_{max} in bar *[psi]*				
	70 *[1015]*	**140** *[2030]*	**210** *[3046]*	**280** *[4061]*	**350** *[5076]*
X external – spring-centered					
E, J, L, M, Q, R, U, W	1100 *[290]*	1040 *[275]*	860 *[227]*	750 *[198]*	680 *[179]*
G, T, H, F, P	900 *[238]*	900 *[238]*	800 *[211]*	650 *[172]*	450 *[119]*
V	1100 *[290]*	1000 *[264]*	680 *[179]*	500 *[132]*	450 *[119]*
X external – pressure-centered (at minimum pilot pressure of 8.5 bar *[123 psi]*)					
all symbols	1100 *[290]*	1040 *[275]*	860 *[227]*	750 *[198]*	680 *[179]*

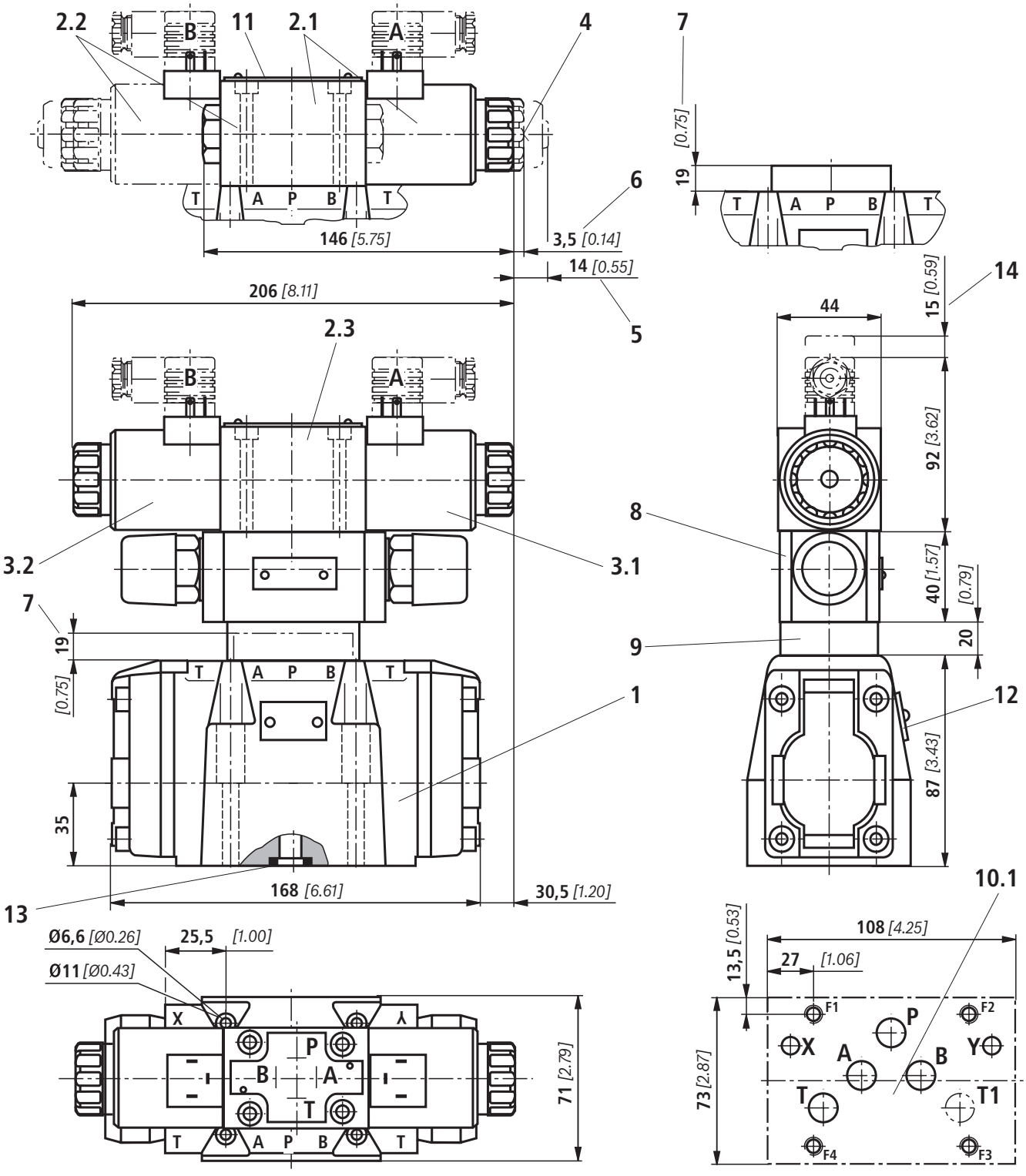
☞ **Important notices see page 28.**

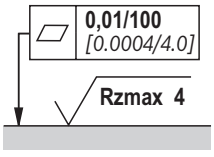
Performance limits: important information

☞ **Notice** (applies to all sizes)**:**
The specified switching power limits apply to the use with two directions of flow (e. g. from P to A and simultaneous return flow from B to T at a ratio of 1:1). Due to the flow forces acting within the valves, the admissible switching power limit may be considerably lower with only one direction of flow (e. g. from P to A while port B is blocked, with flow in the same or in different directions)!
In such cases of application, please consult us!
The switching power limit was established while the solenoids were at operating temperature, at 10% undervoltage, and without tank preloading.

NG16	▶ With pilot oil supply **X internal**, a preload valve has to be used for flows < 160 l/min *[42 US gpm]* due to the negative overlap of the symbols C, Z and HC, HZ. ▶ 4/3 directional valves with pressure centering of the control spool in the main valve can be used above the indicated performance limit. In this case, a higher pilot pressure is required (values see performance limits of the corresponding size). ▶ With pilot oil supply **X internal**, sufficient flow needs to be ensured due to the negative overlap of symbols F, G, H, P, S and T (for determination of the required flow, see "Preload valve" characteristic curves (page 39). If the required flow is not reached, a preload valve has to be used (see page 16).
NG25 ("W.H 22")	▶ With pilot oil supply **X internal,** a preload valve has to be used for flows < 180 l/min *[47.5 US gpm]* due to the negative overlap of symbols Z, HZ and V. ▶ With pilot oil supply **X internal**, sufficient flow needs to be ensured due to the negative overlap of symbols C, HC, F, G, H, P and T (for determination of the required flow, see "Preload valve" characteristic curves (page 39). If the required flow is not reached, a preload valve has to be used (see page 16).
NG25 ("W.H 25")	▶ With pilot oil supply **X internal,** a preload valve has to be used for flows < 180 l/min *[47.5 US gpm]* due to the negative overlap of symbols Z, HZ and V. ▶ 4/3 directional valves with pressure centering of the control spool in the main valve can be used above the indicated performance limit. In this case, a higher pilot pressure is required (values see performance limits of the corresponding size). ▶ With pilot oil supply **X internal**, sufficient flow needs to be ensured due to the negative overlap of symbols C, HC, F, G, H, P and T (for determination of the required flow, see "Preload valve" characteristic curves (page 39). If the required flow is not reached, a preload valve has to be used (see page 16).
NG32	▶ With pilot oil supply **X internal,** a preload valve has to be used for flows < 180 l/min *[47.5 US gpm]* due to the negative overlap of symbols Z, HZ and V. ▶ 4/3 directional valves with pressure centering of the control spool in the main valve can be used above the indicated performance limit. In this case, a higher pilot pressure is required (values see performance limits of the corresponding size). ▶ With pilot oil supply **X internal**, sufficient flow needs to be ensured due to the negative overlap of symbols C, HC, F, G, H, P and T (for determination of the required flow, see "Preload valve" characteristic curves (page 39). If the required flow is not reached, a preload valve has to be used (see page 16).

Dimensions: NG10
(dimensions in mm *[inch]*)



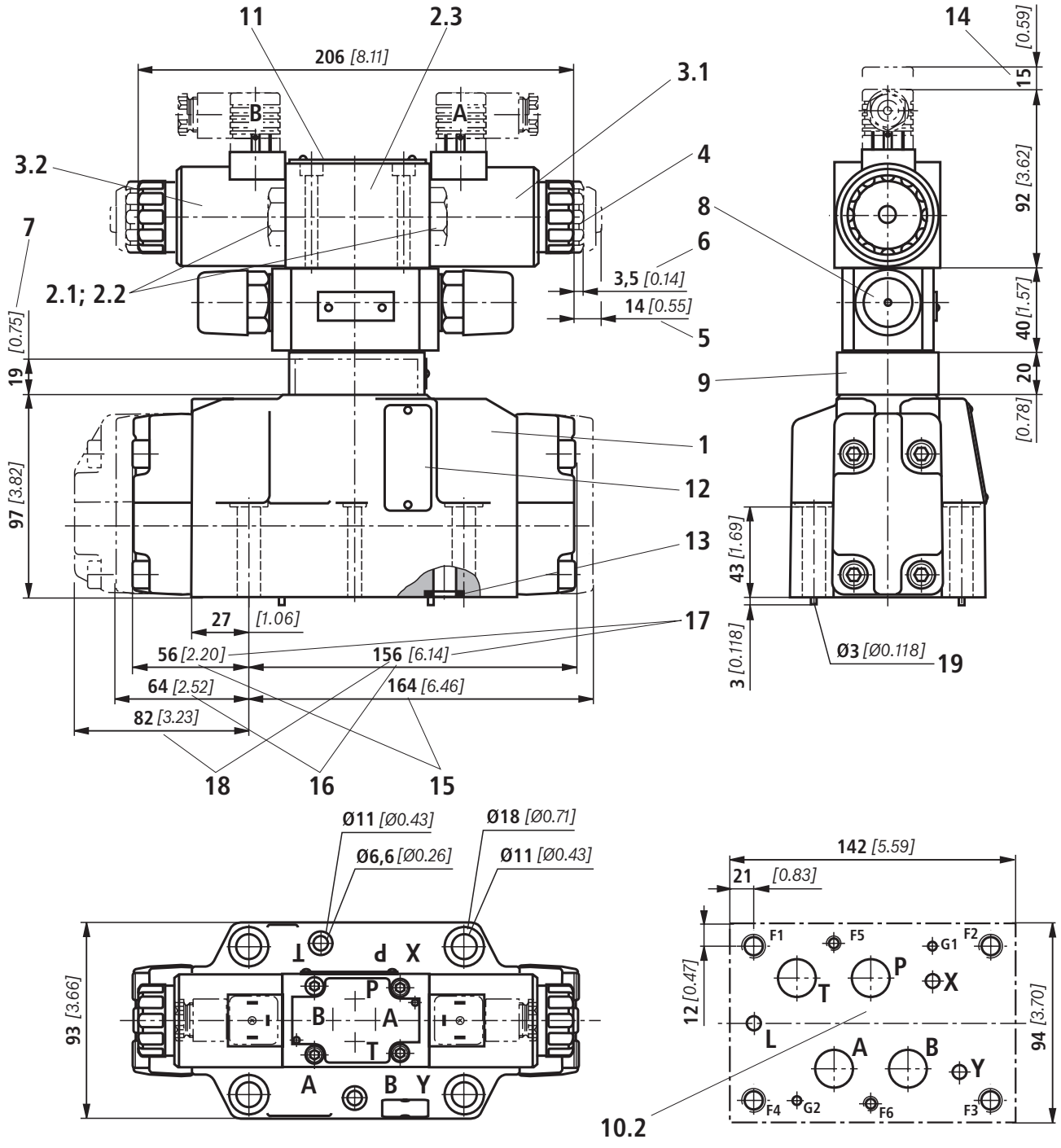


Required surface quality of the valve contact surface

☞ **Notice:**
The dimensions are nominal dimensions which are subject to tolerances.

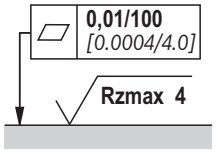
For item explanations and subplates see page 34.
Valve mounting screws see page 35.

Dimensions: NG16
(dimensions in mm *[inch]*)



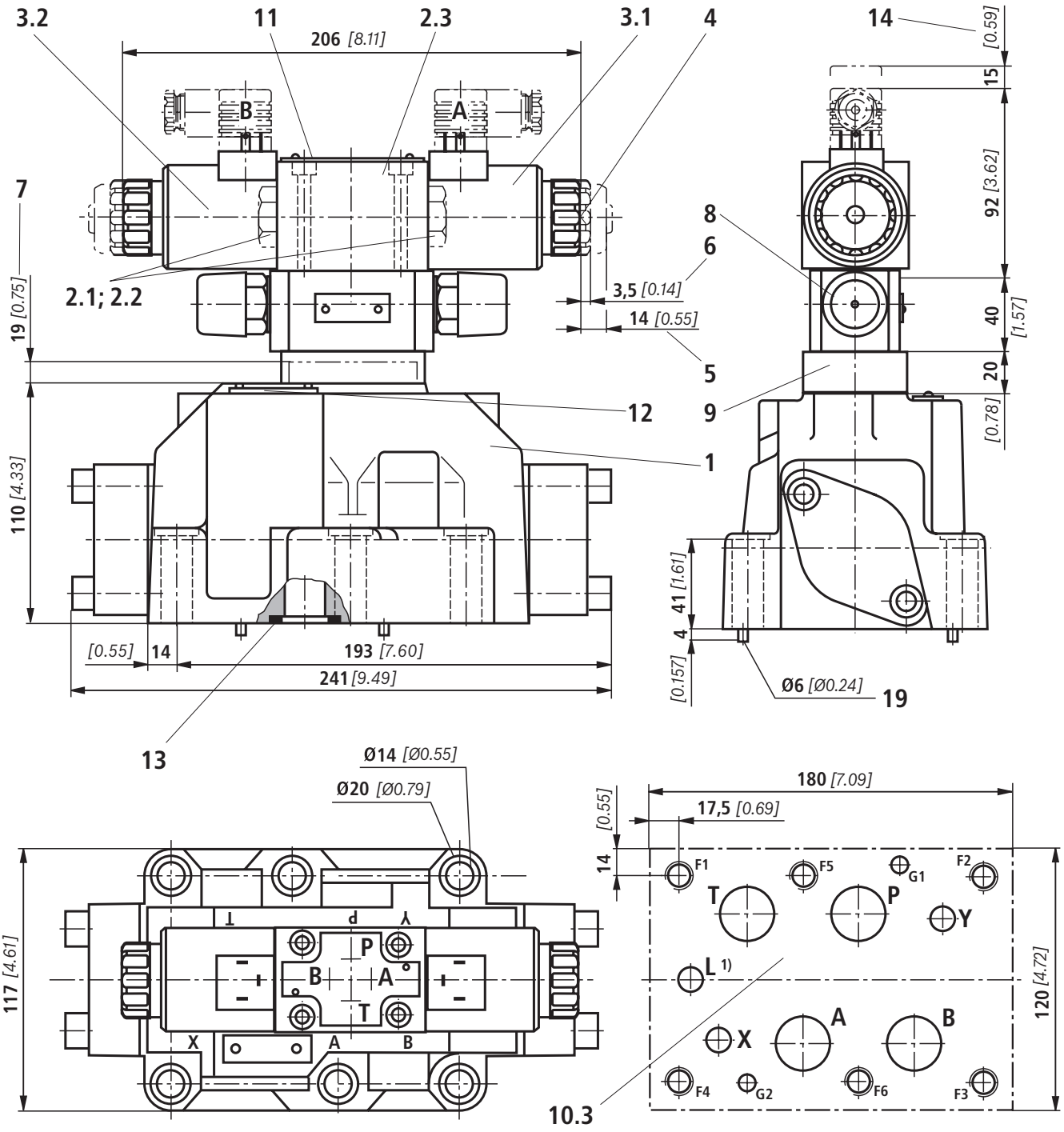
For item explanations and subplates see page 34.
Valve mounting screws see page 35.

☞ **Notice:**
The dimensions are nominal dimensions which are subject to tolerances.



Required surface quality of the valve contact surface

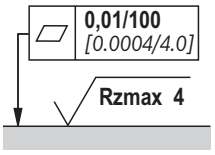
Dimensions: NG25 ("W.H **22**")
(dimensions in mm *[inch]*)



1) Port L only for valves with pressure-centered zero position

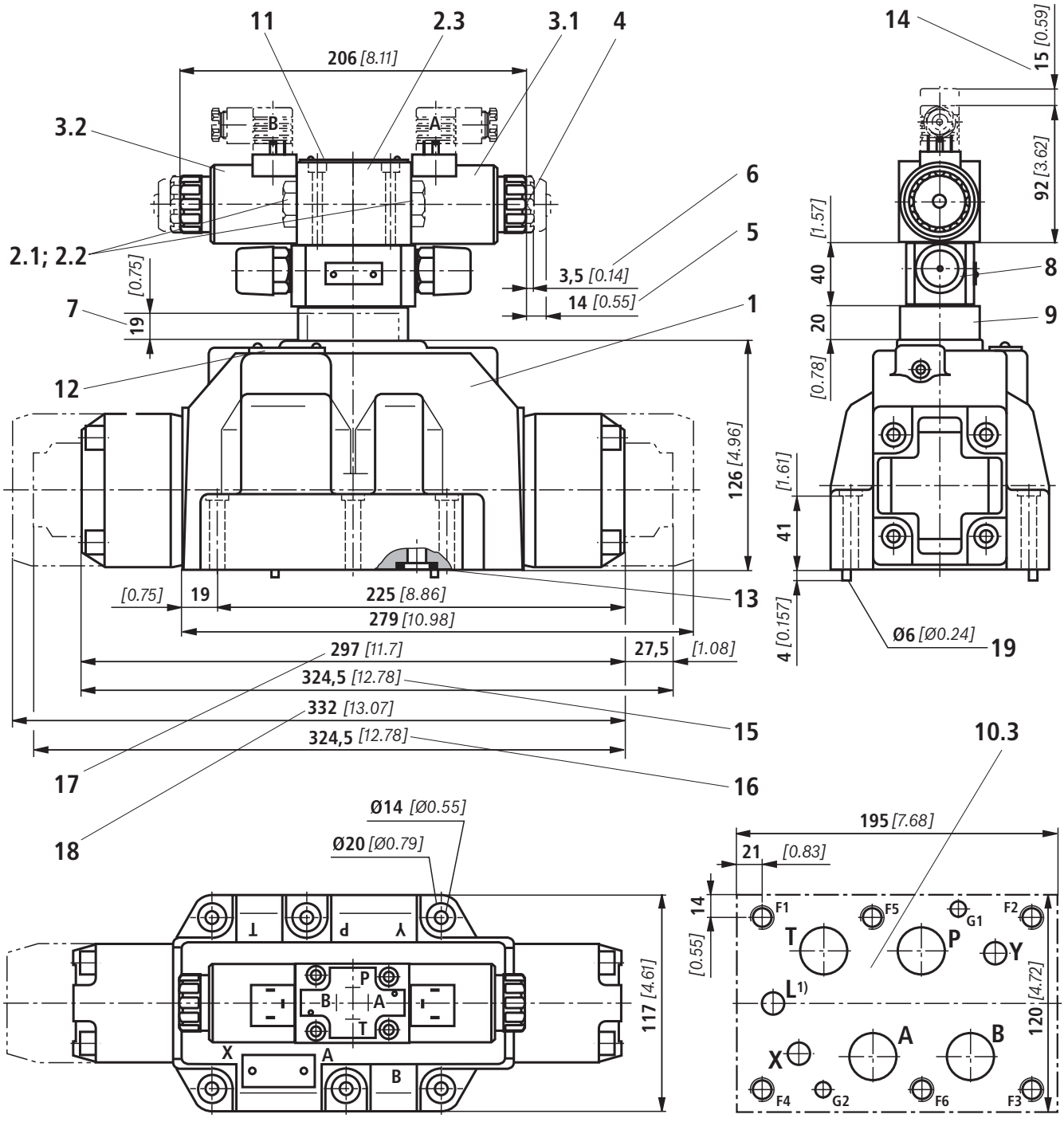
For item explanations and subplates see page 34.
Valve mounting screws see page 35.

☞ **Notice:**
The dimensions are nominal dimensions which are subject to tolerances.



Required surface quality of the valve contact surface

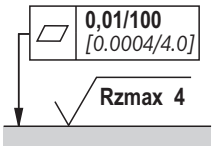
Dimensions: NG25 ("W.H **25**")
(dimensions in mm *[inch]*)



1) Port L only for valves with pressure-centered zero position

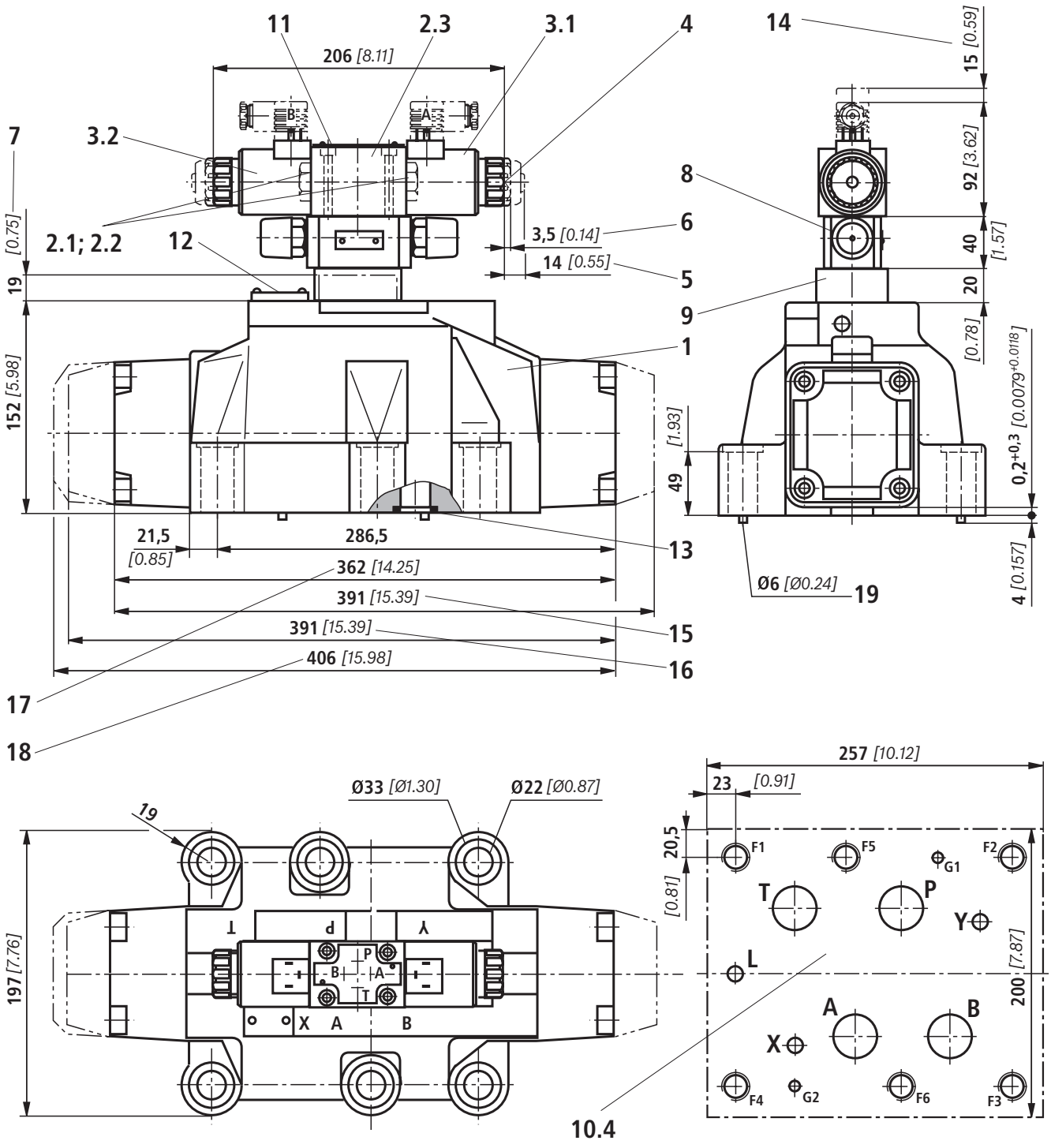
For item explanations and subplates see page 34.
Valve mounting screws see page 35.

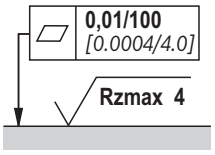
☞ **Notice:**
The dimensions are nominal dimensions which are subject to tolerances.



Required surface quality of the valve contact surface

Dimensions: NG32
(dimensions in mm *[inch]*)





Required surface quality of the valve contact surface

For item explanations and subplates see page 34.
Valve mounting screws see page 35.

☞ **Notice:**
The dimensions are nominal dimensions which are subject to tolerances.

Dimensions

1 Main valve

2 Pilot control valve type 4WE 6 ... (data sheet 23178):

2.1
- ▶ Pilot control valve type 4WE 6 D... (1 solenoid) for main valves with symbols C, D, K, Z
  symbols HC, HD, HK, HZ
- ▶ Pilot control valve type 4WE 6 JA... (1 solenoid "a") for main valves with symbols EA, FA, etc., spring return
- ▶ Pilot control valve type 4WE 6 MA... (1 solenoid "a") for main valves with symbols HEA, HFA, etc., hydraulic spool return

2.2
- ▶ Pilot control valve type 4WE 6 Y... (1 solenoid) for main valves with symbol Y
  symbol HY
- ▶ Pilot control valve type 4WE 6 JB... (1 solenoid "b") for main valves with symbols EB, FB, etc., spring return
- ▶ Pilot control valve type 4WE 6 MB... (1 solenoid "b") for main valves with symbols HEB, HFB, etc., hydraulic spool return

2.3
- ▶ Pilot control valve type 4WE 6J... (2 solenoids) for main valves with 3 spool positions, spring-centered
- ▶ Pilot control valve type 4WE 6 M... (2 solenoids) for main valves with 3 spool positions, pressure-centered

3.1 Solenoid "a"

3.2 Solenoid "b"

4 Manual override, "N", optional
- ▶ Actuation of the manual override is only possible up to a tank pressure of approx. 50 bar. Avoid damage to the bore of the manual override! (Special tool for the operation, separate order, material no. **R900024943**). When the manual override is blocked, the operation of the solenoid must be prevented!
- ▶ Simultaneous actuation of the solenoids must be prevented.

5 Solenoid **without** manual override

6 Solenoid **with** manual override

7 Height of the diversion plate with hydraulic actuation (type WH...)

8 Switching time adjustment (wrench size 6), optional

9 Pressure reducing valve, optional

10.1 Machined valve contact surface; porting pattern according to ISO 4401-05-05-0-05 and NFPAT3.5.1 R2-D05

10.2 Machined valve contact surface; porting pattern according to ISO 4401-07-07-0-05 and NFPAT3.5.1 R2-D07

10.3 Machined valve contact surface; porting pattern according to ISO 4401-08-08-0-05 and NFPAT3.5.1 R2-D08

10.4 Machined valve contact surface; porting pattern according to ISO 4401-10-09-0-05 and NFPAT3.5.1 R2-D10

11 Name plate pilot control valve

12 Name plate complete valve

13 Seal rings

14 Space required for removing the mating connector

15 2-spool position valves with spring end position in the main valve (symbols A, C, D, K, Z)

16 2-spool position valves with spring end position in the main valve (symbols B, Y)

17 3-spool position valves, spring-centered; 2-spool position valves with hydraulic end position in the main valve

18 3-spool position valves, pressure-centered

19 Locking pin

Subplates (separate order) with porting pattern according to ISO 4401 see data sheet 45100.

Valve mounting screws see page 35.

Dimensions

Valve mounting screws (separate order)

- NG10:
  4 metric hexagon socket head cap screws
  ISO 4762 - M6 x 45 - 10.9-flZn-240h-L
  (friction coefficient μ_{total} = 0.09 ... 0.14);
  tightening torque M_A = 12.5 Nm *[9.2 ft-lbs]* ±10%,
  material no. **R913000258**

  4 hexagon socket head cap screws UNC
  1/4-20 UNC x 1 3/4" ASTM-A574
  on request

- NG16:
  4 metric hexagon socket head cap screws
  ISO 4762 - M10 x 60 - 10.9-flZn-240h-L
  (friction coefficient μ_{total} = 0.09 ... 0.14);
  tightening torque M_A = 58 Nm *[42.8 ft-lbs]* ±10%,
  material no. **R913000116**

  2 metric hexagon socket head cap screws
  ISO 4762 - M6 x 60 - 10.9-flZn-240h-L
  (friction coefficient μ_{total} = 0.09 ... 0.14);
  tightening torque M_A = 12.5 Nm *[9.2 ft-lbs]* ±10%,
  material no. **R913000115**

  4 hexagon socket head cap screws
  UNC 3/8-16 UNC x 2 1/4" ASTM-A574 on request

  2 hexagon socket head cap screws
  UNC 1/4-20 UNC x 2 1/4" ASTM-A574 on request

- NG25:
  6 metric hexagon socket head cap screws
  ISO 4762 - M12 x 60 - 10.9-flZn-240h-L
  (friction coefficient μ_{total} = 0.09 ... 0.14);
  tightening torque M_A = 130 Nm *[95.9 ft-lbs]* ±10%,
  material no. **R913000121**

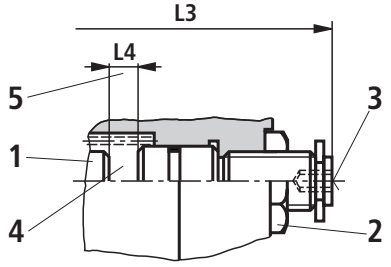
  6 hexagon socket head cap screws
  UNC 1/2-13 UNC x 2 1/2" ASTM-A574 on request

- NG32:
  6 metric hexagon socket head cap screws
  ISO 4762 - M20 x 80 - 10.9-flZn-240h-L
  (friction coefficient μ_{total} = 0.09 ... 0.14);
  tightening torque M_A = 430 Nm *[317.2 ft-lbs]* ±10%,
  material no. **R901035246**

  6 hexagon socket head cap screws
  UNC 3/4-10 UNC x 3 1/4" ASTM-A574 on request

Stroke setting, mounting options
(dimensions in mm *[inch]*)

The stroke of the control spool is limited by the stroke setting (1). The control spool stroke is shortened by loosening the lock nut (2) and clockwise rotation of the adjustment spindle (3). The control chamber (4) must be depressurized for this.

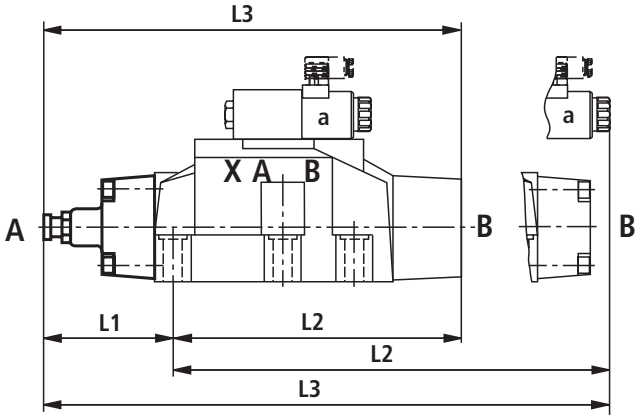


NG	L4
10	6.5 *[0.26]*
16	10 *[0.39]*
25 ("W.H 22")	9.5 *[0.37]*
25 ("W.H 25")	12.5 *[0.49]*
32	15 *[0.59]*

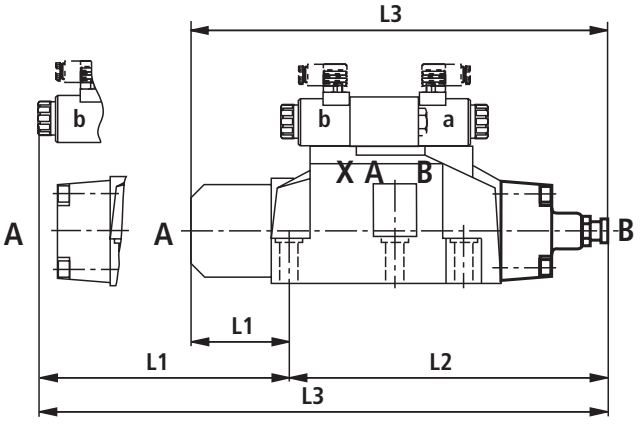
More dimensions see below and page 37.

5 Adjustment range
- ▶ NG10:
  1 rotation = 1 mm *[0.0394 inch]* adjustment travel
- ▶ NG16 and 32:
  1 rotation = 1.5 mm *[0.0591 inch]* adjustment travel

Stroke limitation on side A



Stroke limitation on side B



Mounting options	Ordering code	NG	3-spool position valve [1] spring-centered L1	L2	L3	pressure-centered L1	L2	L3
Stroke setting on valve side A and B	**10**	10	90 *[3.54]*	144 *[5.67]*	234 *[9.21]*			
		16	100 *[3.94]*	200 *[7.87]*	300 *[11.81]*			
		25 [2]	96 *[3.77]*	241 *[9.49]*	337 *[13.27]*			
		25 [3]	123 *[4.84]*	276 *[10.87]*	399 *[15.71]*			
		32	133 *[5.24]*	344 *[13.54]*	477 *[18.78]*			
Stroke setting on valve side A	**11**	10	90 *[3.54]*	106 *[4.17]*	196 *[7.72]*			
		16	100 *[3.94]*	156 *[6.14]*	256 *[10.08]*			
		25 [2]	96 *[3.77]*	193 *[7.60]*	289 *[11.38]*			
		25 [3]	123 *[4.84]*	225 *[8.86]*	348 *[13.70]*			
		32	133 *[5.24]*	287 *[11.30]*	420 *[16.54]*			
Stroke setting on valve side B	**12**	10	52 *[2.05]*	144 *[5.67]*	196 *[7.72]*	–	–	–
		16	56 *[2.20]*	200 *[7.87]*	256 *[10.08]*	81 *[3.19]*	200 *[7.87]*	281 *[11.06]*
		25 [2]	48 *[1.89]*	241 *[9.49]*	289 *[11.38]*	–	–	–
		25 [3]	72 *[2.83]*	276 *[10.87]*	348 *[13.70]*	107 *[4.21]*	276 *[10.87]*	283 *[11.14]*
		32	76 *[2.99]*	344 *[13.54]*	420 *[16.54]*	120 *[4.72]*	344 *[13.54]*	464 *[18.27]*

Stroke setting, mounting options
(dimensions in mm *[inch]*)

Mounting options	Ordering code	NG	2-spool position valve								
			Spring end position						Hydraulic end position		
			A, C, D, K, Z			B, Y			HC, HD, HK, HZ, HY		
			L1	**L2**	**L3**	**L1**	**L2**	**L3**	**L1**	**L2**	**L3**
Stroke setting on valve side A and B	**10**	10	90 *[3.54]*	144 *[5.67]*	234 *[9.21]*	90 *[3.54]*	144 *[5.67]*	234 *[9.21]*	90 *[3.54]*	144 *[5.67]*	234 *[9.21]*
		16	–	–	–	–	–	–	100 *[3.94]*	200 *[7.87]*	300 *[11.81]*
		25 [2]	96 *[3.78]*	241 *[9.49]*	337 *[13.27]*	96 *[3.78]*	241 *[9.49]*	337 *[13.27]*	96 *[3.78]*	241 *[9.49]*	337 *[13.27]*
		25 [3]	–	–	–	–	–	–	123 *[4.84]*	276 *[10.87]*	399 *[15.71]*
		32	–	–	–	–	–	–	133 *[5.24]*	344 *[13.54]*	477 *[18.78]*
Stroke setting on valve side A	**11**	10	90 *[3.54]*	106 *[4.17]*	196 *[7.72]*	–	–	–	90 *[3.54]*	106 *[4.17]*	196 *[7.72]*
		16	100 *[3.94]*	180 *[7.09]*	280 *[11.02]*	–	–	–	100 *[3.94]*	156 *[6.14]*	256 *[10.08]*
		25 [2]	96 *[3.78]*	193 *[7.60]*	289 *[11.38]*	96 *[3.78]*	193 *[7.60]*	289 *[11.38]*	96 *[3.78]*	193 *[7.60]*	289 *[11.38]*
		25 [3]	123 *[4.84]*	253 *[9.96]*	376 *[14.8]*	–	–	–	123 *[4.84]*	225 *[8.86]*	348 *[13.70]*
		32	133 *[5.24]*	316 *[12.44]*	449 *[17.68]*	–	–	–	133 *[5.24]*	287 *[11.30]*	420 *[16.53]*
Stroke setting on valve side B	**12**	10	52 *[2.05]*	144 *[5.67]*	196 *[7.72]*	52 *[2.05]*	144 *[5.67]*	196 *[7.72]*	52 *[2.05]*	144 *[5.67]*	196 *[7.72]*
		16	–	–	–	80 *[3.15]*	200 *[7.87]*	280 *[11.02]*	56 *[2.21]*	200 *[7.87]*	256 *[10.08]*
		25 [2]	48 *[1.89]*	241 *[9.49]*	289 *[11.38]*	48 *[1.89]*	241 *[9.49]*	289 *[11.38]*	48 *[1.89]*	241 *[9.49]*	289 *[11.38]*
		25 [3]	–	–	–	100 *[3.94]*	276 *[10.87]*	376 *[14.80]*	72 *[2.84]*	276 *[10.87]*	348 *[13.70]*
		32	–	–	–	105 *[4.13]*	344 *[13.54]*	449 *[17.68]*	76 *[2.99]*	344 *[13.54]*	420 *[16.53]*

[1] With symbol A only version "11", with symbol B only version "12" possible.

[2] Version "W.H **22**"

[3] Version "W.H **25**"

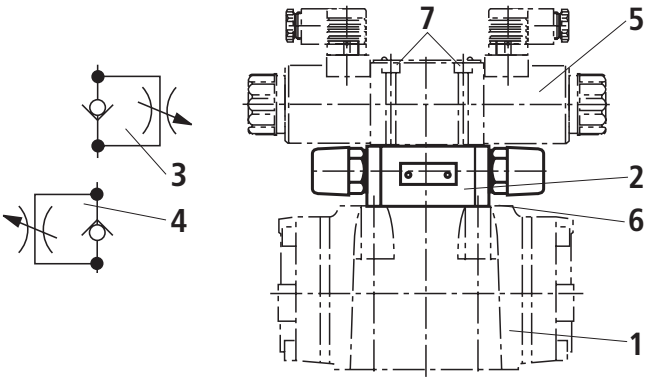
☞ **Notice:**
The dimensions are nominal dimensions which are subject to tolerances.

Switching time adjustment

The switching time of the main valve (1) is influenced by using a twin throttle check valve (2) (type Z2FS 6; data sheet 27506).

Modification of supply (3) to discharge control (4):
Remove the pilot control valve (5) – The plate (6) to accept the seal rings stays in place – Turn the switching time adjustment (2) around its longitudinal axis and put it back, install the pilot control valve (5).

☞ **Notice:**
The modification may only be performed by authorized specialists or at the factory!

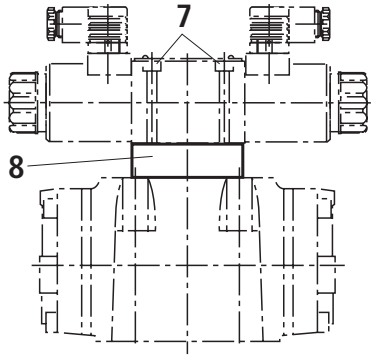


Type .WEH 10 ..4X/...S
Type .WEH 10 ..4X/...S2

Pressure reducing valve "D3"

The pressure reducing valve (8) has to be used at a pilot pressure above 250 bar *[3626 psi]* (with "WEH 22 ...": 210 bar *[3046 psi]*) and with version "H".
The secondary pressure is kept at a constant level of 45 bar *[652 psi]*.

☞ **Notice:**
- If a pressure reducing valve "D3" (8) is used, a "B10" throttle insert has to be installed in channel P of the pilot control valve.
- The modification may only be performed by authorized specialists or at the factory!

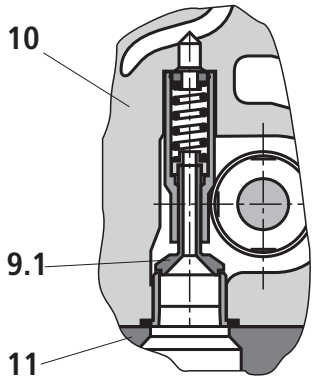


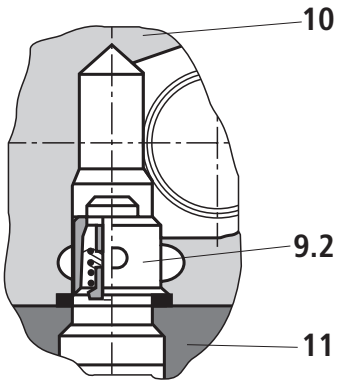
Type .WEH 10 ..4X/.../..D3

Preload valve (not for NG10)

In case of valves with depressurized circulation and internal pilot oil supply, the installation of the preload valve (9) in channel P of the main valve is required in order to build up the minimum pilot pressure.

The pressure differential of the preload valve is to be added to the pressure differential of the main valve (see characteristic curves) to result in one total value.
The cracking pressure amounts to approx. 4.5 bar *[65 psi]*.



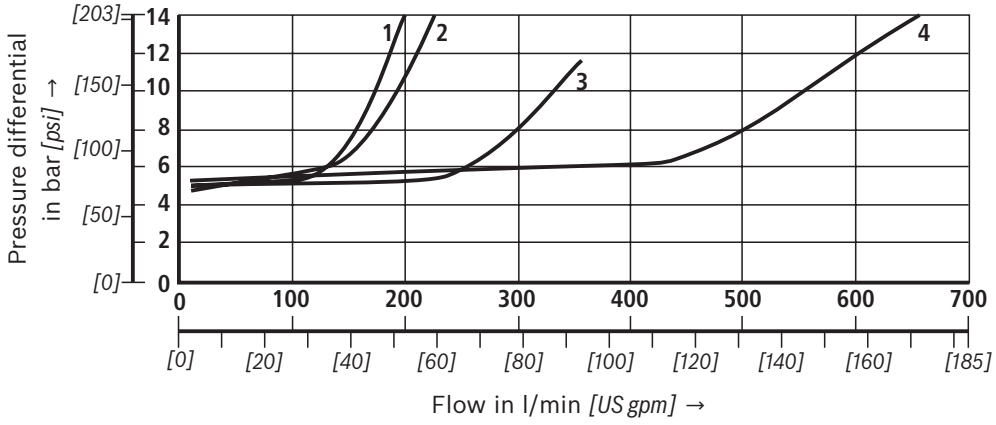


9.1 Preload valve
9.2 Preload valve
10 Main valve
11 Subplate

☞ **Notice:**
Series-production status, see ordering key on the name plate.

Size	**Material number P4,5**	
	Item 9.2	**Item 9.1**
16	R961009417 (up to component series 71)	R961009415 (from component series 72)
25 ("W.H **22**")	R961009609 (up to component series 76)	–
25 ("W.H **25**")	R961009416 (up to component series 67)	R961009166 (from component series 68)
32	R961009610 (up to component series 63)	–

***Δp–q*$_V$ characteristic curve** (measured with HLP46, ϑ_{Oil} = 40 °C ± 5 °C *[104 °F ±9 °F]*)



1 NG16
2 NG25 ("W.H **25**")
3 NG25 ("W.H **22**")
4 NG32

Project planning information

The stipulations of the Machinery Directive 2006/42/EC are to be adhered to!
Please also note data sheet 08012 with information on MTTFd values and shock and vibration loads!

Further information

▶ Directional spool valve	Data sheet 23178
▶ Subplates	Data sheet 45100
▶ Inductive position switch and proximity sensors (contactless)	Data sheet 24830
▶ Hydraulic fluids on mineral oil basis	Data sheet 90220
▶ Environmentally compatible hydraulic fluids	Data sheet 90221
▶ Flame-resistant, water-free hydraulic fluids	Data sheet 90222
▶ Flame-resistant hydraulic fluids - containing water (HFAE, HFAS, HFB, HFC)	Data sheet 90223
▶ Reliability characteristics according to EN ISO 13849	Data sheet 08012
▶ Hexagon socket head cap screw, metric/UNC	Data sheet 08936
▶ Hydraulic valves for industrial applications	Operating instructions 07600-B
▶ General product information on hydraulic products	Data sheet 07008
▶ Assembly, commissioning and maintenance of industrial valves	Data sheet 07300
▶ Directional spool valves and directional seat valves with electrical actuation and M12x1 plug-in connection	Data sheet 08010
▶ Use of non-electrical hydraulic components in an explosive environment (ATEX)	Data sheet 07011
▶ Selection of filters	www.boschrexroth.com/filter
▶ Information on available spare parts	www.boschrexroth.com/spc

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Proportional pressure reducing valve, direct operated, increasing characteristic curve

Type MHDRE 06 SK (high-performance)

RE 64655
Edition: 2015-01
Replaces: 07.12

H8039

- Size 6
- Component series 3X
- Maximum control pressure 30 bar
- Max. flow 40 l/min

Features

- Direct operated proportional pressure reducing valve for reducing the system pressure
- Pilot control valve
- Screw-in cartridge valve
- Suitable for mobile applications
- Operation by means of proportional solenoid
- In case of power failure, the minimum pressure is set
- Recommended control electronics: Type RA and RC mobile amplifiers

Contents

Ordering codes [1)]

01	02	03	04	05		06	07	08	09	10	11
MHDRE	**06**	**S**	**K**	**3X**	**/**		**A**			**V**	*****

01	Proportional pressure reducing valve, direct operated	**MHDRE**
02	Size 6	**06**
03	Increasing characteristic curve	**S**
04	Screw-in cartridge valve	**K**
05	Component series 30 ... 39 (30 ... 39; unchanged installation and connection dimensions)	**3X**
06	Maximum control pressure 18 bar	**18**
	Maximum control pressure 20 bar	**20**
	Maximum control pressure 26 bar	**26**
	Maximum control pressure 30 bar	**30**
07	Proportional solenoid, wet-pin	**A**

Supply voltage

08	Control electronics 12 V DC	**G12**
	Control electronics 24 V DC	**G24**

Electrical connection [1)]

09	**Without** mating connector; connector according to DIN EN 175301-803	**K4**
	Without mating connector; with connector DT 04-2P (Deutsch plug)	**K40**
	Without mating connector, with connector AMP Junior-Timer	**C4**

Seal material

10	FKM seals	**V**
	Observe compatibility of seals with hydraulic fluid used! (Other seals upon request)	
11	Further details in the plain text	*****

[1)] Mating connectors; separate order, see data sheet 08006.

Valve types

Type	Material number
MHDRE 06 SK3X/18AG12K40V	R901220628
MHDRE 06 SK3X/20AG12K40V	R901150864
MHDRE 06 SK3X/26AG12K40V	R901220722
MHDRE 06 SK3X/30AG12K40V	R901220724

Type	Material number
MHDRE 06 SK3X/18AG24K40V	R901156353
MHDRE 06 SK3X/20AG24K40V	R901220641
MHDRE 06 SK3X/26AG24K40V	R901220719
MHDRE 06 SK3X/30AG24K40V	R901220723

Function, section, symbol

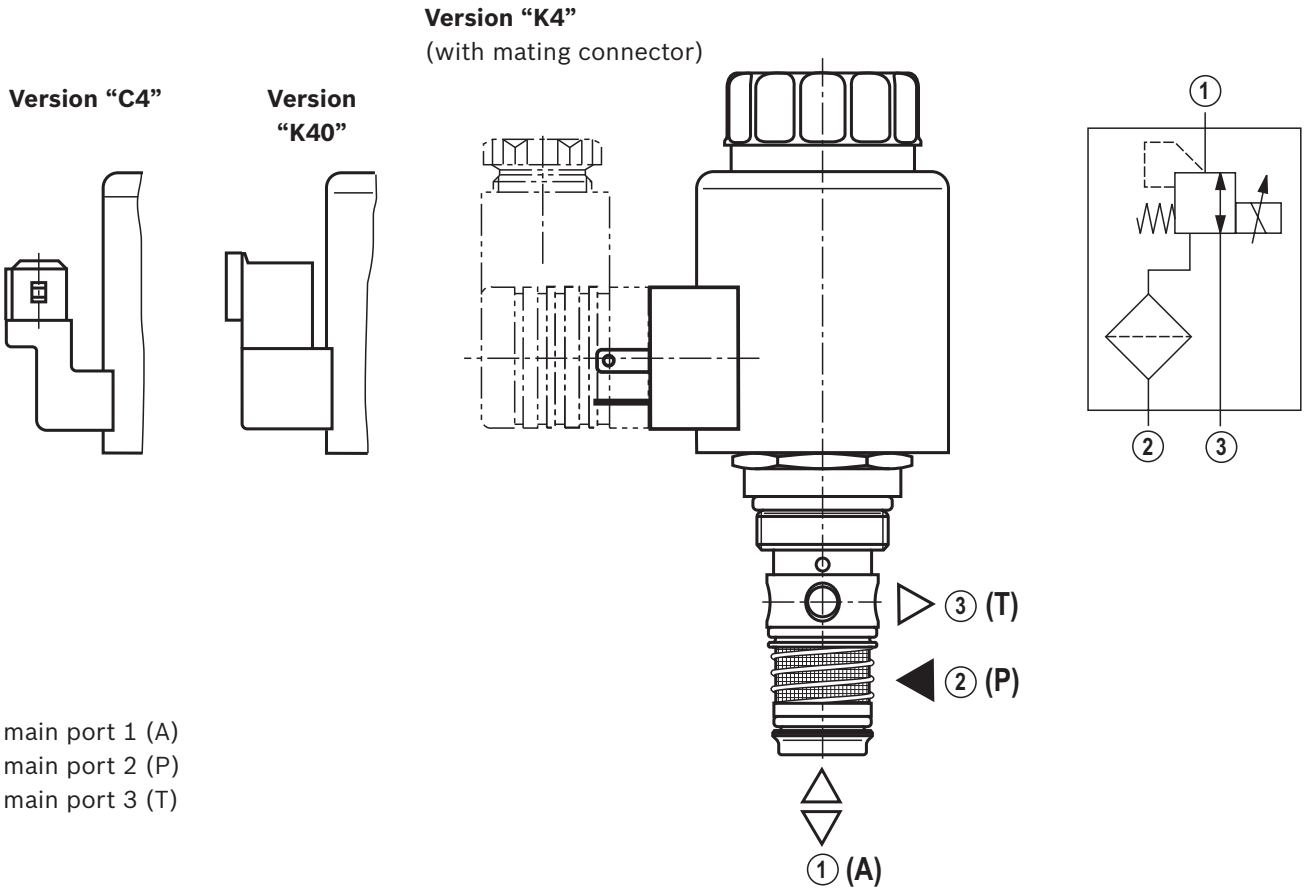
General

The type MHDRE 06 SK proportional pressure reducing valve is a direct operated, 3-way version screw-in cartridge valve. It reduces the control pressure (main port ①) proportionally to the solenoid current and largely works independently of the inlet pressure (main port ②).
When the command value = 0 or in the event of power failure, the minimum pressure is set. Operation is effected by means of proportional solenoid. The solenoid's interior is connected to the main port ③ and filled with hydraulic fluid.
Depending on the electric command value, these valves can be used to continuously reduce the system pressure. The valve is suitable for controlling couplings, pumps, and directional valves, and is also suitable for use in proportional pilot controls (especially in mobile applications).

Basic principle

The valve controls the pressure in the main port ① in accordance with the current on the solenoid. The “S” version signifies an increasing characteristic curve, i.e. an increasing current brings about an increased pressure (see characteristic curves on pages 6 and 7).
The proportional solenoid converts the electric current into mechanical force that acts upon the piston via the armature. The piston controls the connection between the main ports.

☞ **Notes:**
The tank pressure that occurs (main port ③) is added to the control pressure (main port ①).



① = main port 1 (A)
② = main port 2 (P)
③ = main port 3 (T)

Technical data
(For applications outside these parameters, please consult us!)

General		
Mass	kg	0.7
Installation position		any – if it is ensured that no air can collect upstream of the valve. Otherwise, we recommend suspended installation of the valve.
Ambient temperature range	°C	See “Admissible working range” on page 5
Storage temperature range	°C	–40 ... +80
Salt spray test according to EN ISO 9227	h	720 (NSS test)
Solenoid surface protection		Coating according to DIN 50962-Fe//ZnNi with thick film passivation

Hydraulic			
Maximum control pressure	▶ Main port ①	bar	18; 20; 26; 30
Maximum inlet pressure	▶ Main port ②	bar	100
Maximum counter pressure	▶ Main port ③	bar	Depressurized (max. 100 bar; the tank pressures that occur are added to the control pressure (main port ①))
Max. flow		l/min	See characteristic curves page 6
Maximum leakage	▶ Main port ③	ml/min	120 (50 bar in ②; I = 0 mA, 46 cSt)
Maximum pilot oil		ml/min	120 (50 bar in ②; I = I_{max}, 46 cSt)
Hydraulic fluid			see table below
Hydraulic fluid temperature range		°C	–40 ... +120
Viscosity range		mm^2/s	5 ... 400
Maximum admissible degree of contamination of the hydraulic fluid Cleanless class according to ISO 4406 (c)			Class 20/18/15 [1)]
Hysteresis (within the tolerance band)		bar	≤ 1.5 (control pressure 18, 20 bar) ≤ 2.0 (control pressure 26, 30 bar)
Step response (T_u + T_g) 0 % → 100 %; 100 % → 0 %		ms	≤ 60 (50 bar in ②; 46 cSt, q_V = 0 l/min, dead volume in ① 140 cm^3)
Repetition accuracy		%	< 2 % of the maximum control pressure
Load cycles			10 million
Strainer element on the main port ② (P)		µm	240

Hydraulic fluid		**Classification**	**Suitable sealing materials**	**Standards**	**Data sheet**
Mineral base oils		HL, HLP	NBR, FKM	DIN 51524	90220
Bio-degradable	▶ insoluble in water	HEES	FKM	ISO 15380	90221
	▶ soluble in water	HEPG	FKM	ISO 15380	

☞ **Important information on hydraulic fluids:**
- ▶ For more information and data about the use of other hydraulic fluids, refer to data sheets above or contact us!
- ▶ There may be limitations regarding the technical valve data (temperature, pressure range, life cycle, maintenance intervals, etc.).
- ▶ The flash point of the hydraulic fluid used must be 40 K higher than the maximum solenoid surface temperature.
- ▶ **Bio-degradable:** When using bio-degradable hydraulic fluids that are also zinc-solving, zinc may accumulate in the fluid (700 mg zinc per pole tube).

1) The cleanliness classes specified for the components must be adhered to in hydraulic systems. Effective filtration prevents faults and at the same time increases the life cycle of the components.
For the selection of the filters see www.boschrexroth.com/filter.
We recommend using a filter with a minimum retention rate of $\beta_{10} \geq 75$.

Technical data
(Please consult us for applications outside these parameters!)

Electrical				
Supply voltage		V	12 DC	24 DC
Maximum control current		A	1.45	0.7
Coil resistance at 20 °C		Ω	5	22.5
Duty cycle (ED) [2]		%	100	
Maximum coil temperature [3]		°C	185	
Protection class according to DIN EN 60529	▶ Version “K4”		IP 65 with mating connector mounted and locked	
	▶ Version “C4”		IP 66 with mating connector mounted and locked	
			IP 69K with Rexroth mating connector, material no. R901022127	
	▶ Version “K40”		IP 69K with mating connector mounted and locked	
Chopper frequency (recommended) [4]		Hz	150	
Control electronics			Analog amplifier type RA... (Data sheet 95230)	
			BODAS control unit type RC... (Data sheet 95200)	
Design according to VDE 0580				

[2] Consultation is recommended for use at > 2000 m above sea level.

[3] Due to the surface temperatures of the solenoid coils, the standards ISO 13732-1 and ISO 4413 need to be adhered to.

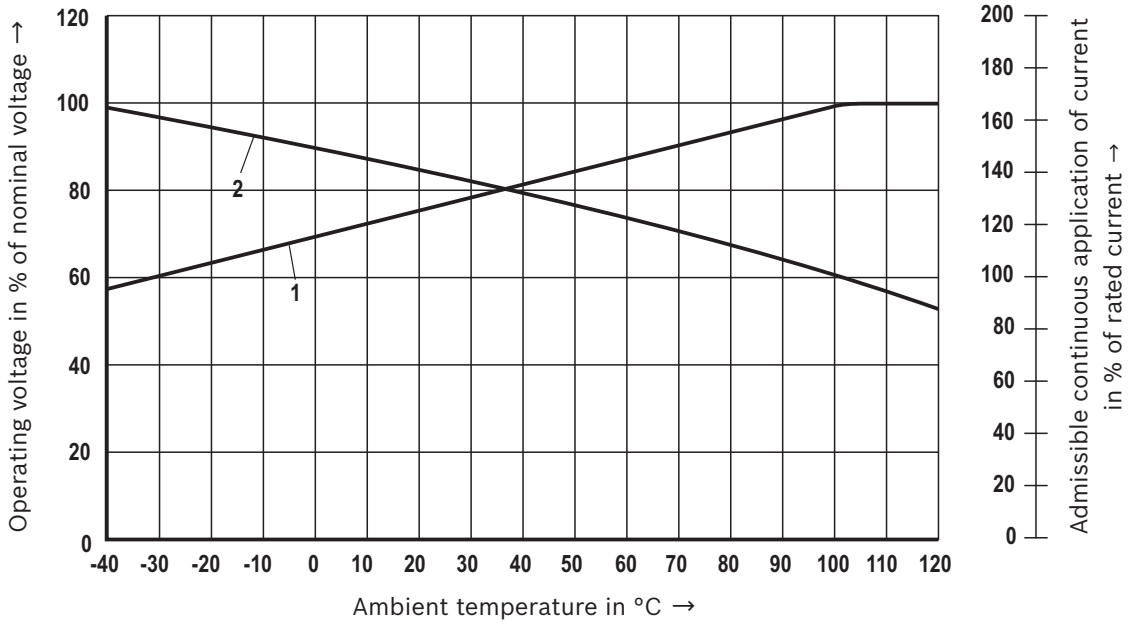
[4] The chopper frequency should be optimized for the application. The working temperature range should be taken into consideration.

When establishing the electrical connection, the protective earthing conductor (PE ⏚) has to be connected correctly.

☞ **Note:**
- The technical data was determined at a viscosity of $\boldsymbol{\nu}$ = 46 mm²/s (HLP46; ϑ_{oil} = 40 °C)
- The following documentation must be observed: 64020-B1 Hydraulic valves for mobile applications

Admissible working range

Admissible working range dependent on the ambient temperature

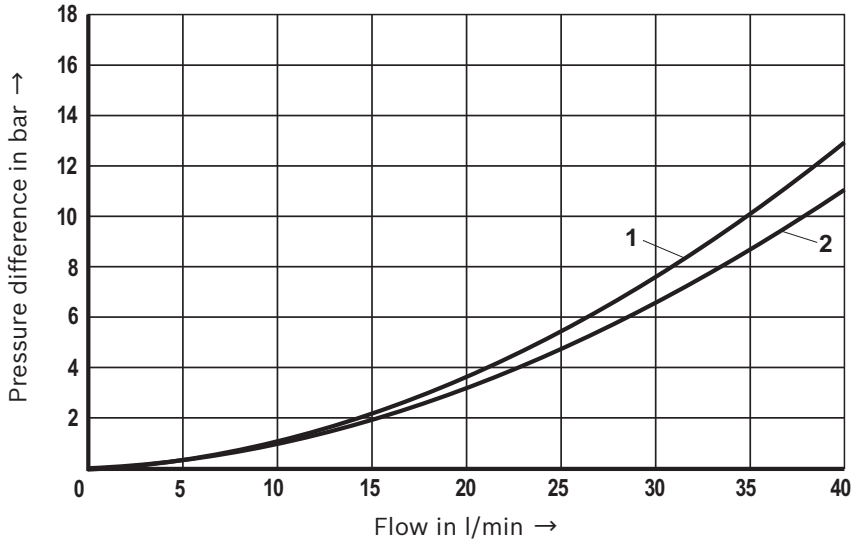


1 Required operating voltage in % of nominal voltage

2 Admissible continuous application of current in % of rated current

Characteristic curves
(measured with HLP46, ϑ_{oil} = 40 ± 5 °C)

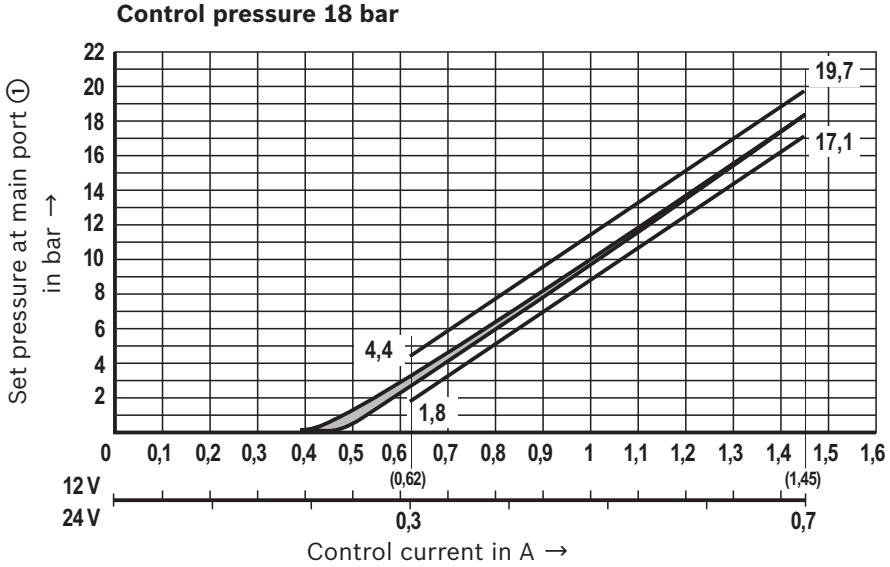
Δ*p*-$q_V$characteristic curves



1 ① → ③
2 ② → ①

Characteristic curves with tolerance band
(measured with HLP46, ϑ_{oil} = 40 ± 5 °C)

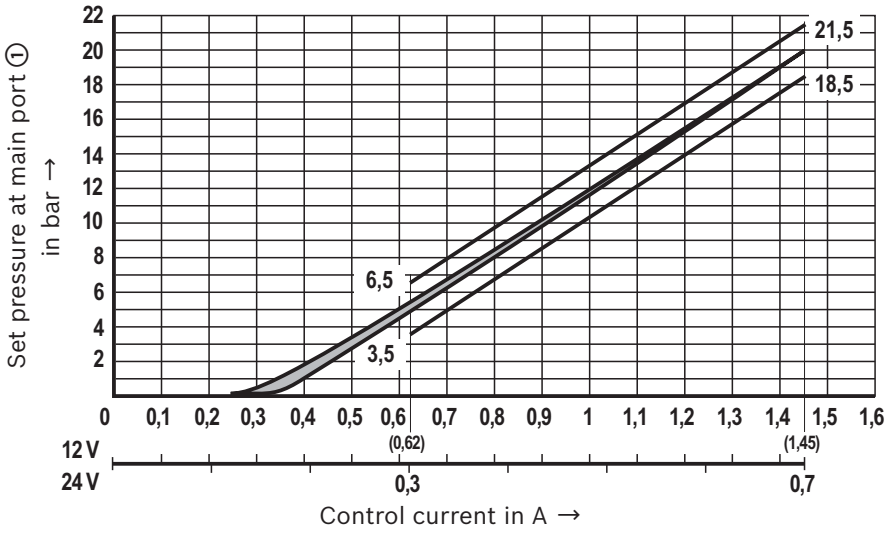
Control pressure 18 bar



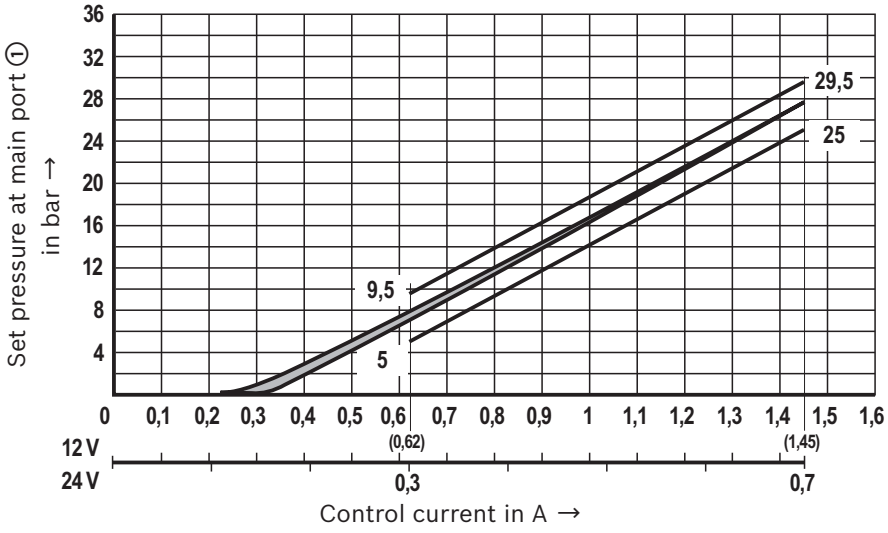
Characteristic curves with tolerance band

(measured with HLP46, ϑ_{oil} = 40 ± 5 °C)

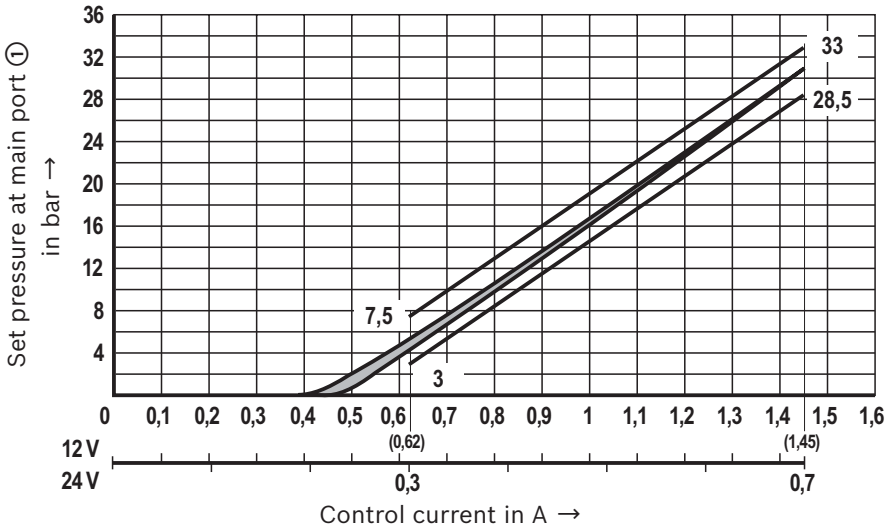
Control pressure 20 bar



Control pressure 26 bar

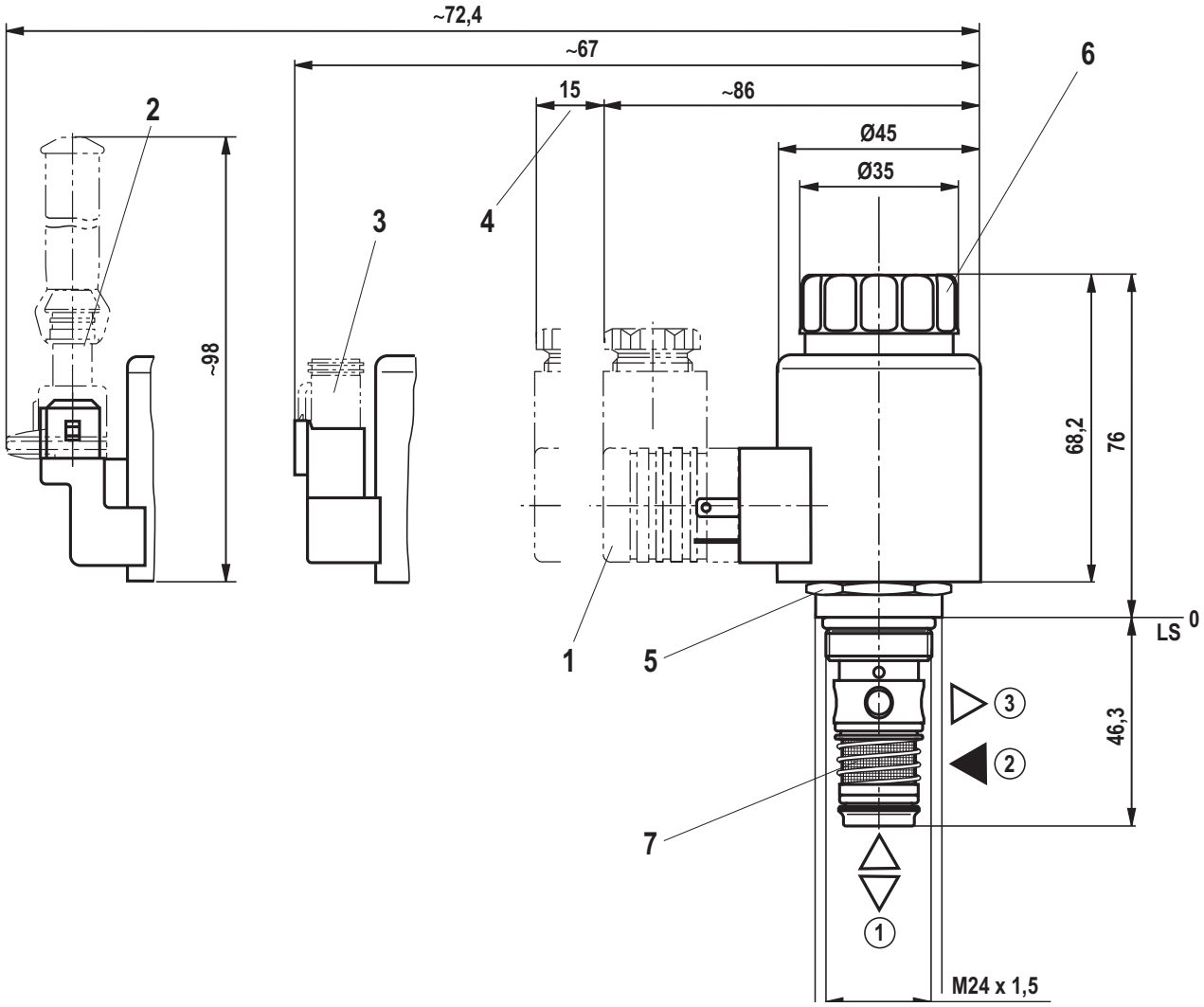


Control pressure 30 bar



6

Dimensions
(dimensions in mm)

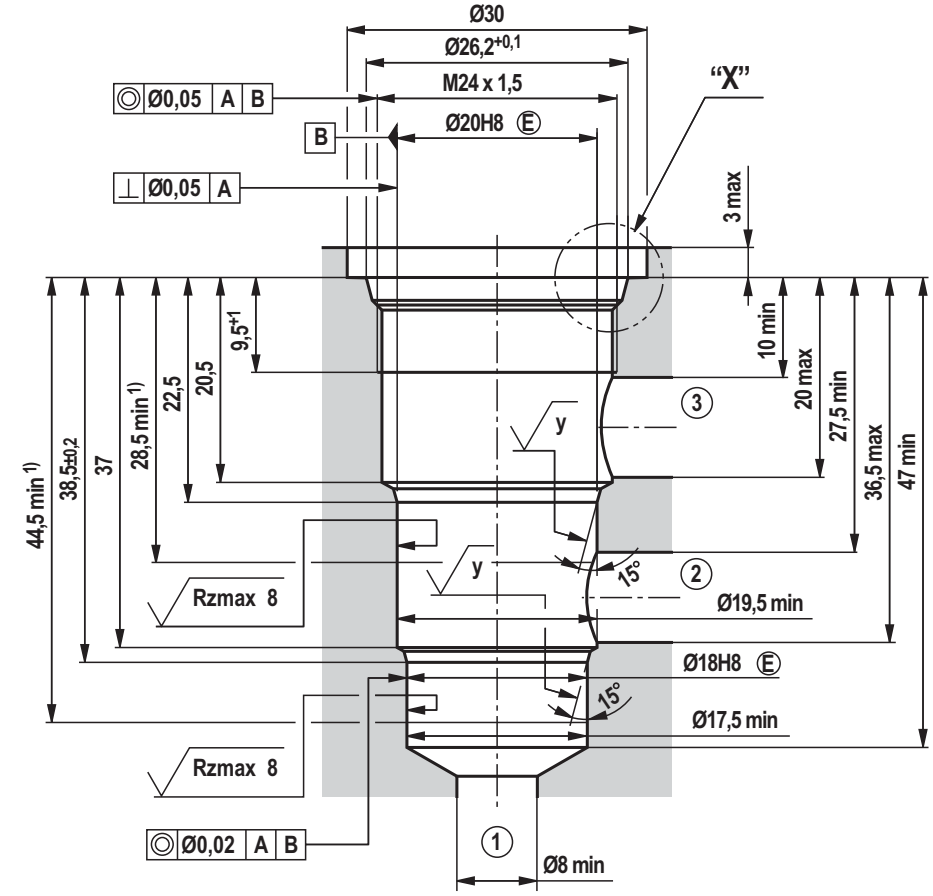


1 Mating connector for connector “K4” (separate order, see data sheet 08006)
2 Mating connector for connector “C4” (separate order, see data sheet 08006)
3 Mating connector for connector “K40” (separate order, see data sheet 08006)
4 Space required for removing the mating connector
5 SW28 hexagon; tightening torque $M_A = 10^{+2}$ Nm
6 Solenoid nut, tightening torque $M_A = 5^{+1}$ Nm
7 Strainer element

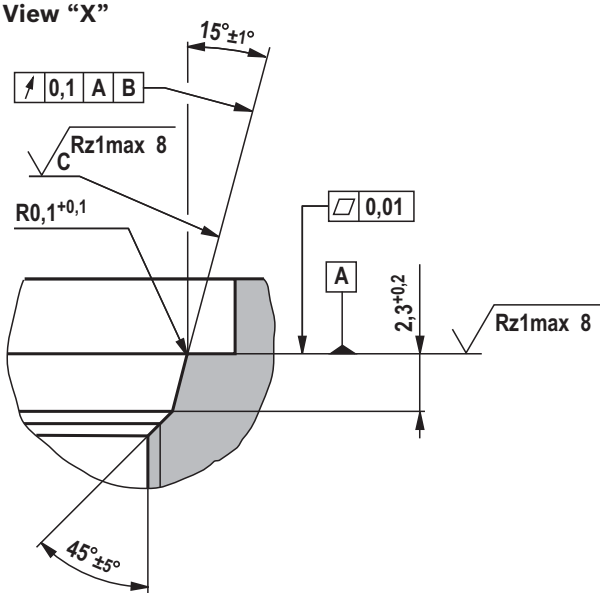
① = main port 1 (A)
② = main port 2 (P)
③ = main port 3 (T)

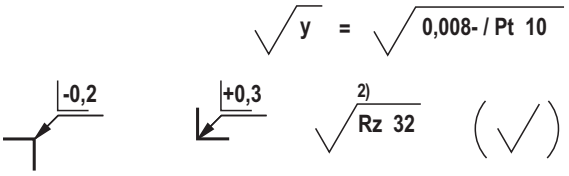
LS = Location Shoulder

Mounting cavity R/MHDRE 06; 3 main ports
(dimensions in mm)



View "X"





1 = main port 1 (A)
2 = main port 2 (P)
3 = main port 3 (T)

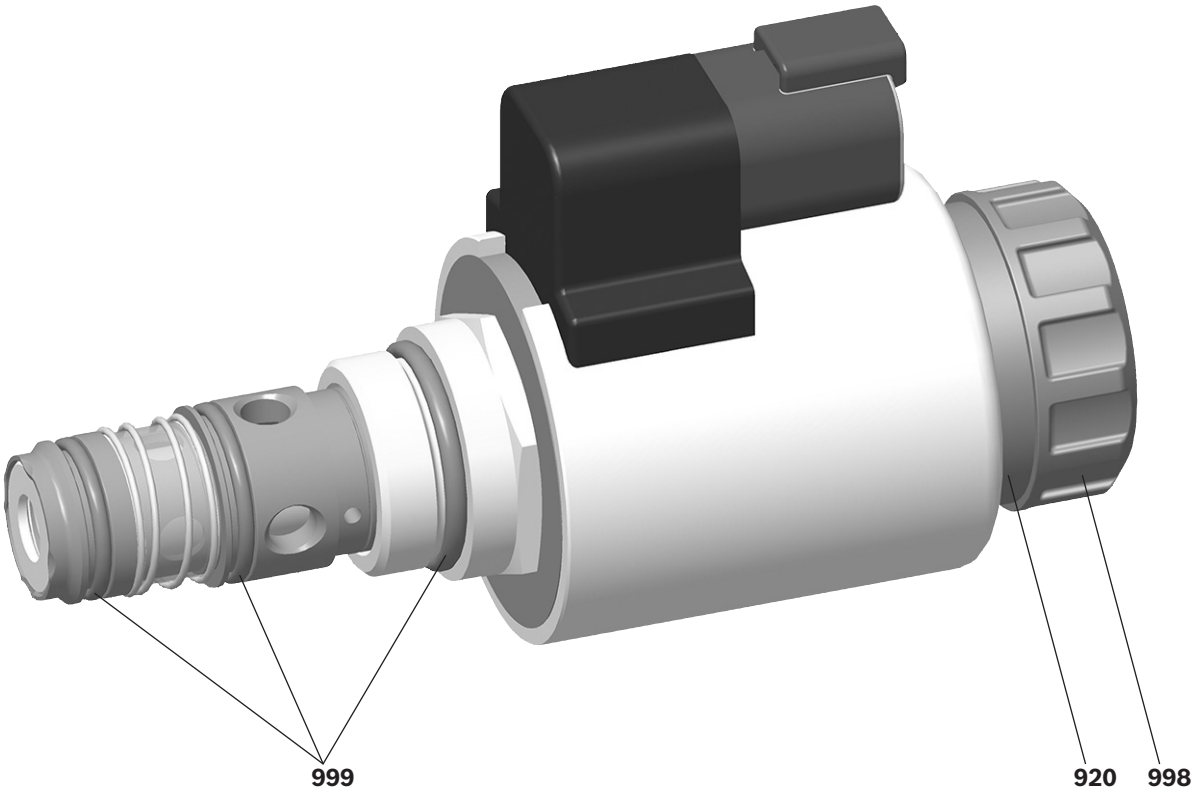
LS = Location Shoulder

1) Depth of fit
2) Visual inspection

Standards:

Workpiece edges	DIN ISO 13715
Form and position tolerance	DIN EN ISO 1101
General tolerance for metal-cutting procedures	DIN ISO 2768-mK
Tolerance	DIN ISO 8015
Surface condition	DIN EN ISO 1302

Individual components available



Item	Denomination	Material no.
998	Nut GZ45-01V BG	R961004245
999	Seal kit of the valve	R961003854
920	O-ring	R900002507

Further information

- Control electronics:
  - Analog amplifier type RA... Data sheet 95230
  - BODAS control unit type RC... Data sheet 95200
- Hydraulic valves for mobile applications Data sheet 64020-B1
- Mineral-oil-based hydraulic fluids Data sheet 90220
- Environmentally compatible hydraulic fluids Data sheet 90221
- Selection of the filters www.boschrexroth.com/filter

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Bosch Rexroth AG, RE 64655, edition: 2015-01

BODAS Pressure sensor
PR3

RE 95155
Edition: 02.2018
Replaces: 09.2017

- Measurement ranges to 25, 50, 160, 200, 250, 400, 600 bar
- Ratiometric output signal 0.5 to 4.5 V with 5 V supply voltage
- Fixed output signal 0.5 to 4.5 V with 8 to 36 V supply voltage
- Output signal 25% to 75% supply voltage with 8 to 12 V supply voltage
- Type of protection: IP67 and IP69K

Features

- Thin-film measurement principle
- Compact dimensions for all pressure ranges
- Shock and vibration resistant
- EMC characteristics to 100 V/m
- High resistance to pressure spikes
- Very good resistance to temperature shock

Inhalt

Ordering code

	01	02	03	04	05		06
BODAS –	**PR3**					**/**	**10**

Type

01	Pressure sensor	**PR3**

Measurement range

02	0 to 25 bar	**025**
	0 to 50 bar	**050**
	0 to 160 bar	**160**
	0 to 200 bar	**200**
	0 to 250 bar	**250**
	0 to 400 bar	**400**
	0 to 600 bar	**600**

Mechanical connection		**25, 50, 160, 200, 250, 400**	**600**	
03	G1/4 A in according to DIN EN ISO 1179-2	●	●	**G**
	M14 x 1.5 according to ISO 6149-2	–	●	**M**

Electrical connection		**25, 50**	**160**	**200**	**250, 400**	**600G**	**600M**	
04	AMP Superseal 1.5	●	●	–	●	●	–	**S**
	DEUTSCH DT04-3P	–	–	–	–	–	●	**D**
	Jet connector	–	●	●	–	–	–	**J**

Supply	**Output signal**		**25, 50**	**160GS**	**160GJ**	**200**	**250, 400**	**600GS**	**600MD**	
05	5 ±0.5 V	0.5 to 4.5 V ratiometric	●	●	–	–	●	●	–	**05**
	8 to 36 V	0.5 to 4.5 V fixed	–	–	–	–	–	–	●	**36**
	8 to 12 V	25% to 75% U_{sup}	–	–	●	●	–	–	–	**12**

Series

06		**10**

● = Available – = Not available

Available variants

Type							Material number	Minimum torque	Maximum torque
PR3	025	G	S	05	/	10	R917008819	25 Nm	30 Nm
PR3	050	G	S	05	/	10	R917008821	25 Nm	30 Nm
PR3	160	G	S	05	/	10	R917008822	25 Nm	30 Nm
PR3	250	G	S	05	/	10	R917008823	25 Nm	30 Nm
PR3	400	G	S	05	/	10	R917008824	25 Nm	30 Nm
PR3	600	G	S	05	/	10	R917008825	30 Nm	45 Nm
PR3	160	G	J	12	/	10	R917008828	25 Nm	30 Nm
PR3	200	G	J	12	/	10	R917008829	25 Nm	30 Nm
PR3	600	M	D	36	/	10	R917008826	30 Nm	45 Nm

Description

This sensor is used for measuring pressure in hydraulic circuits, but is also suitable for measuring all kinds of gases of fluid group 2 according to the pressure vessel directive up to 200 bar (e.g. air). Due to its outstanding characteristics, it is also ideally suited for use in mobile hydraulics: shock and vibration resistance, type of protection, resistance to pressure spikes, resistance to temperature shock, EMC characteristics (up to 100 V/m), and much more. The measurement principle uses a hermetically welded thin-film measurement cell, which ensures long-term leak resistance. The sensor signal can be directly evaluated by a BODAS controller RC.

Technical data

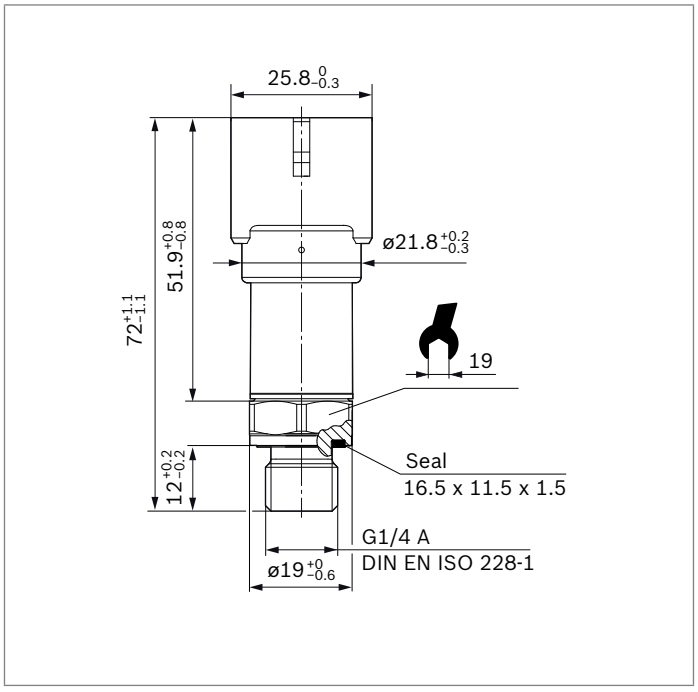
Type PR3		**025 GS05**	**050 GS05**	**160 GS05**	**250 GS05**	**400 GS05**	**600 GS05**	**600 MD36**	**160 GJ12**	**200 GJ12**
Pressure Equipment Directive		–	–	–	–	–	2014/68/EU	2014/68/EU	–	–
Measurement range	bar	0...25	0...50	0...160	0...250	0...400	0...600	0...600	0...160	0...200
Bursting pressure	bar	125	250	800	1200	1700	2400	2400	800	1000
Output signal		0.5 V to 4.5 V, ratiometric						0.5 to 4.5 V, fixed	25 to 75% U_{sup}	
Supply voltage U_{sup}		5 V ± 0.5 V						8 to 36 V	8 to 12 V	
Connector		AMP Superseal 1.5						DEUTSCH DT04-3P	Jet connector	
Parts contacting measuring materials		CrNi steel, HNBR								
Housing material		PPS GF40/CrNi steel								
Load resistance		4.5 kΩ, for Jet connectors however > 1 kΩ								
Maximum current consumption										
For voltage interface		≤ 5 mA without load								
Jet connector variants		≤ 10 mA without load								
Response time (10 to 90%)		≤ 2 ms						2 ms	≤ 2 ms	
Overall accuracy		≤ ±2%								
Reproducibility		≤ 0.2% of tensioning								
Stability per year		≤ 0.3% of tensioning (with reference conditions)								
Medium temperature range		–40 °C to +125 °C								
Ambient temperature range		–40 °C to +100 °C								
Storage temperature range		–40 °C to +120 °C								
Compensated range		0 °C to +80 °C								
Middle temperature coefficient zero point		≤ 0.15 % of tensioning / 10K in compensated range								
Middle temperature coefficient of tensioning		≤ 0.15 % of tensioning / 10K in compensated range								
Temperature error in the nominal temperature range		≤ 1 % of tensioning typ. ≤ 1.5% of tensioning								
CE conformity		Pressure vessel directive 2014/68/EU UN ECE 10 Rev4 and ISO 11452-2, -4, -5 as well as according to IEC 61000-4-3.								
E1 type approval		existing								
Pressure cycles over service life		20 million cycles (10% to 90% of nominal pressure)								
Shock resistance		50 g (DIN EN 60068-2-27, 11 ms), 500 g (DIN EN 60068-2-27, 1 ms)								
Vibration resistance		20 g (DIN EN 60068-2-6, 5 Hz to 2000 Hz)								
Electromagnetic compatibility EMC		100 V/m; Irradiation: ISO 11452-2 intensity IV; emissions: ISO 14982								
Electrical protection		Protection from voltage reversal, short circuits and undervoltage; protection from overvoltage in the defined supply voltage range								
Type of protection with installed mating connector		IP67 and IP69K								
Weight		approx. 50 g								

The following oils are suitable for the PR3:

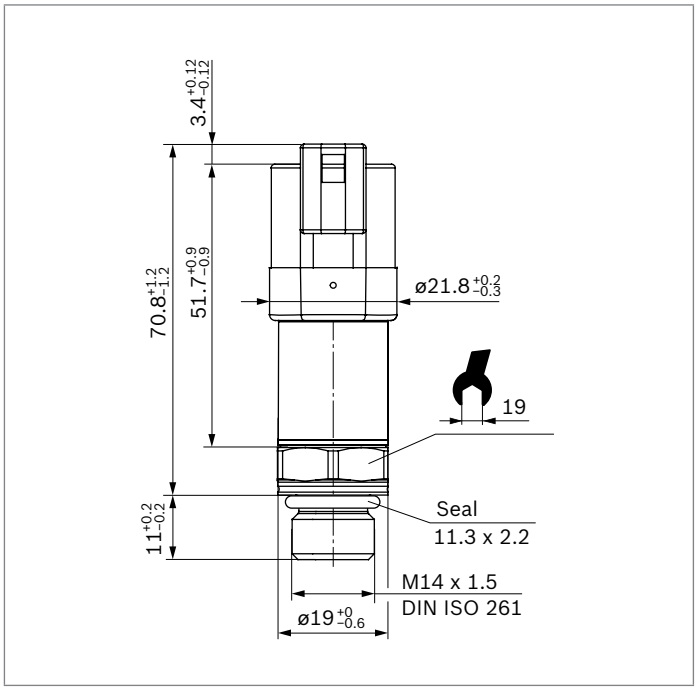
HETG, HEPG, HFE, HFB; HFB, HFC, HFA	
HEES:	Panolin HLP Synth 46
	Naturelle HF-E46
	Naturelle HFX 32
	Hydraulic HE 15
	Hydraulic HE 46
	Plantosyns Super S40
	Hydraulic oil based on mineral oils according to DIN 51524
	HLP according to DIN 51524
	Hydraulic oil HVLP 32/46/68 according to DIN 51524
	HD SAE 10 W 40
	HETG Fuchs Plantohyd 40/ Fragol TR46
	HEES Fuchs Plantosyns Super S40/ Fragol Hydraulic HE 15 + 46
	Motor oil according to API-C
	Motor oil according to API-CD
	Motor oil according to API-CF
	Colourant Renolin FST 101
HFD:	On request

Dimensions

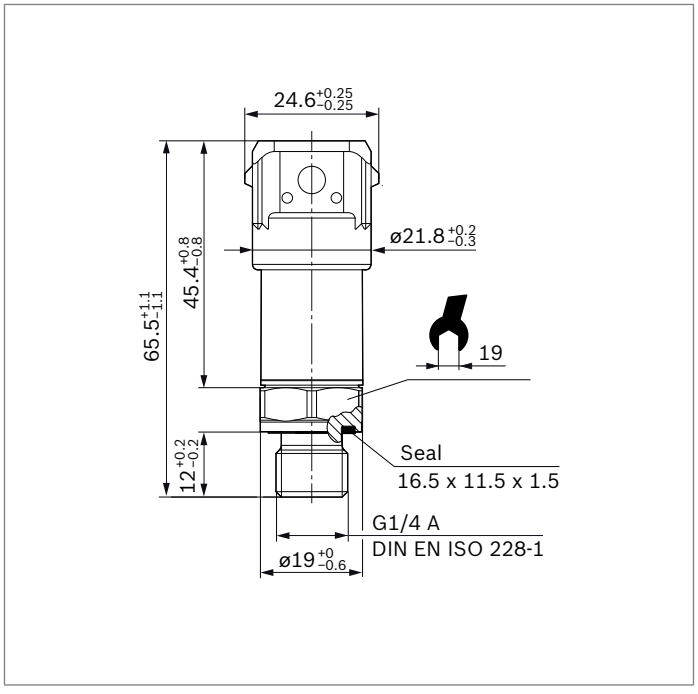
AMP Superseal



DEUTSCH DT04-3P



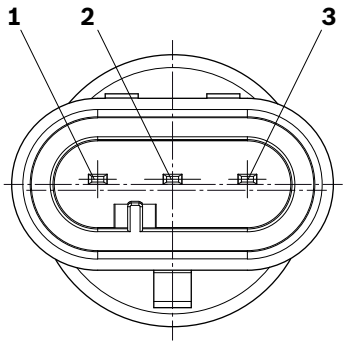
Jet connector



Connector

AMP Superseal

▼ **Pin assignment**



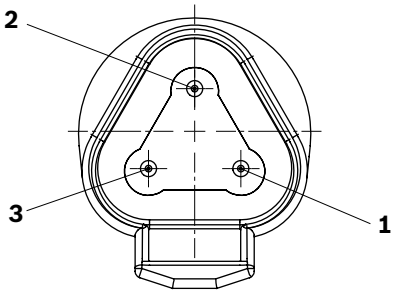
1 Ground GND
2 Signal voltage U_{sig}
3 Supply voltage U_{sup}

▼ **Mating connector**[1)]

Designation	Number	Material number
Mating connector set		R902602132[1)]
Socket housing 3-pin	1	282087-1[2)]
Single-wire seal, yellow	3	281934-2[2)]
Socket contact	3	183025-1[2)]

DEUTSCH DT04-3P

▼ **Pin assignment**



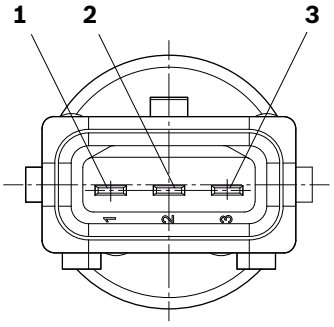
	Sensor DT04-3P	Connector DT06-3S-EP04
Ground GND	**1**	**B**
Signal voltage U_{sig}	**2**	**C**
Supply voltage U_{sup}	**3**	**A**

▼ **Mating connector**[1)]

Designation	Number	Material number
Mating connector set		R902603524[1)]
Housing 3-pin	1	DT06-3S-EP04[3)]
Wedge	1	W3S[3)]
Sockets	3	0462-201-16141[3)]

Jet connector

▼ **Pin assignment**



1 Ground GND
2 Signal voltage U_{sig}
3 Supply voltage U_{sup}

▼ **Mating connector**[1)]

Designation	Number	Material number
Bosch connector, 3-pin		R917000515[1)]
Connector housing with retention spring	1	1928402579[4)]
Contact for mini timer	3	929939[2)]
Protection cap	1	1280703022[4)]
Single seal	3	828904-1[2)]

1) The mating connectors are not included in the scope of supply. These are available from Bosch Rexroth under the corresponding material numbers.
2) Available from AMP
3) Available from DEUTSCH
4) Available from Bosch

Manufacturer confirmation of $MTTF_d$-values

The $MTTF_d$-values was determined in accordance with ISO 13849-1:2015, Appendix D, Parts Count Method.

According to ISO 13849-2:2012, the product meets the basic safety principles and the well-tried safety principles to the extent that they apply to the product.

The sensor is not a safety component in the sense of Directive on Machinery 2006/42/EC and has not been developed according to ISO 13849-1:2015, bzw. ISO 13849-2:2012.

Note
The $MTTF_d$-values given are only valid for the sensor. For assessment of the functional safety for sensors according to ISO ISO 13849-1:2015, the entire signal chain has to be considered. For this reason, the corresponding kinematics (e.g. geared ring) are also to be taken into account for sensor application in hydraulic drive units.

PR3 DEUTSCH-Connector

Valid for PR3-600MD36

Calculated with IEC TR 62380:2004 with real stress of the components

Ambient temperatur Control unit [°C]	**Self-heating [°C]**	**Temperature profile, Operating time share [%]**					
		1	**2**	**3**	**4**	**5**	**6**
10	10	1	1	1	1	1	0
30	10	2	2	2	2	1	0
40	10	3	3	3	3	1	0
50	10	4	3	3	3	1	100
60	10	5	3	3	3	1	0
70	10	6	3	3	3	1	0
80	10	79	85	3	3	1	0
90	10	0	0	82	3	1	0
100	10	0	0	0	79	92	0
110	10	0	0	0	0	0	0
125	10	0	0	0	0	0	0
$MTTF_d$-value [years] with use	4h per day	845	841	756	685	872	3547
	8h per day	802	797	712	639	617	3211
	16h per day	721	715	632	562	536	2672
	24h per day	783	774	661	570	534	4673

Ambient temperatur Control unit [°C]	**Self-heating [°C]**	**Temperature profile, Operating time share [%]**					
		7	**8**	**9**	**10**	**11**	**12**
10	10	0	0	0	0	0	0
30	10	0	0	0	0	0	0
40	10	0	0	0	0	0	0
50	10	0	0	0	0	0	0
60	10	0	0	0	0	0	0
70	10	100	0	0	0	0	0
80	10	0	100	0	0	0	0
90	10	0	0	100	0	0	0
100	10	0	0	0	100	0	0
110	10	0	0	0	0	100	0
125	10	0	0	0	0	0	100
$MTTF_d$-value [years] with use	4h per day	3017	2743	2470	2205	1952	1605
	8h per day	2582	2273	1978	1705	1457	1139
	16h per day	1977	1666	1390	1150	947	704
	24h per day	2578	1938	1469	1124	868	599

PR3 AMP-Connector

Valid for PR3-025GS05, PR3-050GS05, PR3-160GS05, PR3-250GS05, PR3-400GS05, PR3-600GS05

Calculated with IEC TR 62380:2004 with real stress of the components

Ambient temperatur Control unit [°C]	**Self-heating [°C]**	**Temperature profile, Operating time share [%]**					
		1	**2**	**3**	**4**	**5**	**6**
10	10	1	1	1	1	1	0
30	10	2	2	2	2	1	0
40	10	3	3	3	3	1	0
50	10	4	3	3	3	1	100
60	10	5	3	3	3	1	0
70	10	6	3	3	3	1	0
80	10	79	85	3	3	1	0
90	10	0	0	82	3	1	0
100	10	0	0	0	79	92	0
110	10	0	0	0	0	0	0
125	10	0	0	0	0	0	0
$MTTF_d$-value [years] with use	4h per day	1077	1071	954	856	1048	4485
	8h per day	1007	999	882	784	751	3954
	16h per day	880	871	761	668	632	3159
	24h per day	1038	1038	880	752	702	4626

Ambient temperatur Control unit [°C]	**Self-heating [°C]**	**Temperature profile, Operating time share [%]**					
		7	**8**	**9**	**10**	**11**	**12**
10	10	0	0	0	0	0	0
30	10	0	0	0	0	0	0
40	10	0	0	0	0	0	0
50	10	0	0	0	0	0	0
60	10	0	0	0	0	0	0
70	10	100	0	0	0	0	0
80	10	0	100	0	0	0	0
90	10	0	0	100	0	0	0
100	10	0	0	0	100	0	0
110	10	0	0	0	0	100	0
125	10	0	0	0	0	0	100
$MTTF_d$-value [years] with use	4h per day	3662	3260	2876	2516	2186	1751
	8h per day	3031	2606	2218	1873	1572	1199
	16h per day	2219	1827	1493	1214	984	718
	24h per day	2537	1902	1439	1098	846	582

PR3 JET-Connector

Valid for PR3-160GJ12 and PR3-200GJ12

Calculated with IEC TR 62380:2004 with real stress of the components

Ambient temperatur Control unit [°C]	**Self-heating [°C]**	**Temperature profile, Operating time share [%]**					
		1	**2**	**3**	**4**	**5**	**6**
10	10	1	1	1	1	1	0
30	10	2	2	2	2	1	0
40	10	3	3	3	3	1	0
50	10	4	3	3	3	1	100
60	10	5	3	3	3	1	0
70	10	6	3	3	3	1	0
80	10	79	85	3	3	1	0
90	10	0	0	82	3	1	0
100	10	0	0	0	79	92	0
110	10	0	0	0	0	0	0
125	10	0	0	0	0	0	0
$MTTF_d$-value [years] with use	4h per day	843	838	751	678	821	3543
	8h per day	788	782	695	621	596	3120
	16h per day	690	683	599	528	501	2489
	24h per day	720	711	602	515	479	3721

Ambient temperatur Control unit [°C]	**Self-heating [°C]**	**Temperature profile, Operating time share [%]**					
		7	**8**	**9**	**10**	**11**	**12**
10	10	0	0	0	0	0	0
30	10	0	0	0	0	0	0
40	10	0	0	0	0	0	0
50	10	0	0	0	0	0	0
60	10	0	0	0	0	0	0
70	10	100	0	0	0	0	0
80	10	0	100	0	0	0	0
90	10	0	0	100	0	0	0
100	10	0	0	0	100	0	0
110	10	0	0	0	0	100	0
125	10	0	0	0	0	0	100
$MTTF_d$-value [years] with use	4h per day	2937	2631	2334	2051	1788	1437
	8h per day	2422	2093	1788	1514	1274	974
	16h per day	1765	1458	1195	973	971	578
	24h per day	2032	1522	1151	879	677	467

Assessment of Safety Principles

List of the safety principles that must be to take into account in the higher-level system.

Basic safety principle A1	**Remarks**	**Assessment**
Application of the principle of energy separation	The safe state is achieved by connection of energy. Please check process for stopping in ISO 12100:2010, 6.2.11.3. Energy is supplied for actuation of movement of a mechanism. Please check process for movement in ISO 12100:2010, 6.2.11.3. Respect different operating categories, e.g. operating mode, maintenance mode. Important: This principle may not be applied if a dangerous situation can happen because of energy loss, e.g. release of a tool by loss of loading force.	Request has to be ensured by higher-level system.
Protection against unexpected movement	Consideration of unexpected movement caused by stored energy and after reestablishment of energy supply for different operation categories like operating mode, maintenance mode etc. A special device to let off stored energy may be is necessary. Special applications, e.g. for saving energy for clamping device or for ensuring of a position have to be considered separately.	Request has to be ensured by higher-level system.
Well-tried safety principle A2		
Application of components with defined breakdown	The predominant occurring breakdown behavior of a component is known in advance and always the same. Please check ISO 12100:2010, 6.2.12.3	Request has to be ensured by higher-level system.
Basic safety principle C1		
Application of principle energy separation	The safe state will be achieved by activating of energy at all relevant devices. Please check process for stopping in ISO 12100:2010, 6.2.11.3. Energy is supplied for actuation of movement of a mechanism.. Please check process for movement in ISO 12100:2010, 6.2.11.3. Respect different operating categories, e.g. operating mode, maintenance mode. This principle may not be applied for some applications, e.g.if because of loss of hydraulic pressure an additional endangering happens.	Request has to be ensured by higher-level system.
Protection against unexpected movement	Consideration of unexpected movement caused by stored energy and after reestablishment of energy supply for different operation categories like operating mode, maintenance mode etc. A special device to let off stored energy may be is necessary. Special applications, e.g. for saving energy for clamping device or for ensuring of a position have to be considered separately.	Request has to be ensured by higher-level system.

Basic safety principle D1	**Remarks**	**Assessment**
Application of energy separation principle	A safe state will be achieved by disconnecting all important devices from energy source, e.g. by application of a common closed contact (NC) for inputs (tactile and position switch) and common open contact (NO) for relay (see also ISO 12100:2010, 6.2.11.3). In some cases exceptions are possible, e.g. if the breakdown of energy source is an additional endangering. Time delayed functions can be necessary to achieve a safe state of the system (see IEC 60204-1:2005, 9.2.2).	Request has to be ensured by higher-level system.
Protection against unexpected movement	Protection of unexpected movement, e.g. recovering of energy supply (see ISO 12100:2010, 6.2.11.4, ISO 14118, IEC 60204-1).	Request has to be ensured by higher-level system.
Protection against steering current circuit	Steering current circuit shall be protected according to IEC 60204-1:2005, 7.2 und 9.1.1.	Request has to be ensured by higher-level system.
Well-tried safety principle D2		
Avoidance of errors in cables	In order to prevent short circuits between two lines: ▶ At every single line use a cable, which shield is connected to the protection system or ▶ In flat cables application of a protection conductor between all signal conductors.	Request has to be ensured by higher-level system.
Limiting of energy	For supply of a limited amount of energy a capacitor has to be used, e.g. for clock pulse steering.	Request has to be ensured by higher-level system.
State alignment of breakdowns	If possible in case of breakdown all devices/circuits shall switch to a safe state or safe conditions.	Request has to be ensured by higher-level system.
Directed breakdown	If realizable all components or systems shall be applied, where the case of breakdown is known ahead, (see ISO 12100:2010, 6.2.12.3).	Request has to be ensured by higher-level system.

Installation instructions

Electrical connection

- The device may only be installed by a trained electrician.
- The national and international specifications regarding the installation of electro-technical systems must be followed.
- Voltage supply according to SELV, PELV.
- De-energize the system.

Mechanical connection

- Before installing and removing the device, make certain that the system is not pressurized.

Safety instructions

Risk of injury!
Overload pressures that exceed the specified maximum permissible pressure are to be prevented through appropriate measures. The specified bursting pressure must not be exceeded. Even exceeding the bursting pressure for brief periods can destroy the device.

General instructions

- Before finalizing your design, request a binding installation drawing.
- The proposed circuits do not imply any technical liability for the system on the part of Bosch Rexroth.
- It is not permissible to open the BODAS pressure sensor PR3 or to modify or repair the BODAS pressure sensor PR3. Modifications or repairs to the wiring could result in dangerous malfunctions.
- Only allow pressure measurement devices to be installed by trained and specialist personnel who are authorized by the system owner.
- Connections must only be opened while in a depressurized state!
- System developments, installation and commissioning of electronic systems for controlling hydraulic drives must only be carried out by trained and experienced specialists who are sufficiently familiar with both the components used and with the complete system.
- While commissioning the BODAS pressure sensor PR3, the machine may pose unforeseen dangers. Before commissioning the system, you must therefore ensure that the vehicle and the hydraulic system are in a safe condition.
- Make sure that nobody is in the machine's danger zone.
- No defective or incorrectly functioning components may be used. If the BODAS pressure sensor PR3 should fail or demonstrate faulty operation, it must be replaced.
- Residual measurement materials in unmounted pressure measurement devices could endanger people, the environment and equipment. Take appropriate precautionary measures.
- In spite of taking great care in preparing this document, all conceivable application cases could not be taken into account. If information is lacking for your specific application, please contact Bosch Rexroth.

Pressure vessel directive

- Devices with MEV (measurement range end value) 600 bar correspond to directive 2014/68/EU and are not designed for overheated fluids of fluid group 2. These devices are manufactured and inspected according to module A.
- Devices with MEV 25 to 400 bar correspond to article 3 paragraph (3) of directive 2014/68/EU and are not designed and manufactured for overheated fluids of fluid group 2, in accordance with good engineering practice.

Notes on the installation location and position

- Do not install the BODAS pressure sensor PR3 close to parts that generate considerable heat (e.g. exhaust).
- A sufficiently large distance to radio systems must be maintained.
- The connector of the BODAS pressure sensor PR3 is to be unplugged during electrical welding and painting operations.
- Cables/wires must be sealed individually to prevent water from entering the device.

Notes on transport and storage

- Please inspect the device for any damages which may have occurred during transport. If there are obvious signs of damage, please immediately inform the transport company and Bosch Rexroth.
- If it is dropped, the BODAS pressure sensor PR3 must not be used any longer as invisible damage could have a negative impact on reliability.

Notes on wiring and circuitry

- Lines to the pressure sensors must be designed as short as possible and be shielded. The shielding must be connected to the electronics on one side or to the machine or vehicle ground via a low-resistance connection.
- The BODAS pressure sensor PR3 should only be plugged and unplugged when it is in a de-energized state.
- Lines from the BODAS pressure sensor PR3 to the electronics must not be routed close to other power-conducting lines in the machine or vehicle.
- The wiring harness should be fixated mechanically in the area in which the sensor is installed (spacing < 150 mm). The wiring harness should be fixated so that in-phase excitation with the sensor occurs (e.g. at the sensor mounting points).
- If possible, lines should be routed in the vehicle interior. If the lines are routed outside the vehicle, make sure that they are securely fixed.
- Lines must not be kinked or twisted, must not rub against edges and must not be routed through sharp-edged ducts without protection.
- Lines are to be routed with sufficient distance from hot or moving vehicle parts.
- The sensor lines are sensitive to radiation interference. For this reason, the following measures should be taken when operating the sensor:
  - Sensor lines should be attached as far away as possible from large electric machines.
  - If the signal requirements are satisfied, it is possible to extend the sensor cable.

Intended use

- The BODAS pressure sensor PR3 is designed for use in mobile working machines provided no limitations/ restrictions are made to certain application areas in this data sheet.
- Prior to installation, commissioning and operation, make certain that the correct pressure measurement device was selected with respect to measurement range, design and – based on the specific measurement conditions – parts which are in contact with measuring materials (corrosion). Furthermore, the respective national safety regulations are to be observed.
- Operation of the BODAS pressure sensor PR3 must generally occur within the operating ranges specified and released in this data sheet, particularly with regard to voltage, temperature, vibration, shock and other described environmental influences.
- Use outside of the specified and released boundary conditions may result in danger to life and/or cause damage to components which could result in consequential damage to the mobile working machine.
- Failure to observe the respective specifications may result in serious bodily injury and/or property damage.

Improper use

- Any use of the BODAS pressure sensor PR3 other than that described in chapter “Intended use" is considered to be improper.
- Use in explosive areas is not permissible.
- Damages which result from improper use and/or from unauthorized, interference in the component not described in this data sheet render all warranty and liability claims with respect to the manufacturer void.

Use in safety-related functions

- The customer is responsible for performing a risk analysis of the mobile working machine and determining the possible safety-related functions.
- In safety-related applications, the customer is responsible for taking suitable measures for ensuring safety (sensor redundancy, plausibility check, emergency switch, etc.).
- Product data that is necessary to assess the safety of the machine can be provided on request or are listed in this data sheet.

Further information

- Further information about the BODAS pressure sensor PR3 can be found at www.boschrexroth.com/mobile-electronics.
- The BODAS pressure sensor PR3 must be disposed according the national regulations of your country.

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Rexroth
Bosch Group

Hydraulic remote controls

RE 64 558/05.06 **1**/10

Replaces: 05.03

Type TH7

Series 1X

Type 1TH7Z

Type 1TH7QL

Type 2TH7Q

Type 2TH7N

Type 4TH7G

Contents

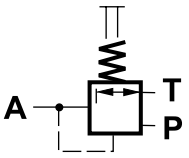
Features

- Progressive, sensitive operation
- Precise and play-free control

Functional description, symbol

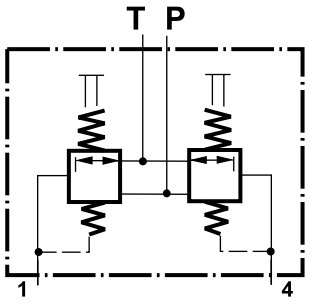
1TH7QL: Single acting hydraulic remote control, operation via one long pedal

1TH7Z: Single acting hydraulic remote control without operator

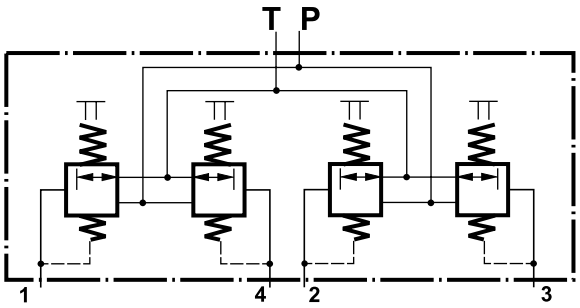


2TH7Q: Single acting hydraulic remote control, operation via two independent pedals

2TH7L, M, N, P: Double acting hydraulic remote control, operation via one side lever



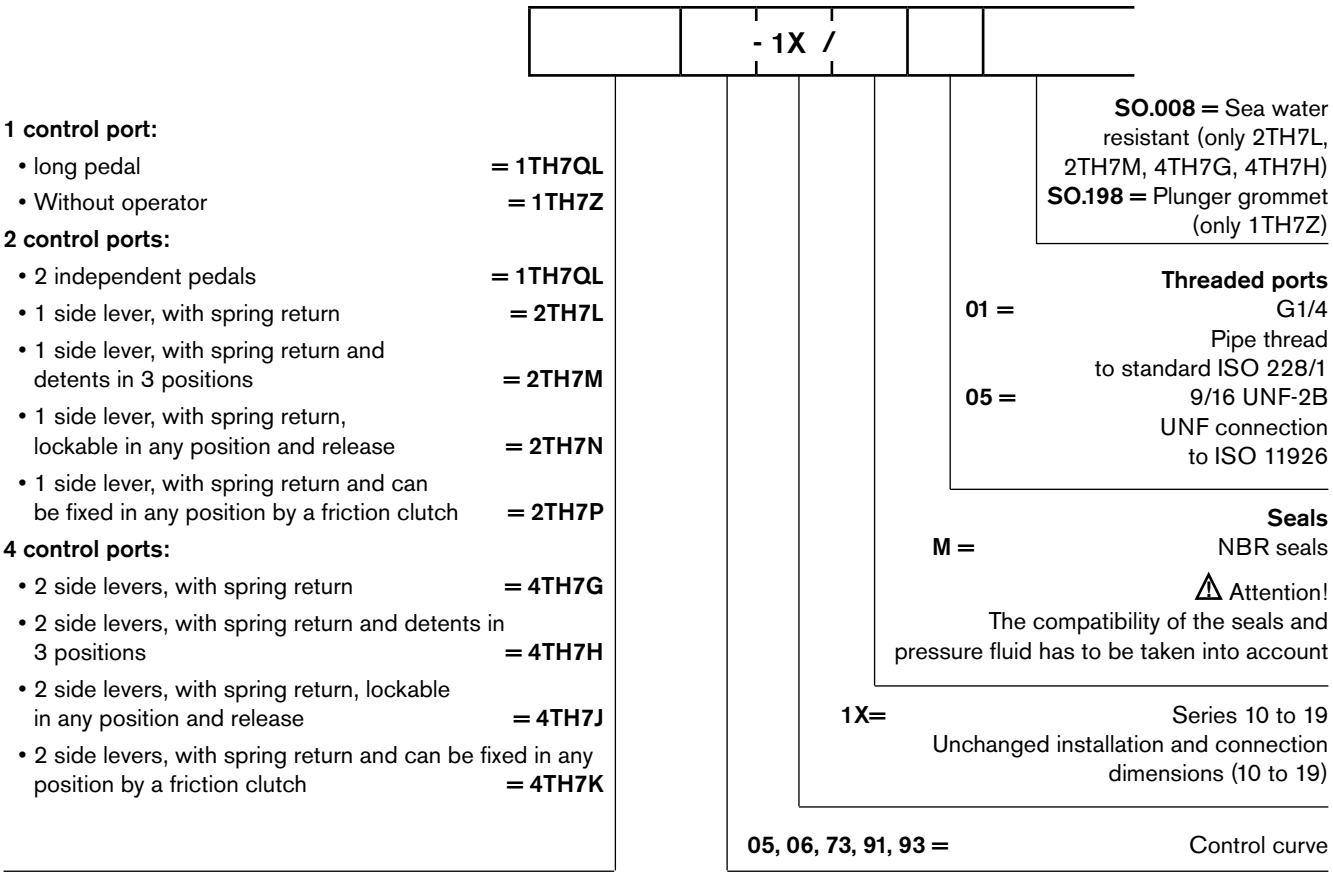
4TH7G, H, J, K: Double acting hydraulic remote control, operation via two side levers



Technical data, mechanical (for applications outside these parameters, please consult us!)

Inlet pressure	bar	50
Back pressure at port T	bar	3
Pilot oil flow	l/min	up to 20
Hysteresis	bar	up to 1
Pressure fluid *1) suitable for NBR seals* *2) consult us*		 Mineral oil (HL, HLP) to DIN 51524 1) Phosphate ester (HFD-R) 2)
Pressure fluid temperature range	°C	– 20 to + 80
Viscosity range	mm^2/s	10 to 380
Degree of pressure fluid contamination		Max. permissible degree of contamination of the pressure fluid is to NAS 1638 class 9. We, therefore, recommend a filter with a minimum retention rate of $ß_{10} \geq 75$.
Max. permissible operating torque at the pedals	Nm	20
Max. permissible actuation force at the plunger	N	88
Max. permissible operating torque at the levers	Nm	8
Weight	kg kg kg kg	3,2 (1TH7QL, 2TH7L, M, N, P) 1,2 (1TH7Z) 6,2 (2TH7Q) 3,5 (4TH7G, H, J, K)

Codification



Application guidelines (these guidelines are not intended to be considered as complete)

– Do not direct the jet of a pressure washing unit directly at the unit.

– Replace worn rubber grommets.

Safety guidelines (these guidelines are not intended to be considered as complete)

– Take into account all of the application limits, particularly those application limits stated within this catalogue sheet!

Installation guidelines

– Mounting flange area: flatness = 0.5 mm

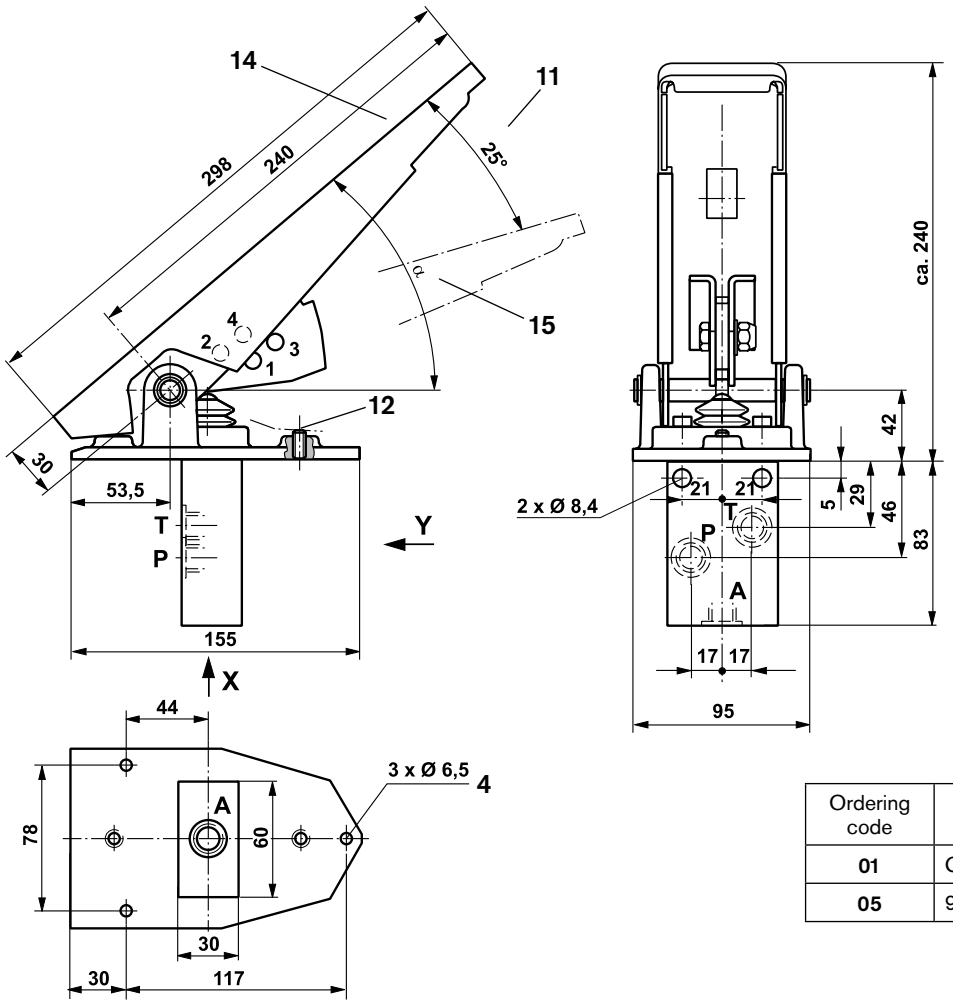
– Screw head dimensions = Ø10 mm

– Tightening torque for the flange fixing screws = 10 Nm max.

– Tightening torque for the pipe connections = 30 Nm max.

Unit dimensions (dimensions in mm)

Type 1TH7QL, one single acting long pedal

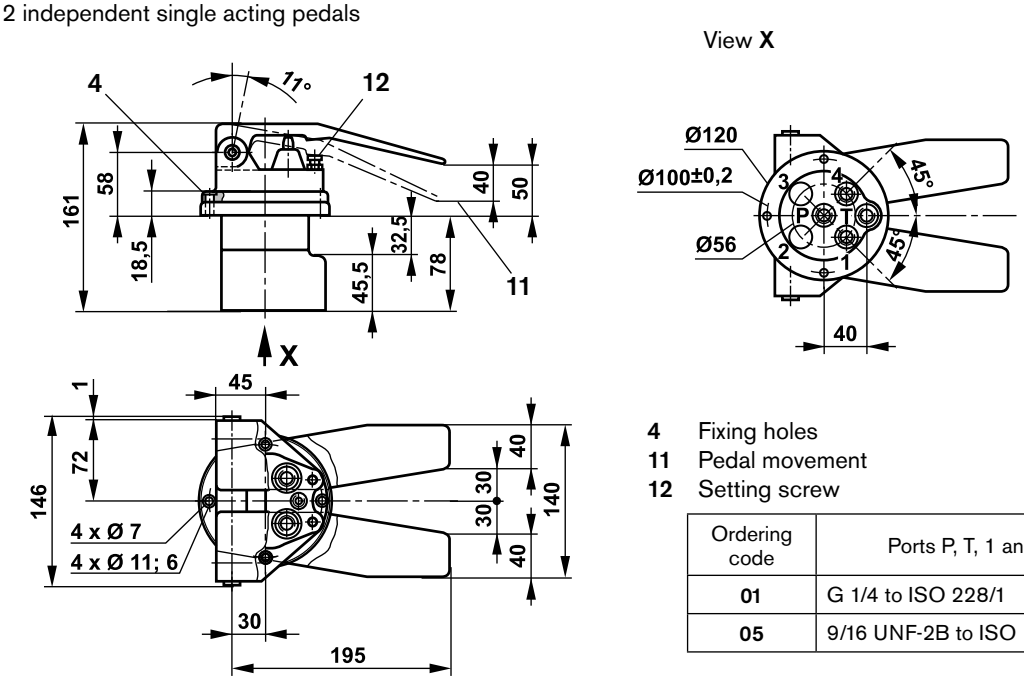


4 Fixing holes
11 Pedal movement
12 Setting screw
14 Anti-slip pedal surface
15 Adjustable angle approx. every 5°:

Hole	α
1	25°
2	30°
3	35°
4	40°

Ordering code	Ports P, T, A
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

Type 2TH7Q, 2 independent single acting pedals

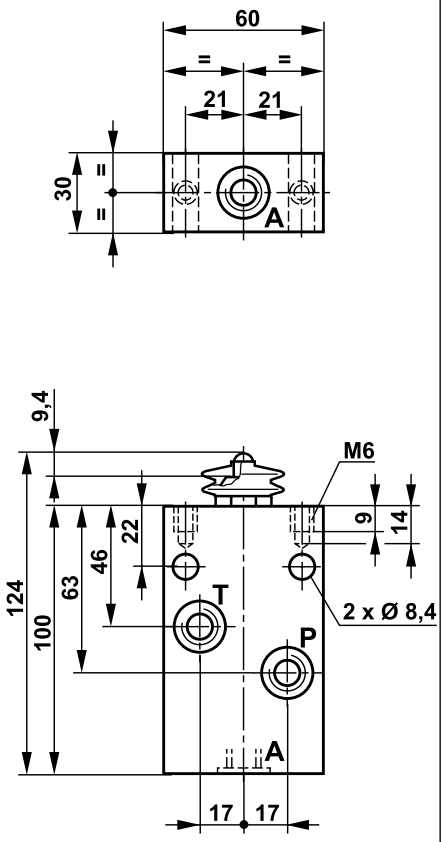


4 Fixing holes
11 Pedal movement
12 Setting screw

Ordering code	Ports P, T, 1 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

Unit dimensions (dimensions in mm)

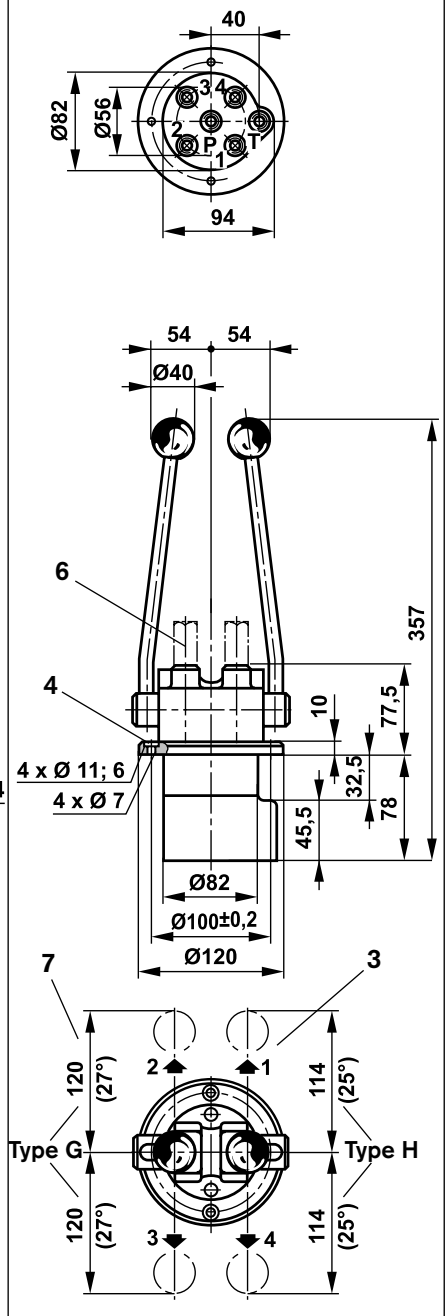
Type 1TH7Z Without operator element (grommet = SO.198)



Ordering code	Ports P, T, A
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

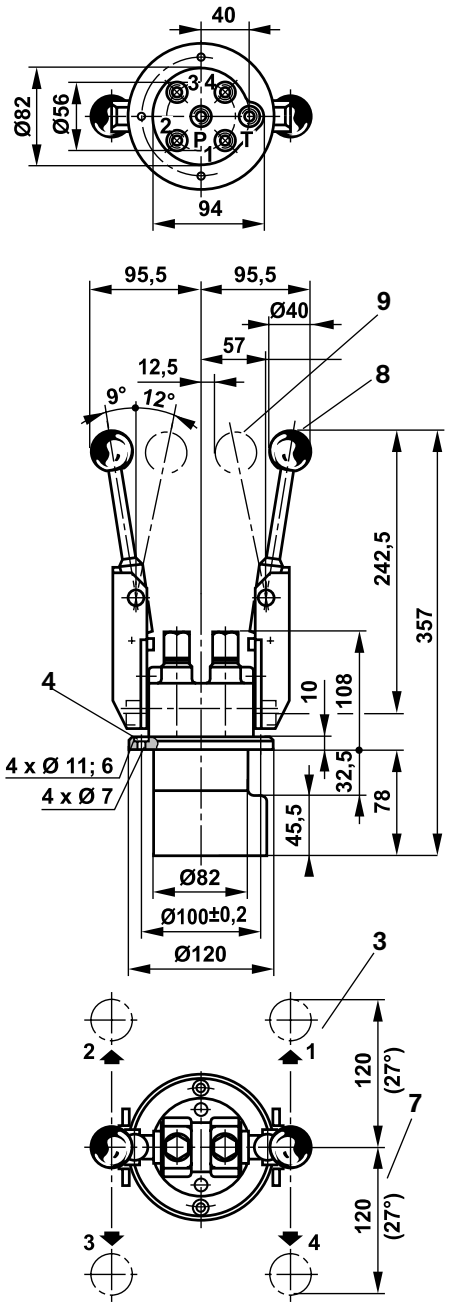
Type G 2 side levers, with spring return

Type H 2 side levers, with spring return and detents in 3 poisitions



Ordering code	Ports P, T, 1, 2, 3 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

Type J 2 side levers, spring return, with lock and release in any position

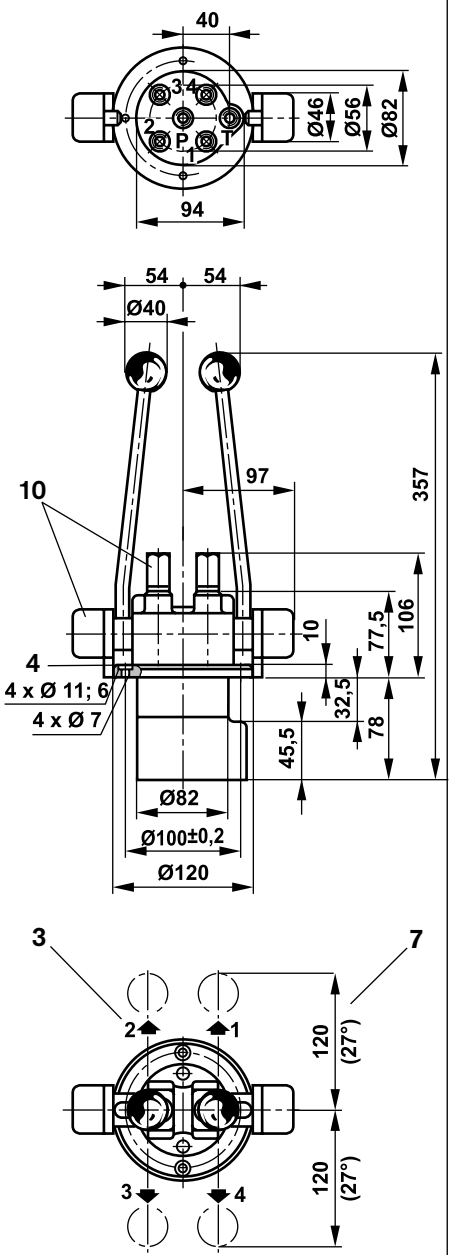


Ordering code	Ports P, T, 1, 2, 3 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

3 Lever operation direction and control ports thereby influenced
4 Fixing holes
6 Detents in 3 positions (type H)
7 Lever deflection
8 Lever position locked
9 Lever position released

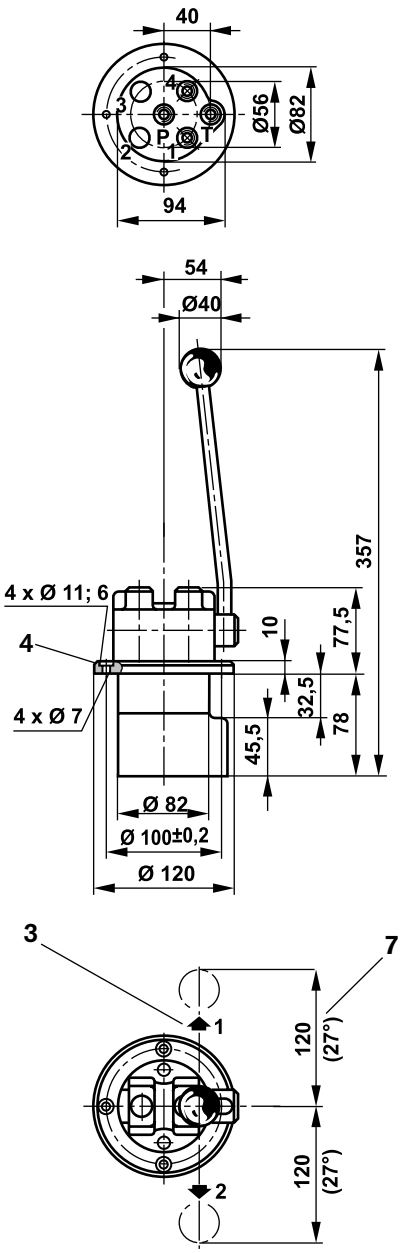
Unit dimensions (dimensions in mm)

Type K 2 side levers, spring return, can be fixed in any position by friction clutch



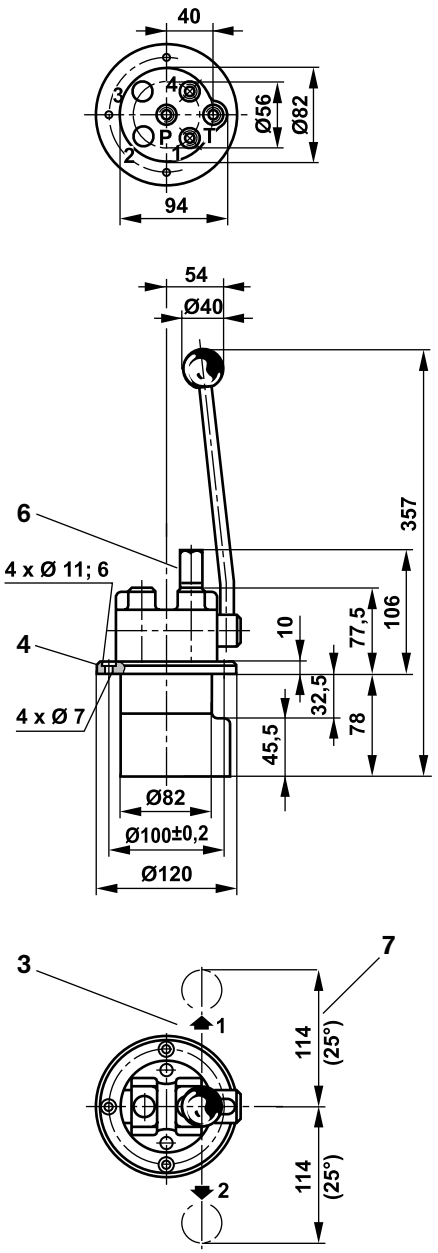
Ordering code	Ports P, T, 1, 2, 3 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

Type L 1 side lever, spring return



Ordering code	Ports P, T, 1 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

Type M 1 side lever, spring return, detents in 3 positions

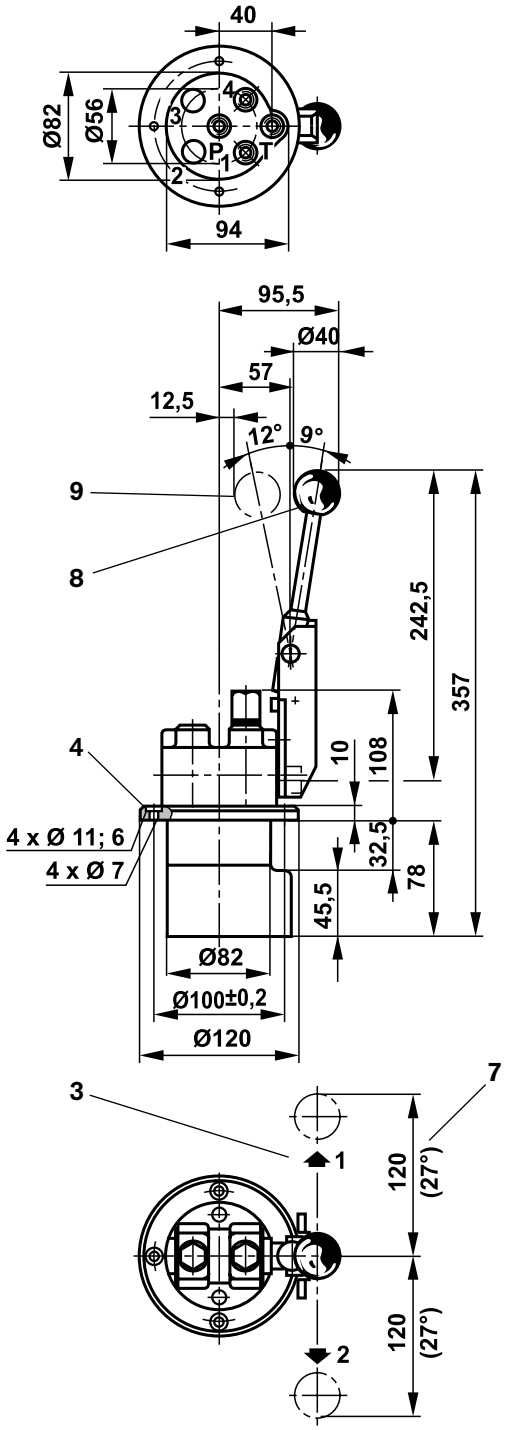


Ordering code	Ports P, T, 1 and 4
01	G 1/4 to ISO 228/1
05	9/16 UNF-2B to ISO 11926

3 Lever operation direction and control ports thereby influenced
4 Fixing holes
6 Detents in 3 positions (type M)
7 Lever deflection
10 Fixed in any position by friction clutch

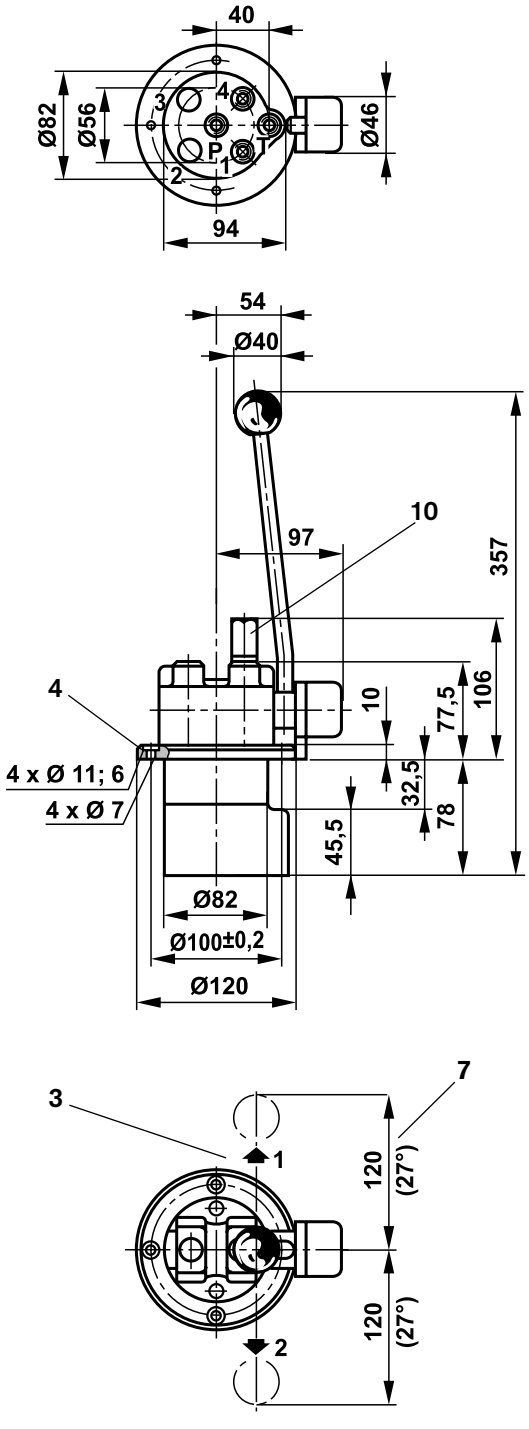
Unit dimensions (dimensions in mm)

Type N 1 side lever, spring return, with lock and release in any position



Ordering code	Ports P, T, 1 and 4
01	G 1/4 selon ISO 228/1
05	9/16 UNF-2B selon ISO 11926

Type P 1 side lever, spring return, can be fixed in any position by friction clutch

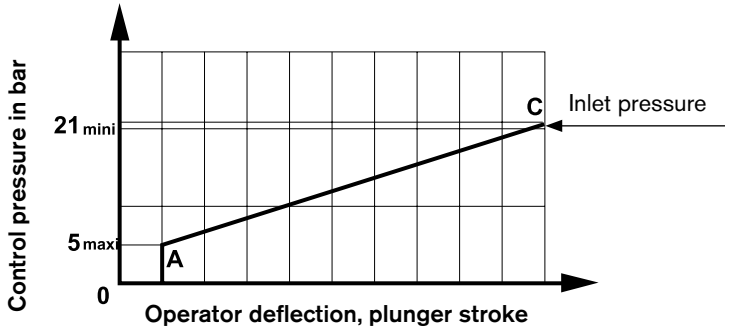


Ordering code	Ports P, T, 1 and 4
01	G 1/4 selon ISO 228/1
05	9/16 UNF-2B selon ISO 11926

3 Lever operation direction and control ports thereby influenced
4 Fixing holes
7 Lever deflection
7 Lever position locked
9 Lever position released
10 Fixed in any position by friction clutch

Characteristic curves: control ranges, actuation moments

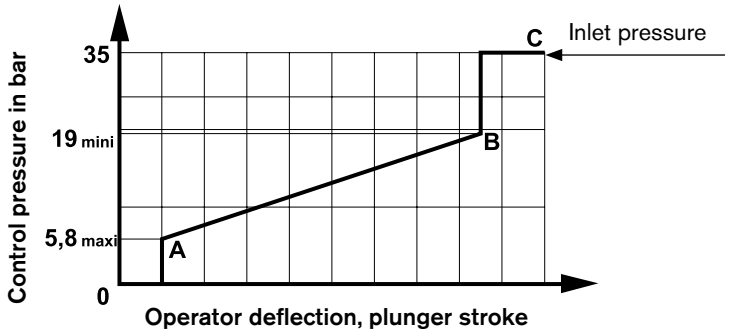
05 Control curve, identification no. 05



	1TH7QL			1TH7Z			2TH7Q			TH7 G/H/J/L/M/N			TH7 K/P		
Intersection point	A		C	A		C	A		C	A		C	A		C
Operator deflection (°)	4°55'		26°10'				1°50'		10°40'	4°40'		27°30'	4°40'		27°30'
Plunger stroke (mm)				1,6		9,2									
Actuation moment (Nm)	0,82		2,38				2,33		6,72	1,95		3,57			
Actuation force (N)				5,49		13,57									

06 Control curve, identification no. 06

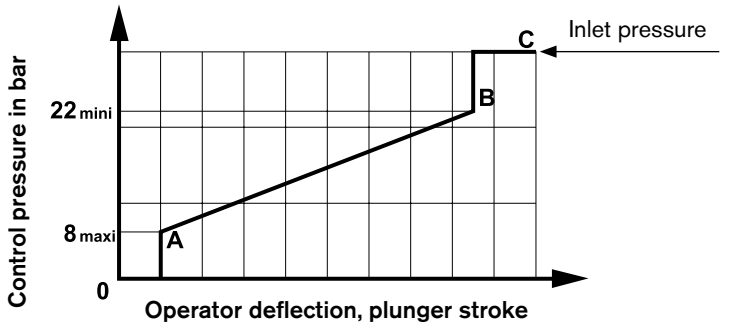
This curve is used for the pilot control of the SM12, SM18, M1 control blocks



	1TH7QL			1TH7Z			2TH7Q			TH7 G/H/J/L/M/N			TH7 K/P		
Intersection point	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Operator deflection (°)	4°55'	20°30'	26°10'				1°50'	8°10'	10°40'	4°40'	21°20'	27°30'	4°40'	21°20'	27°30'
Plunger stroke (mm)				1,6	7,1	9,2									
Actuation moment (Nm)	0,86	2,29	2,66				2,42	6,48	7,53	1,17	3,33	3,63			
Actuation force (N)				6,57	12,80	18,96									

73 Control curve, identification no. 73

This curve is used for the pilot control of the SP12 control blocks

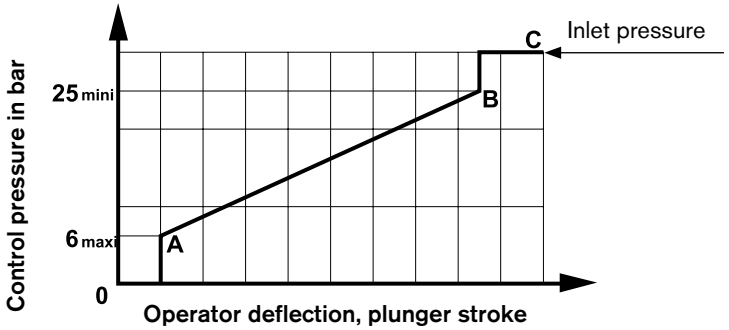


	1TH7QL			1TH7Z			2TH7Q			TH7 G/H/J/L/M/N			TH7 K/P		
Intersection point	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Operator deflection (°)	4°55'	20°30'	26°10'				1°50'	8°10'	10°40'	4°40'	21°20'	27°30'	4°40'	21°20'	27°30'
Plunger stroke (mm)				1,6	7,1	9,2									
Actuation moment (Nm)	0,94	2,29	2,66				2,67	6,48	7,53	1,29	3,13	3,63			
Actuation force (N)				8,57	13,96	18,96									

Characteristic curves: control ranges, actuation moments

91 Control curve, identification no. 91

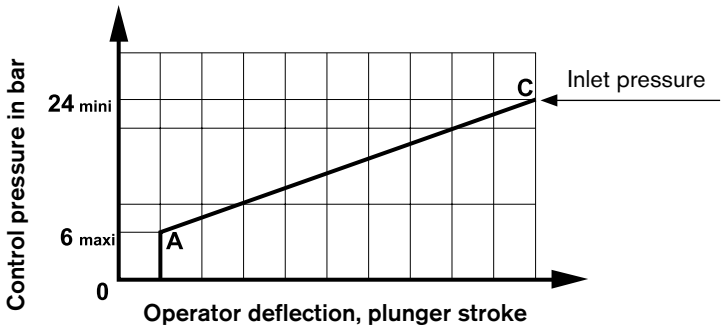
This curve is used for the pilot control of the SX12, SX14, SX18 control blocks



	1TH7QL			1TH7Z			2TH7Q			TH7 G/H/J/L/M/N			TH7 K/P		
Intersection point	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Operator deflection (°)	4°55'	20°30'	26°10'				1°50'	8°10'	10°40'	4°40'	21°20'	27°30'	4°40'	21°20'	27°30'
Plunger stroke (mm)				1,6	7,1	9,2									
Actuation moment (Nm)	0,86	2,29	2,66				2,44	6,48	7,53	1,18	3,13	3,63			
Actuation force (N)				7,79	15,11	18,96									

93 Control curve, identification no. 93

This curve is used for the pilot control of the M7, M4 control blocks



	1TH7QL			1TH7Z			2TH7Q			TH7 G/H/J/L/M/N			TH7 K/P		
Intersection point	A		C	A		C	A		C	A		C	A		C
Operator deflection (°)	4°55'		26°10'				1°50'		10°40'	4°40'		27°30'	4°40'		27°30'
Plunger stroke (mm)				1,6		9,2									
Actuation moment (Nm)	2,44		6,72				1,18		3,25	0,86		2,74			
Actuation force (N)				7,79		14,73									

Notes

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Notes

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Directional poppet type, shuttle

Common cavity, Size 08

SELB-08A

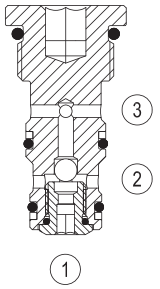
04.94.05.00.56.00

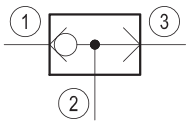
RE 18319-80
Edition: 03.2016
Replaces: 11.2015

Description
The single ball shuttle allows flow from the higher pressure of two work ports 1 and 3 to the 2 port.

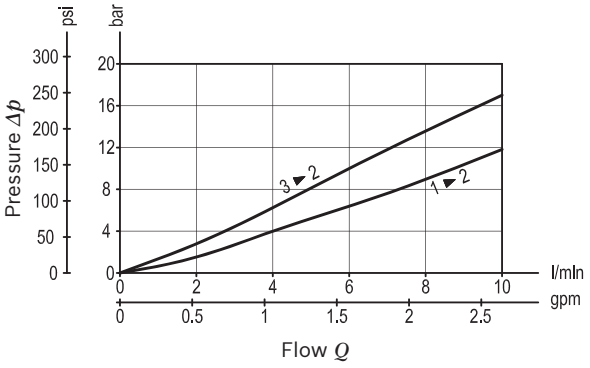
Technical data	
Max. operating pressure	350 bar (5000 psi)
Max. flow	See performance graph
Max. internal leakage	15 drops/min.
Fluid temperature range	-30 to 100 °C (-22 to 212 °F)
Installation torque	34 - 41 Nm (25 - 30 ft-lbs)
Weight	0.06 kg (0.13 lbs)
Common cavity	CA-08A-3N (see data sheet 18325-70)
Lines bodies and standard assemblies	Please refer to section “Hydraulic integrated circuit” or consult factory
Seal kit[1)]	Code: RG08A3010520100
	material no: R930000861
Fluids	Mineral-based or synthetics with lubricating properties at viscosities of 5 to 800 mm²/s (cSt)
Recommended degree of fluid contamination	Nominal value max. 10µm (NAS 8) / ISO 4406 19/17/14
Installation position	No restrictions
Other Technical Data	See data sheet 18350-50

1) Only external seals for 10 valves





Characteristic curve



Ordering code

04.94.05.00	56	00	00	*

Series 0/A to L
unchanged performances and dimensions

Directional poppet type, shuttle

Version and options standard

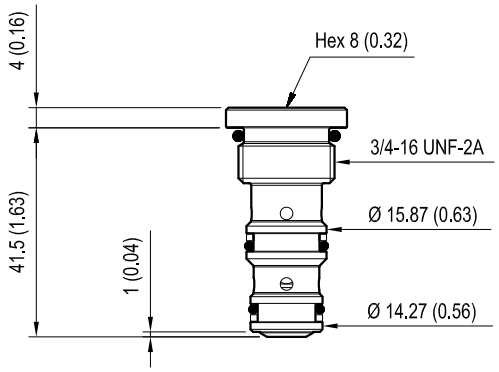
Common cavity, Size 08

Preferred types

Type	Material number
049405005600000	R901161981

Type	Material number

Dimensions



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Bosch Rexroth Oil Control S.p.A., RE 18319-80/03.2016

Priority unloading pilot operated

Common cavity, Size 08

VMSN-08A

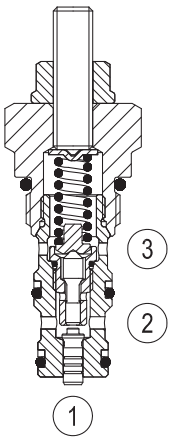
04.75.21 - X - 56 - Z

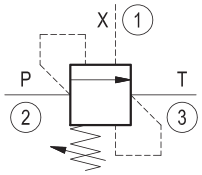
RE 18318-16
Edition: 03.2016
Replaces: 12.2011

Description
Flow is blocked from 2 to 3 until pressure increases to meet the selected valve setting, lifting the small, pilot-stage poppet from its seat. This action exhausts oil above the main-stage piston (spool type), allowing it to shift fully and unload flow from 2 through 3 with minimal pressure drop. Similarly, when remote pilot pressure at 1 exceeds the pressure setting, a secondary piston lifts the pilot-stage poppet from its seat, again exhausting fluid from 2 through 3.

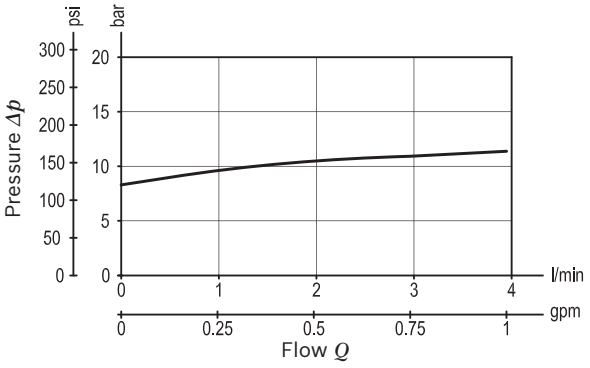
Technical data	
Max. operating pressure port 1-2	350 bar (5000 psi)
Max. pressure admitted port 3	50 bar (750 psi)
Max. flow	3 l/min (1 gpm)
Max. internal leakage[1)]	15 drops/min.
Fluid temperature range	-30 to 100 °C (-22 to 212 °F)
Installation torque	34 - 41 Nm (25 - 30 ft-lbs)
Weight	0.14 kg (0.31 lbs)
Cavity	CA-08A-3N (see data sheet 18325-70)
Lines bodies and standard assemblies	Please refer to section “Hydraulic integrated circuit” or consult factory
Seal kit[2)]	Code: RG08A3010520100
	material no: R930000861
Fluids	Mineral-based or synthetics with lubricating properties at viscosities of 10 to 500 mm²/s (cSt)
Recommended degree of fluid contamination	Nominal value max. 10µm (NAS 8) / ISO 4406 19/17/14
Installation position	No restrictions
Other Technical Data	See data sheet 18350-50

1) At 80% of pressure setting
2) Only external seals for 10 valves





Characteristic curve



Ordering code

04.75.21	X	56	Z	00	*

Series 0/A to L
unchanged performances and dimensions

Priority unloading pilot operated

Version and options standard

Differential unload / reload

05 Re-seat at (57 ± 2.5) % of pressure setting

06 Re-seat at (66 ± 2.5) % of pressure setting

08 Re-seat at (80 ± 2.5) % of pressure setting

56 Common cavity, Size 08

	SPRINGS	
	Adj. press. range bar (psi)	Std. setting bar (psi) Q=1 l/min.
03 *	20-40 (290-580)	30 (435)
05 *	35-70 (500-1000)	50 (725)
10 *	70-140 (1000-2000)	100 (1450)
20	105-210 (1500-3000)	200 (2900)
35	175-350 (2500-5000)	350 (5000)

***** Available only for x=05 and x=06

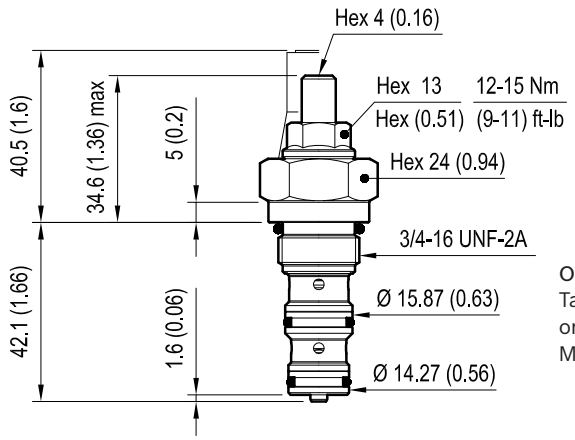
Note: Special settings available. Contact factory authorized representative for ordering code.

Preferred types

Type	Material number
047521055603000	R930006649
047521055605000	R930006650
047521055610000	R930006651
047521055620000	R930006647
047521055635000	R930006648
047521065603000	R901109763
047521065605000	R901109764

Type	Material number
047521065610000	R901109765
047521065620000	R901109766
047521065635000	R901109767
047521085620000	R930055341
047521085635000	R930055303

Dimensions



OPTION
Tamper resistant cap
ordering code: 11.04.23.002
Mat. no. R930000752

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Bosch Rexroth Oil Control S.p.A., RE 18318-16/03.2016

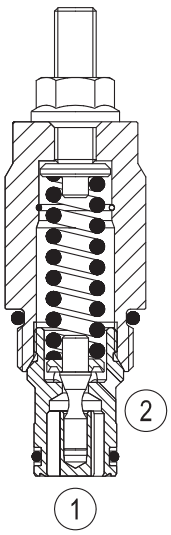
Relief, direct acting guided poppet type
Common cavity, Size 10

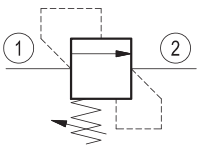
VSBN-10A

04.11.55 - X - 85 - Z

RE 18318-05
Edition: 07.2016
Replaces: 03.2016

Description
Flow is blocked from 1 to 2 until pressure increases to meet the selected valve setting, lifting the poppet from its seat and allowing relief flow through port 2 to tank. Pressure at port 2 is additive to the relief setting of the valve. The unique Bosch Rexroth Oil Control poppet design provides enhanced stability at all flows and pressures.

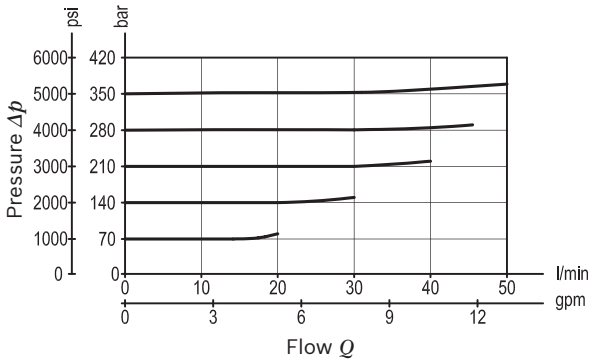




Technical data	
Max. operating pressure port 1 (P)	350 bar (5000 psi)
Max. pressure admitted port 2 (T)	350 bar (5000 psi)
Max. flow	50 l/min (13 gpm)
Max. internal leakage[1)]	15 drops/min.
Fluid temperature range	-30 to 100 °C (-22 to 212 °F)
Installation torque	41 - 47 Nm (30 - 35 ft-lbs)
Weight	0.2 kg (0.44 lbs)
Cavity	CA-10A-2N (see data sheet 18325-70)
Lines bodies and standard assemblies	Please refer to section “Hydraulic integrated circuit” or consult factory
Seal kit[2)]	Code: RG10A2010530100
	material no: R901111366
Fluids	Mineral-based or synthetics with lubricating properties at viscosities of 10 to 500 mm²/s (cSt)
Recommended degree of fluid contamination	Nominal value max. 10µm (NAS 8) / ISO 4406 19/17/14
Installation position	No restrictions
Other Technical Data	See data sheet 18350-50

1) At 80% of pressure setting
2) Only external seals for 10 valves

Characteristic curve



Ordering code

04.11.55	X	85	Z	00	*

Series 0/A to L
unchanged performances and dimensions

Relief, direct acting guided

Version and options standard

Adjustments

03 Leakproof hex. socket screw

04 Handknob and locknut

85 Common cavity, Size 10

		SPRINGS		
		Adj. press. range bar (psi)	Pressure increase bar/turn (psi/turn)	Std. setting bar (psi) Q=5 l/min
for X= 03	**05**	* 5-70 (75-1000)	16 (232)	50 (725)
	10	35-140 (500-2000)	24 (348)	100 (1450)
	20	105-210 (1500-3000)	54 (783)	200 (2900)
	35	175-350 (2500-5000)	84 (1218)	350 (5000)
for X= 04	**10**	25-110 (363-1595)	19 (276)	100 (1450)
	35	90-350 (1305-5075)	68 (986)	350 (5000)

Note: Special settings available. Contact factory authorized representative for ordering code.
* minimum pressure setting intended with Q=5 l/min

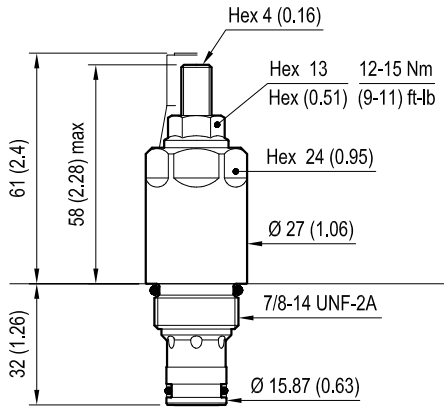
Preferred types

Type	Material number
041155038505000	R901191831
041155038510000	R901113609
041155038520000	R901113610
041155038535000	R901115702

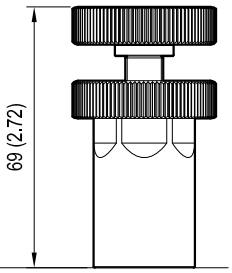
Type	Material number
041155048510000	R930058261
041155048535000	R930058262

Dimensions

Leakproof hex. socket screw



Handknob and locknut



OPTION
Tamper resistant cap
ordering code 11.04.23.002
Mat. no. R930000752

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Bosch Rexroth Oil Control S.p.A., RE 18318-05/07.2016

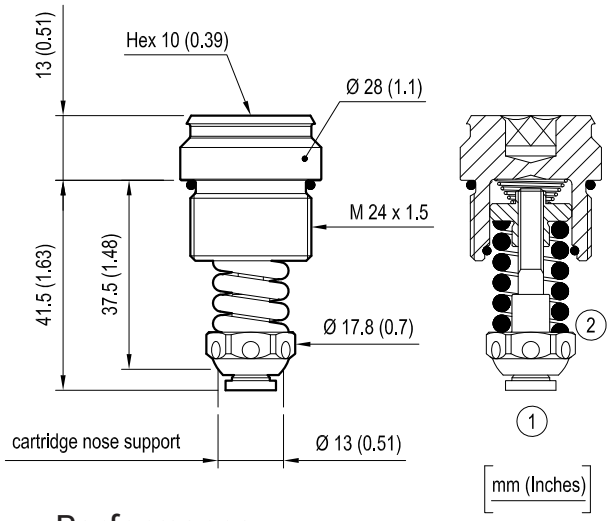
RE 18329-14/03.16
Replaces: RE 18329-14/11.10

Insert type
Relief, direct acting and anti-cavitation function

Special cavity, 870

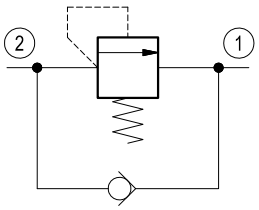
VMA1.080 0T.M4.08 - X - 99 - Z - W

Dimensions

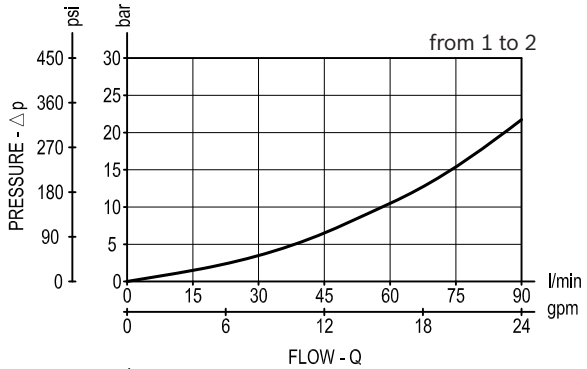


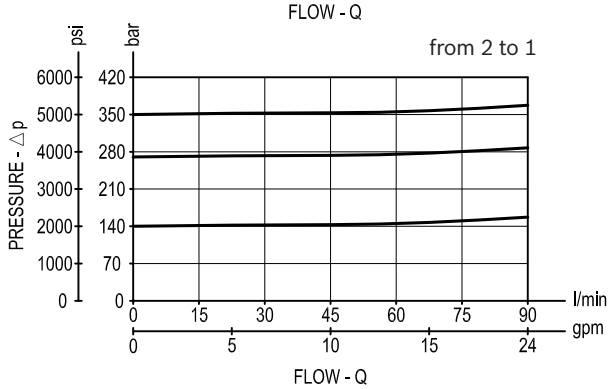
Description

Flow is free from 1 to 2 until pressure increases to meet the selected valve setting, allowing relief flow through port 1 to tank. This valve combine the typical function of shock relief valve (direct acting) and anticavitation function through the check valve. The direct action and the specific design allow a very fast opening and closing.
Note: to obtain a good leak proof performance coin the cavity seat using a loose valve seat (P/N 0F.S0.011) as a coining tool.
Please consult factory for any question.



Performance





Technical data

Max. operating pressure bar (psi)	400 (5800)
Max. flow l/min. (gpm)	90 (24)
Max. internal leakage (*) drops/min.	30
Fluid temperature range °C (°F)	-30 to 100 (-22 to 212)
Installation torque Nm (ft-lbs)	50-55 (37-41)
Weight kg (lbs)	0.11 (0.23)
Special cavity	870 see data sheet RE 18325-75
Lines bodies and standard assemblies	Please refer to section “Hydraulic integrated circuit” or consult factory
Seal kit (**) code material no.	RG0870020000100 R931002407
Recommended degree of fluid contamination	Mineral-based or synthetics with lubricating properties at viscosities of 10 to 500 mm^2/s (cSt)
Filtration	Nominal value max. 10µm (NAS 8) ISO 4406 19/17/14
Installation	No restrictions
Other Technical Data	See data sheet RE 18350-50

(*) at 80% of pressure setting

(**) Only external seals for 10 valves

Ordering code

0T.M4.08	X	99	Z	W	*

Insert type - Relief, direct acting and anti-cavitation function

Adjustments

= 00 Fixed setting

Special cavity, 870

Series 0/A to L
unchanged performances and dimensions

SPRINGS	
Adj. pressure range bar (psi)	
90-140 (1300-2000)	= 10
140-270 (2000-3900)	= 20
270-350 (3900-5000)	= 35
350-400 (5000-5800)	= 40

	Std. SETTING bar (psi) Q=10 l/min (2.6 gpm)					
	for Z=10	for Z=20	for Z=35	for Z=40		
= 01	90 (1310)					
= 02	100 (1450)	150 (2180)	280 (4060)	360 (5220)		
= 03	110 (1600)	160 (2320)	290 (4210)	370 (5370)		
= 04	120 (1740)	170 (2470)	300 (4350)	380 (5510)		
= 05	130 (1890)	180 (2610)	310 (4500)	390 (5660)		
= 06	140 (2030)	190 (2760)	320 (4640)	400 (5800)		
= 07		200 (2900)	330 (4790)			
= 08		210 (3050)	340 (4930)			
= 09		220 (3190)	350 (5080)			
= 10		230 (3340)				
= 11		240 (3480)				
= 12		250 (3630)				
= 13		260 (3770)				
= 14		270 (3920)				

Type	Material number
0TM408009910010	R931002087
0TM408009910020	R931002219
0TM408009910030	R931002220
0TM408009910040	R931002221
0TM408009910050	R931002222
0TM408009910060	R931002088
0TM408009920020	R931002223
0TM408009920030	R901191435
0TM408009920040	R931002224
0TM408009920050	R931002225
0TM408009920060	R931000754
0TM408009920070	R931002226
0TM408009920080	R901192838
0TM408009920090	R931002227
0TM408009920100	R931002228
0TM408009920110	R931002229

Type	Material number
0TM408009920120	R931002230
0TM408009920130	R931002231
0TM408009920140	R931002232
0TM408009935020	R901196681
0TM408009935030	R931002233
0TM408009935040	R931002234
0TM408009935050	R931002235
0TM408009935060	R931002236
0TM408009935070	R931002237
0TM408009935080	R931002238
0TM408009935090	R931002239
0TM408009940020	R931002241
0TM408009940030	R931002242
0TM408009940040	R931002243
0TM408009940050	R931002244
0TM408009940060	R931002245

Bosch Rexroth Oil Control S.p.A.
Via Leonardo da Vinci 5
P.O. Box no. 5
41015 Nonantola – Modena, Italy
Tel. +39 059 887 611
Fax +39 059 547 848
compact-hydraulics-cv@boschrexroth.com
www.boschrexroth.com/compacthydraulics

Bourdon tube pressure gauge, copper alloy
Standard version
Models 111.10, 111.12

for further approvals
see page 3

Applications

- For gaseous and liquid media that are not highly viscous or crystallising and will not attack copper alloy parts
- Pneumatics
- Heating and air-conditioning technology
- Medical engineering

Special features

- Reliable and cost-effective
- Design per EN 837-1
- Nominal size 40, 50, 63, 80, 100 and 160
- Scale ranges up to 0 ... 400 bar

Fig. left: Model 111.12, back mount
Fig. right: Model 111.10, lower mount (radial)

Description

The model 111 pressure gauges are based on the proven Bourdon tube measuring system. On pressurisation, the deflection of the Bourdon tube, proportional to the incident pressure, is transmitted to the movement via a link and indicated.

The modular design enables a multitude of combinations of case materials, process connections, nominal sizes and scale ranges. Due to this high variance, the instrument is suitable for use in a wide range of applications within industry.

For mounting in control panels, the pressure gauges can, depending on the process connection, be fitted with a surface mounting flange or with a triangular bezel and mounting bracket.

The standard version of the model 111 is manufactured, cost-optimised on modern production lines, in volumes of several million instruments per year.

Data sheets showing similar products:
Panel mounting series; models 111.16, 111.26; see data sheet PM 01.10
With VdS approval; model 111.12.040; see data sheet SP 01.23

Specifications

Design
EN 837-1

Nominal size in mm
40, 50, 63, 80, 100
160 only with model 111.10

Accuracy class
2.5

Scale ranges
0 ... 0.6 to 0 ... 400 bar (NS 160: max. 40 bar)
or all other equivalent vacuum or combined pressure and vacuum ranges

Pressure limitation
Steady: 3/4 x full scale value
Fluctuating: 2/3 x full scale value
Short time: Full scale value

Permissible temperature
Ambient: -20 ... +60 °C
Medium: +60 °C maximum

Temperature effect
When the temperature of the measuring system deviates from the reference temperature (+20 °C): max. ±0.4 %/10 K of the span

Process connection
Copper alloy
For process connections and spanner widths see page 4

Pressure element
Copper alloy
C-type or helical type

Movement
Copper alloy

Dial
NS 40, 50, 63: Plastic, white, with pointer stop pin
NS 80, 100, 160: Aluminium, white, with pointer stop pin
Black lettering, red mark pointer with measuring ranges 0 ... 0.6 to 0 ... 60 bar

Pointer
Plastic, black
NS 160: Aluminium, black

Case
Plastic, black
Model 111.12, NS 100: Steel, black
Model 111.10, NS 160: Steel, black

Window
Plastic, crystal-clear, snap-fitted in case
Model 111.10, NS 160: Instrument glass

Options

- Other process connection
- Accuracy class 1.6
- Steel case, black
- Model 111.10: Surface mounting flange (not with NS 40 and 50)
- Model 111.12: Triangular bezel with mounting bracket

Special versions

For closed heating systems
NS 63, 80
with red mark pointer and adjustable green sector, scale ranges 0 ... 4 bar, red mark at 2.5 or 3 bar

For refrigeration plants
NS 63, 80
with additional temperature scale in °C for refrigerants

For water-level indication (hydrometer) and heating systems
NS 80, 100, 160
Scale ranges 0 ... 0.6 to 0 ... 25 bar, with second scale in mWS and red mark pointer

For drinking water installations
Material suitability of the wetted parts in accordance with the evaluation criteria for metallic substances of the German federal environmental agency and the “4MS Common Composition List”.

Approvals

Logo	Description	Country
CE	**EU declaration of conformity** Pressure equipment directive	European Union
EAC	**EAC (option)** Pressure equipment directive	Eurasian Economic Community
	GOST (option) Metrology, measurement technology	Russia
	KazInMetr (option) Metrology, measurement technology	Kazakhstan
-	**MTSCHS (option)** Permission for commissioning	Kazakhstan
	BelGIM (option) Metrology, measurement technology	Belarus
	UkrSEPRO (option) Metrology, measurement technology	Ukraine
-	**CPA** Metrology, measurement technology	China
-	**CRN** Safety (e.g. electr. safety, overpressure, ...)	Canada

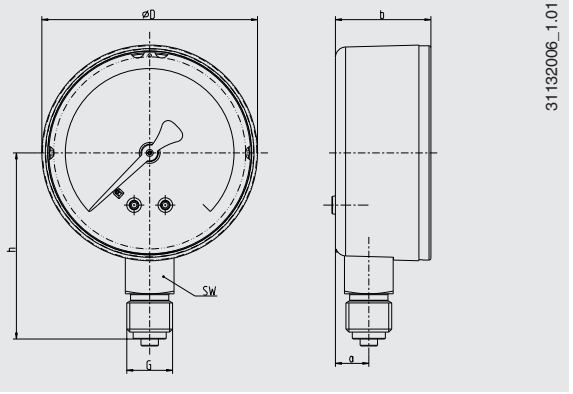
Certificates (option)

- 2.2 test report per EN 10204 (e.g. state-of-the-art manufacturing, material proof, indication accuracy)
- 3.1 inspection certificate per EN 10204 (e.g. indication accuracy)

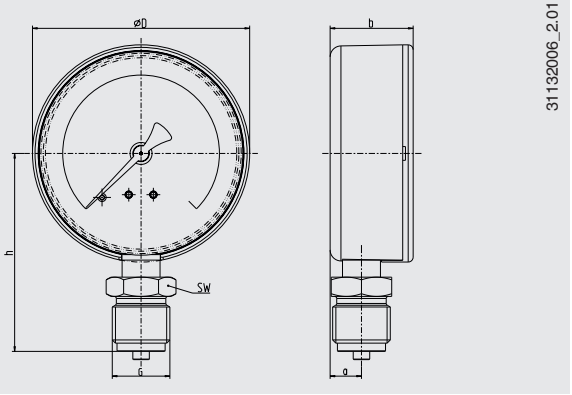
Dimensions in mm

Model 111.10, lower mount (radial)

NS 40, 50, 63 and 160



NS 80 and 100

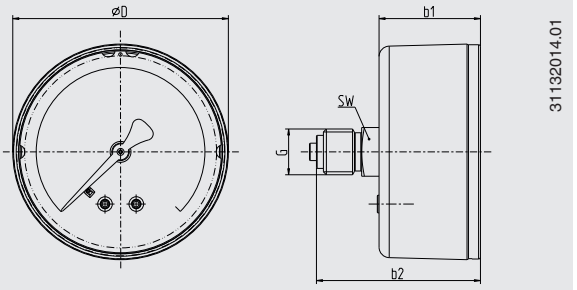


NS	Dimensions in mm						Weight in kg
	a	b ±0.5	D	G	h ±1	SW	
40	9.5	26	39	G ⅛ B	36	14	0.08
50	10	27.5	49	G ¼ B	45	14	0.10
63	9.5	27.5	62	G ¼ B	53.5	14	0.13
80	11.5	30	79	G ½ B	72	22	0.18
100	11.5	30.5	99	G ½ B	83.5	22	0.21
160	15.5	42	160	G ½ B	115.5	22	0.85

Process connection per EN 837-1 / 7.3

Model 111.12, back mount

NS 40, 50, 63, 80 and 100



NS	Dimensions in mm					Weight in kg
	b1 ±0.5	b2 ±1	D	G	SW	
40	26	42	39	G ⅛ B	14	0.06
50	29.5	47.5	49	G ¼ B	14	0.07
63	29	47	62	G ¼ B	14	0.08
80	32	49	79	G ¼ B	14	0.11
100	31	49	99	G ¼ B	14	0.26

Process connection per EN 837-1 / 7.3

Ordering information

Model / Nominal size / Scale range / Process connection / Options

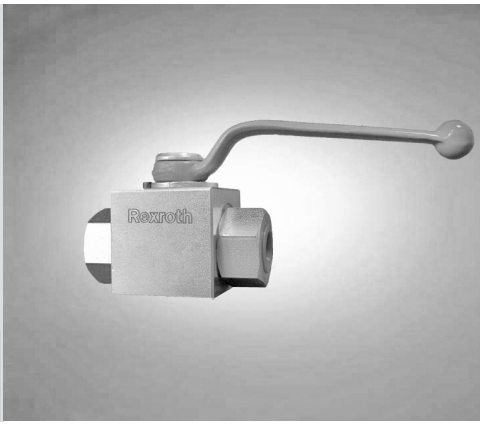
06/2017 EN

WIKA Alexander Wiegand SE & Co. KG
Alexander-Wiegand-Straße 30
63911 Klingenberg/Germany
Tel. +49 9372 132-0
Fax +49 9372 132-406
info@wika.de
www.wika.de

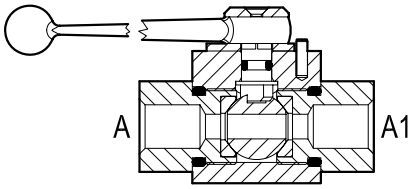
Rexroth
Bosch Group

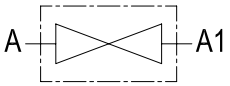
Ball valves

Ball type cut-off valves



AD Series

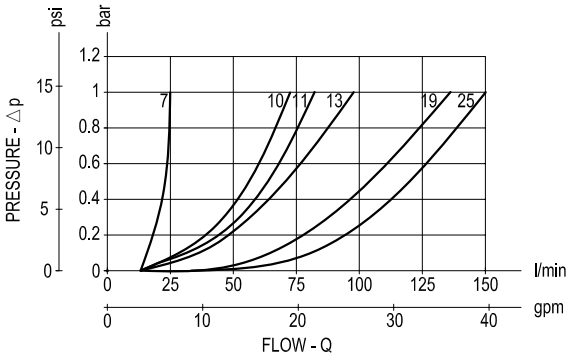




Description

They are 2 ways lever controlled cut-off valves which can be shifted from fully closed to fully open through a ¼ turn rotation of the lever. A mechanical stroke limiter prevents the lever from being rotated behind the 90° adjustment range. Normally, the valve is fully open when the control lever is lined-up with the ports.

Performance



Technical data

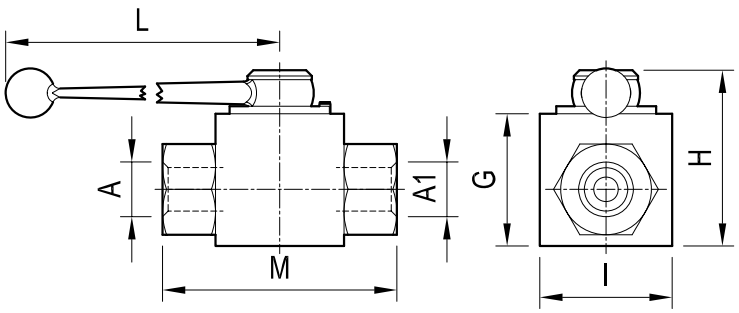
Code	Pressure **P** max bar (psi)	Weight kg (lbs)
AD 7-E	350 (5000)	0.43 (0.95)
AD 10-E	350 (5000)	0.81 (1.79)
AD 11-E	350 (5000)	0.81 (1.79)
AD 13-E	350 (5000)	0.78 (1.72)
AD 19-E	250 (3600)	1.24 (2.73)
AD 25-E	250 (3600)	2.1 (4.6)

Steel body, zinc plated; painted lever

Advantages

- Very compact design and inline mounting for space saving.
- Mounting position is optional.
- Six sizes provide great adaptability to the system.

Dimensions



Ports size / Dimensions

Code	Ø DN mm (inches)	Port size A-A1	G mm (inches)	H mm (inches)	I mm (inches)	L mm (inches)	M mm (inches)
AD7-E	7 (0.28)	G 1/4	35 (1.38)	47 (1.85)	35 (1.38)	104.5 (4.11)	61.5 (2.42)
AD10-E	10 (0.39)	G 3/8	45 (1.77)	63 (2.48)	35 (1.38)	158 (6.22)	80 (3.15)
AD11-E	11 (0.43)	M 18x1.5	45 (1.77)	63 (2.48)	35 (1.38)	158 (6.22)	80 (3.15)
AD13-E	13 (0.51)	G 1/2	45 (1.77)	63 (2.48)	35 (1.38)	158 (6.22)	80 (3.15)
AD19-E	19 (0.75)	G 3/4	53 (2.09)	71 (2.80)	45 (1.77)	158 (6.22)	100 (3.94)
AD25-E	25 (0.98)	G 1	70 (2.76)	88.5 (3.48)	55 (2.17)	197.5 (7.78)	115 (4.53)

note: Ø DN = flow area I.D. (nominal).

Ordering code

AD | |

series 7-E	= **7-E**
series 10-E	= **10-E**
series 11-E	= **11-E**
series 13-E	= **13-E**
series 19-E	= **19-E**
series 25-E	= **25-E**

Port size (see below)

	AD 7-E	AD 10-E	AD 11-E	AD 13-E	AD 19-E	AD 25-E
Port size A-A1	G 1/4	G 3/8	M 18x1.5	G 1/2	G 3/4	G 1

Applications

They are employed to prevent or allow flow delivery to one line. The control lever can be easily rotated when the line is not pressurized.

Type	Material number
AD7-E	R932500002
AD10-E	R932500004
AD11-E	R932006964
AD13-E	R932500005
AD19-E	R932500006
AD25-E	R932500007

Type	Material number

Type	Material number

Bosch Rexroth Oil Control S.p.A.
Fimma Division (Rge 2)
Via G. Bovio, 7 Z.I. Mancasale
42124 Reggio Emilia, Italy
Tel. +39 0522 517 277
Fax +39 0522 517 125
cartridges@oilcontrol.com
www.boschrexroth.com

Filtro tipo SPIN-ON
secondo standard Bosch Rexroth

Tipo 50 da SL 30 a 80D

RI 51476
Edizione: 2015-06

56558_d

- Grandezze nominali: da 30 a 80D
- Attacco fino a G1; SAE 10

Caratteristiche

I filtri delle cartucce sostituibili vengono impiegati in impianti idraulici per la separazione delle sostanze solide dai fluidi e dagli oli lubrificanti.

Si contraddistinguono per:

- Filtro per il montaggio in linea
- Ottimizzati per applicazioni mobili con ingombri ridotti e di facile manutenzione
- Montaggio possibile in tubazioni di aspirazione, di mandata o di ritorno
- Materiali filtranti speciali e ad alte prestazioni
- Filtrazione di particelle finissime ed elevata capacità di ritenzione
- Esecuzione opzionale con indicatore di intasamento
- Valvola di bypass integrata nell'alloggiamento del filtro
- Cartuccia sostituibile 82. con diversi attacchi disponibile come parte di ricambio

Indice

Codici di ordinazione filtro

01	02	03		04		05	06	07	08		09	10	11	12
50 SL			**–**	**S00**	**–**	**0**				**–**			**0**	**0**

Serie

01	Filtro tipo SPIN-ON	**50 SL**

Grandezza nominale

02	Conforme allo **standard Bosch Rexroth** Esecuzione **con** filettatura UNF	**30** **45** **60** **80**
	Conforme allo **standard Bosch Rexroth** Esecuzione **con** filettatura UN	**30D** **45D** **60D** **80D**

Capacità filtrante in µm

03	**Assoluta** **(ISO 16889; β_x(c) ≥200)**	Materiale in fibra di vetro, non pulibile	**H3XL** **H6XL** **H10XL** **H20XL**
	Nominale	Carta, non pulibile	**P10** **P25**

Differenza di pressione

04	Differenza di pressione max. consentita dell'elemento filtrante 5 bar *[72 psi]*	**S00**

Magnete

05	**Senza**	**0**

Valvola di bypass

06	**Senza**	**0**
	Pressione di apertura 2,5 bar *[36.3 psi]* – configurabile con indicatore di intasamento M1,5	**5**
	Pressione di apertura 3,5 bar *[50.8 psi]* – configurabile con indicatore di intasamento M2,5	**7**

Indicatore di intasamento

07	**Senza**	**0** [1)]
	Indicatore della differenza di pressione, elettrico	**M**

Pressione di commutazione

08	Pressione di commutazione 1,5 bar *[21.8 psi]*	**1,5**
	Pressione di commutazione 2,5 bar *[36.3 psi]*	**2,5**

Attacco

09	**Dimensione**	**50 SL 30; 45 (D)**	**50 SL 60; 80 (D)**	
	Attacco			
	ISO 228	G3/4	G1	**R0**
	SAE J 1926	SAE 10 (7/8-14 UNF-2B)		**U0**

Guarnizione

10	NBR	**M**
	FKM	**V**

Materiale alloggiamento

11	Materiale standard	**0**

Codici di ordinazione filtro

01	02	03		04		05	06	07	08		09	10	11	12
50 SL			**–**	**S00**	**–**	**0**				**–**			**0**	**0**

Informazioni aggiuntive

12	**Senza**	**0**

1) Non configurabile con valvola di bypass, pressione di apertura 2,5 bar *[36.3 psi]*

Esempio di ordinazione:
50 SL 60 H10XL-S00-07M2,5-R0M00

Cod. prodotto: R928054914

Altre versioni su richiesta.

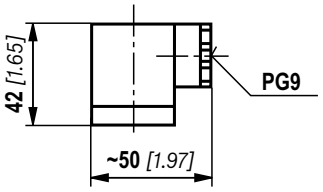
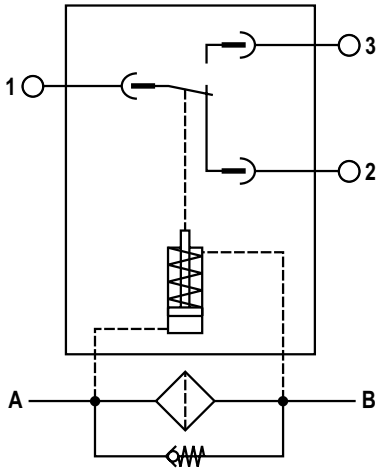
Tipi preferenziali

50 SL, indicazioni della portata per 30 mm²/s *[143 SUS]*
Capacità filtrante 10 µm

Tipo	**Portata in l/min** *[gpm]* **e Δ*p* = 0,5 bar** *[7,25 psi]* 1)	**Cod. prodotto Filtro**	**Cod. prodotto Cartuccia sostituibile di ricambio**
50 SL 30 H10XL-S00-07M2,5-R0M00	*25 [362.60]*	**R928054912**	**R928038865**
50 SL 45 H10XL-S00-07M2,5-R0M00	*40 [580.16]*	**R928054913**	**R928019444**
50 SL 60 H10XL-S00-07M2,5-R0M00	*90 [1305.36]*	**R928054914**	**R928019719**
50 SL 80 H10XL-S00-07M2,5-R0M00	100 *[1450.40]*	**R928054987**	**R928054791**
50 SL 30D H10XL-S00-07M2,5-R0M00	*25 [362.60]*	**R928054915**	**R928019173**
50 SL 45D H10XL-S00-07M2,5-R0M00	*40 [580.16]*	**R928054916**	**R928019180**
50 SL 60D H10XL-S00-07M2,5-R0M00	*90 [1305.36]*	**R928054917**	**R928019183**
50 SL 80D H10XL-S00-07M2,5-R0M00	*100 [1450.40]*	**R928054918**	**R928019720**

1) Differenza di pressione misurata tramite filtro e dispositivo di misura conforme a ISO 3968. La differenza di pressione misurata sull'indicatore di intasamento è più bassa.

Simbolo
(quote in mm *[pollici]*)

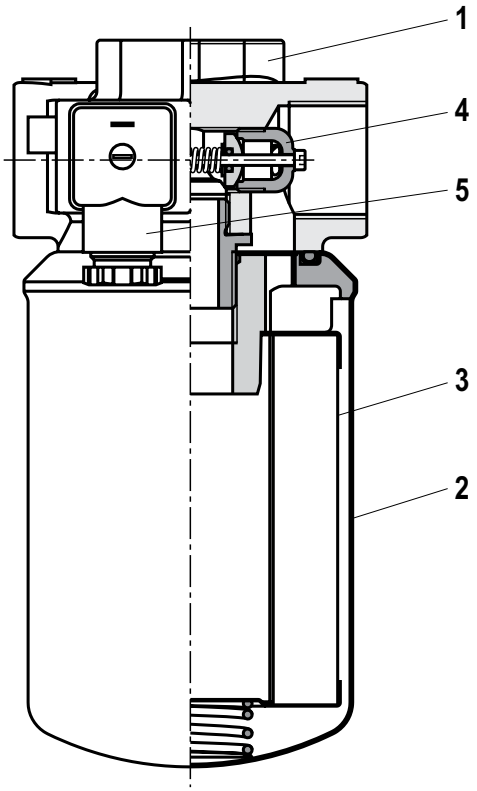
Ricambio	Disegno	Codice di ordinazione	Simbolo
Ottico/elettrico con connettore apparecchio		M	

Funzionamento, sezione

Il filtro tipo SPIN-ON è adatto per il montaggio diretto nelle tubazioni di mandata o di ritorno. Viene inserito davanti ai componenti da proteggere.

È costituito essenzialmente da una testa del filtro (1) e una cartuccia sostituibile avvitata (2) con elemento filtrante integrato (3). In opzione per il filtro è configurabile un indicatore di intasamento (5) o una valvola di bypass (4). L'alloggiamento dell'indicatore di intasamento è integrato nella testa del filtro.

Il fluido arriva mediante l'entrata alla cartuccia sostituibile e qui viene depurato. Le particelle di sporco filtrate si depositano nell'elemento filtrante. Attraverso l'uscita, il fluido filtrato arriva quindi nel circuito idraulico.



50 SL 30 ... 80D

Dati tecnici
(in caso di impiego dell'apparecchio con valori diversi da quanto indicato, interpellateci!)

Dati generali						
Posizione di installazione			verticale			
Campo di temperatura ambiente		°C *[°F]*	–40 ... +65 *[–40 ... +149]*			
Condizioni di stoccaggio	▶ Guarnizione NBR	°C *[°F]*	–40 ... +65 *[–40 ... +149]*; umidità relativa dell'aria max 65 %			
	▶ Guarnizione FKM		–20 ... +65 *[–4 ... +149]*; umidità relativa dell'aria max 65 %			
Massa		GN	**30(D)**	**45(D)**	**60(D)**	**80(D)**
		kg *[lbs]*	1,1 *[2.4]*	1,5 *[3.3]*	1,8 *[4.0]*	1,9 *[4.2]*
Volume		GN	**30(D)**	**45(D)**	**60(D)**	**80(D)**
		l *[US gal]*	0,6 *[0.16]*	0,9 *[0.24]*	1,3 *[0.34]*	1,5 *[0.4]*
Materiale	▶ Testa del filtro		Alluminio			
	▶ Cartuccia sostituibile		Acciaio / alluminio			
	▶ Indicatore di intasamento		Alluminio / ottone / plastica			

Dati idraulici			
Pressione d'esercizio massima	▶ Testa del filtro	bar *[psi]*	50 *[725]*
	▶ Cartuccia sostituibile	bar *[psi]*	40 *[580]* [1]
Campo di temperatura del fluido idraulico		°C *[°F]*	–10 ... +100 *[+14 ... +212]*
☞ **Nota per l'avviamento a freddo:**			–40... –10 *[–40...+14]* Durante la fase di riscaldamento si deve tener conto di una riduzione della pressione e della portata pari almeno al 50 %. È assolutamente necessaria una valvola di bypass
Conduttività minima del mezzo		pS/m	300

Indicatore di intasamento			**Indicatore elettrico della differenza di pressione**
Lettera dell'opzione di ordinazione			M
Esecuzione			W...GW0200...
Sollecitazione dei contatti, tensione continua		$A_{max.}$	0,25
Campo di tensione		$V_{max.}$	175 CA/CC
Potenza di commutazione max.		VA	5
Tipo di commutazione	▶ Segnale 100 %		Contatto di scambio
Tipo di protezione ai sensi della norma EN 60529		IP	65
Campo di temperatura ambiente		°C *[°F]*	–10 ... +85 *[+14 ... +185]*
Temperatura d'esercizio		°C *[°F]*	–10 ... +100 *[+14 ... +212]*
Con tensione continua superiore a 24 V deve essere previsto un dispositivo di soppressione delle scintille per la protezione dei contatti di commutazione.			
Massa		kg *[lbs]*	0,3 *[0.66]*
Materiale	▶ Alloggiamento		Alluminio / plastica / ottone
	▶ Guarnizioni		NBR o FKM

[1] Validazione secondo ISO 10771

Dati tecnici
(in caso di impiego dell’apparecchio con valori diversi da quanto indicato, interpellateci!)

Elemento filtrante				
Materiale in fibra di vetro H...XL			Elemento monouso in fibre inorganiche	
			Rapporto di filtrazione conforme a ISO 16889 fino a Δp = 5 bar *[72.5 psi]*	Purezza dell'olio raggiungibile secondo ISO 4406 *[SAE-AS 4059]*
Separazione particelle		H20XL	$\beta_{20}(c) \geq 200$	19/16/12 – 22/17/14
		H10XL	$\beta_{10}(c) \geq 200$	17/14/10 – 21/16/13
		H6XL	$\beta_{6}(c) \geq 200$	15/12/10 – 19/14/11
		H3XL	$\beta_{5}(c) \geq 200$	13/10/8 – 17/13/10
Pressione differenziale consentita	▶ S00	bar *[psi]*	5 *[72.5]*	

Compatibilità con fluidi idraulici consentiti

Fluido idraulico	**Classificazione**	**Materiali guarnizioni adatti**	**Norme**
Oli minerali	HLP	NBR	DIN 51524

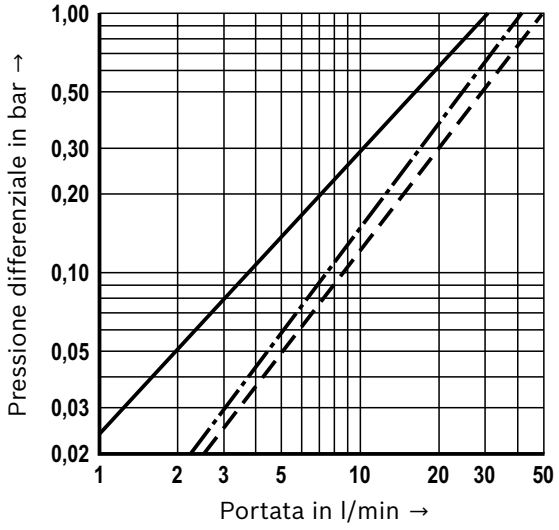
Curve caratteristiche
(misurate con olio minerale HLP46 secondo DIN 51524)

Peso specifico: < 0,9 kg/dm³
Curve caratteristiche Δ*p*-Q per filtro completo Δ*p* iniziale consigliato per dimensionamento = 0,5 bar *[7.25 psi]*

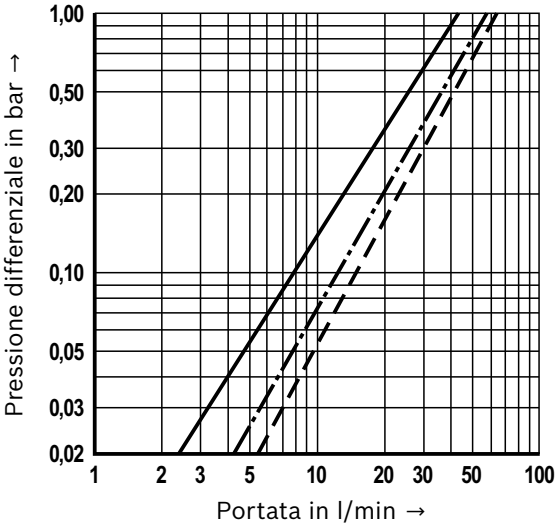
Il nostro software di progettazione online "Bosch Rexroth FilterSelect" permette una selezione del filtro ottimale.

H3XL — H10XL — P10

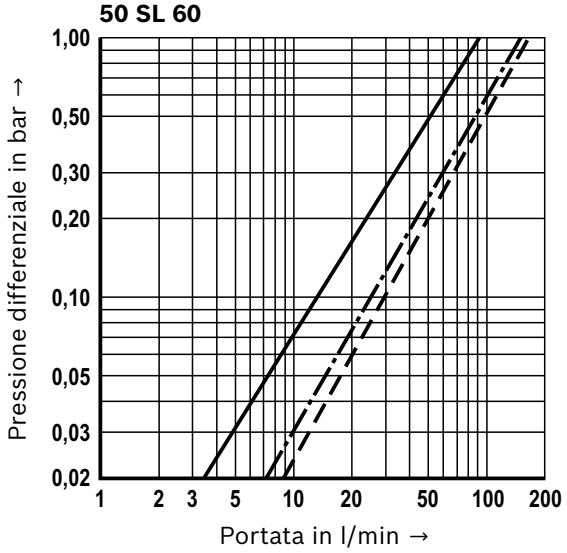
50 SL 30



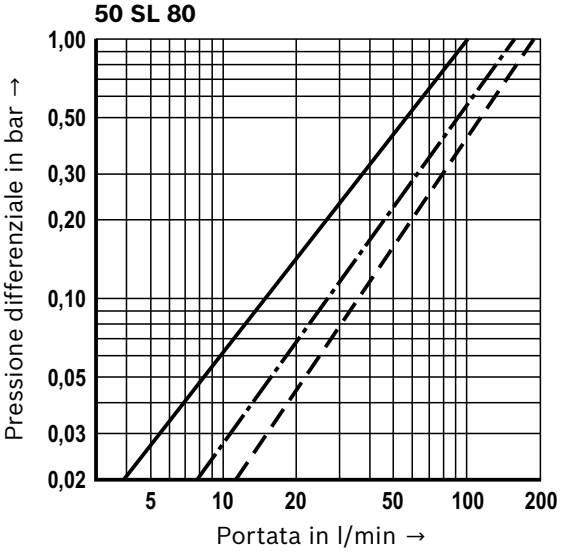
50 SL 45



50 SL 60

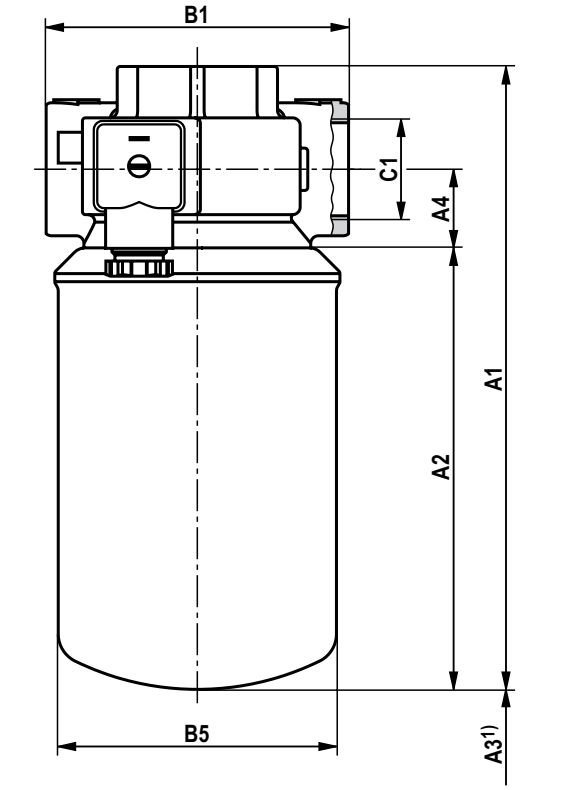


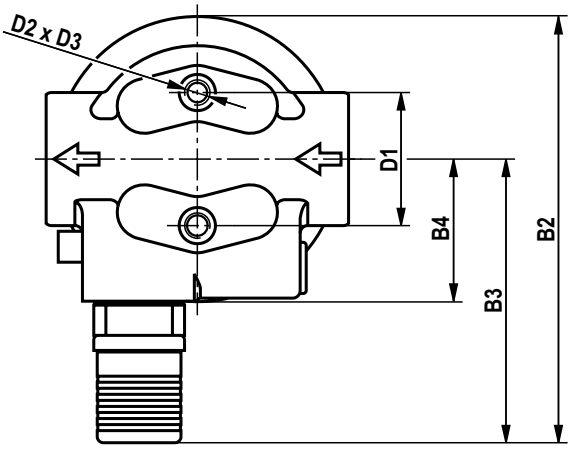
50 SL 80



Dimensioni: 50 SL 30 ... 80D

(quote in mm *[pollici]*)





Tipo di filtro	A1	A2	A3 [1]	A4	B1	B2	B3	B4	ØB5	Attacchi C1 R0	Attacchi C1 U0	D1	D2	D3	Attacco cartuccia sostituibile
50 SL 30	173 *[6.81]*	113 *[4.45]*	20 *[0.79]*	26 *[1.02]*	100 *[3.94]*	140 *[5.51]*	94 *[3.70]*	47 *[1.85]*	$92^{\pm 0,3}$ *[$3.62^{\pm 0.01}$]*	G3/4	SAE 10 (7/8-14 UNF)	44 *[1.73]*	M8	12 *[0.47]*	UNF 1"-12
50 SL 30D															UNF 1 3/8"-12
50 SL 45	209 *[8.23]*	149 *[5.87]*													UNF 1"-12
50 SL 45D															UNF 1 3/8"-12
50 SL 60	275 *[10.83]*	215 *[8.46]*								G1					UNF 1"-12
50 SL 60D															UNF 1 3/8"-12
50 SL 80D	300 *[11.81]*	240 *[9.45]*													UNF 1 3/8"-12

[1] Quota di smontaggio per cartuccia sostituibile

Codici di ordinazione parti di ricambio

Cartuccia sostituibile

01	02	03		04	05	06		
82.			**–**	**S00**	**–**	**0**	**–**	

Cartuccia sostituibile

01	Tipologia costruttiva	**82.**

Grandezza nominale

02	Conforme allo **standard Bosch Rexroth** Esecuzione **con** filettatura UNF	**30** **45** **60** **80**
	Conforme allo **standard Bosch Rexroth** Esecuzione **con** filettatura UN	**30D** **45D** **60D** **80D**

Capacità filtrante in µm

03	**Assoluta** **(ISO 16889; β_x(c) ≥200)**	Materiale in fibra di vetro, non pulibile	**H3XL** **H6XL** **H10XL** **H20XL**
	Nominale	Carta, non pulibile	**P10** **P25**

Differenza di pressione

04	Differenza di pressione max. consentita dell'elemento filtrante 5 bar *[72 psi]*	**S00**

Valvola di bypass

05	**Senza** valvola di bypass	**0**

Guarnizione

06	NBR	**M**
	FKM	**V**

Esempio di ordinazione:
82.45 H10XL-S00-0-M

Cod. prodotto: R928019444

Prodotti preferenziali cartucce sostituibili di ricambio

Tipo di cartuccia sostituibile	Materiale filtrante / cod. prodotto	
	H10XL	**P10**
82.30...S00-0-M	**R928038865**	**R928046556**
82.45...S00-0-M	**R928019444**	**R928025436**
82.60...S00-0-M	**R928019719**	**R928046571**
82.80...S00-0-M	**R928054791**	**R928054790**

☞ **Nota:**
L'indicatore di intasamento non può essere fornito come parte di ricambio in quanto è integrato nella testa del filtro.

Montaggio, messa in funzione, manutenzione

Montaggio

- La pressione d'esercizio massima dell'impianto non deve superare la pressione d'esercizio del filtro massima consentita (vedere targhetta).
- Durante il montaggio del filtro occorre considerare la direzione del flusso (vedere frecce di direzione) e la quota di smontaggio necessaria della cartuccia sostituibile (vedere capitolo "Dimensioni").
- Con la posizione di installazione – cartuccia sostituibile a piombo verso il basso – è garantita un'agevole sostituzione della cartuccia.
- Togliere i tappi di plastica all'ingresso e all'uscita del filtro.
- Il collegamento dell'indicatore di intasamento elettrico si realizzata mediante una presa, che viene inserita sui contatti dell'indicatore di intasamento e fissata con una vite.

Messa in funzione

- Mettere in funzione l'impianto.

☞ **Nota:**
Non è previsto uno sfiato sul filtro.

Manutenzione

- Se nell'indicatore di intasamento elettrico viene attivato il processo di commutazione, la cartuccia sostituibile è sporca e deve essere sostituita. Poiché le cartucce sostituibili non presentano resistenza alle sollecitazioni, devono essere sostituite dopo un massimo di 6 mesi o dopo max. 1000 ore d'esercizio.
- Il codice prodotto della cartuccia sostituibile di ricambio è indicato sulla targhetta del filtro completo. Esso deve corrispondere al codice prodotto presente sulla cartuccia sostituibile.
- Mettere fuori esercizio l'impianto.
- Diminuire la pressione d'esercizio dell'impianto.

☞ **Nota:**
Non è previsto uno sfiato sul filtro.

- Svitare la cartuccia sostituibile.
- Avvitare saldamente a mano la nuova cartuccia sostituibile.
- **Osservare quanto segue:**
  Se necessario, serrare più saldamente di ca. 30° con cautela (eventualmente con una chiave a cinghia) in condizioni di assenza di pressione
- Mettere in funzione l'impianto.
- Se dopo la messa in funzione fuoriesce del fluido tra la cartuccia sostituibile e la testa del filtro, riserrare la cartuccia sostituibile.

☞ **Avvertenze per l'applicazione:**

- In caso di sollecitazione dinamica, il serbatoio della cartuccia sostituibile subisce una deformazione elastica.
- Le cartucce sostituibili non presentano resistenza alle sollecitazioni.

⚠ AVVERTENZA!

- Montaggio e smontaggio solo con l'impianto senza pressione!
- Il serbatoio è sotto pressione!
- Rimuovere la cartuccia sostituibile solo dopo aver scaricato la pressione!
- Non sostituire l'indicatore di intasamento se il filtro si trova sotto pressione!
- Se durante il montaggio non viene rispettata la direzione del flusso, l'elemento filtrante viene danneggiato irreparabilmente. Eventuali particelle possono penetrare nell'impianto e danneggiare i componenti collegati.

☞ **Note:**

- Tutti i lavori sul filtro devono essere eseguiti da personale specializzato addestrato.
- Il funzionamento e la sicurezza costruttiva sono garantiti solo in caso di uso di cartucce sostituibili e parti di ricambio originali Bosch Rexroth.
- La garanzia decade quando l'oggetto di fornitura viene modificato, montato, installato, sottoposto a manutenzione, riparato o utilizzato in modo non conforme da parte del committente o di terzi oppure esposto a condizioni ambientali diverse da quelle da noi specificate.

Coppie di serraggio
(quote in mm *[pollici]*)

Serie 50 SL...		**30(D)**	**45(D)**	**60(D)**	**80(D)**
Viti di fissaggio con μ_{tot} 0,14	Nm *[lb-ft]*	max. 30 *[22]*			
Vite di fissaggio		M8			
Profondità di avvitamento minima per il fissaggio	mm *[pollici]*	8 *[0.3]*			

Direttive e standardizzazione

Classificazione secondo la direttiva sugli apparecchi a pressione

I filtri delle cartucce sostituibili per applicazioni idrauliche secondo 51476 sono accessori atti a mantenere la pressione ai sensi dell'articolo 1, comma 2.1.4 della Direttiva sugli apparecchi a pressione 97/23/CE. In base alla clausola d'esclusione di cui all'articolo 1, comma 3.6 della direttiva sugli apparecchi a pressione, i filtri idraulici sono esclusi dalla direttiva se non hanno un livello superiore alla categoria I (orientamento 1/19).

Per la classificazione vengono presi in considerazione i fluidi specificati nel capitolo “Compatibilità con fluidi idraulici consentiti”.
L'utilizzo conforme è consentito solo con fluidi del gruppo 2 e nell'ambito dei limiti di impiego prescritti (vedere il capitolo “Dati tecnici”).
Questi filtri non ricevono pertanto alcuna marcatura CE.

Impiego in aree a rischio di esplosione in conformità alla direttiva 94/9/CE (ATEX)

I filtri delle cartucce sostituibili senza indicatore di intasamento conformi a 51476 non sono apparecchi o componenti ai sensi della direttiva 94/9/CE e non dispongono di alcuna marcatura CE. Mediante l’analisi dei pericoli di accensione è stato dimostrato che i filtri delle cartucce sostituibili non presentano fonti di accensione proprie conformemente alla norma DIN EN 13463-1:2009.

I filtri delle cartucce sostituibili senza indicatore di intasamento possono essere utilizzati per le seguenti aree a rischio d'esplosione:

	Idoneità zone	
Gas	1	2
Polvere	21	22

Filtro completo senza indicatore di intasamento			
Uso/assegnazione		**Gas 2G**	**Polvere 2D**
Assegnazione [1)]		Ex II 2G c IIC TX	Ex II 2D c IIC TX
Conduttività del mezzo pS/m	min	300	
Deposito di polvere	max	–	0,5 mm

1) TX = max. temperatura d'esercizio, vedere il capitolo “Dati tecnici”

Direttive e standardizzazione

⚠ AVVERTENZA!

- Pericolo di deflagrazione a causa di temperatura elevata!
  La temperatura si orienta verso quella del mezzo nel circuito idraulico e non deve superare il valore indicato. È necessario adottare delle misure per far sì che non si superi la temperatura di ignizione consentita nell'area a rischio di deflagrazione.
- Se si utilizzano filtri delle cartucce sostituibili conformi a 51476 in aree a rischio di deflagrazione, fare attenzione a che la compensazione di potenziale sia sufficiente. Mettere a terra il filtro preferibilmente mediante le viti di fissaggio. Contestualmente accertarsi che la verniciatura e gli strati protettivi di ossidazione non siano conduttori di elettricità.
- Durante la sostituzione della cartuccia sostituibile rimuovere il materiale di imballaggio dalla cartuccia sostituibile, all'esterno dell'area a rischio di deflagrazione.

☞ **Note:**

- Manutenzione riservata solo a personale specializzato, addestramento da parte dell'operatore ai sensi della DIRETTIVA 1999/92/CE, appendice II, paragrafo 1.1
- Il funzionamento e la sicurezza sono garantiti solo con parti di ricambio originali Rexroth.

Ambiente e riciclaggio

- La cartuccia sostituibile usata deve essere smaltita in conformità alle disposizioni di legge sulla tutela dell'ambiente valide a livello nazionale.
- Al termine della durata di vita del filtro, i suoi componenti possono essere destinati al processo di riciclaggio in conformità alle disposizioni di legge sulla tutela dell'ambiente valide a livello nazionale.

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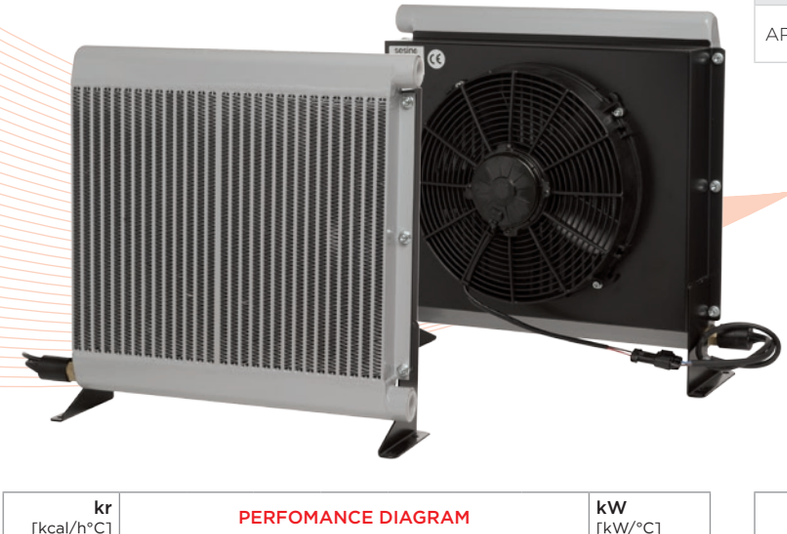
APL 430



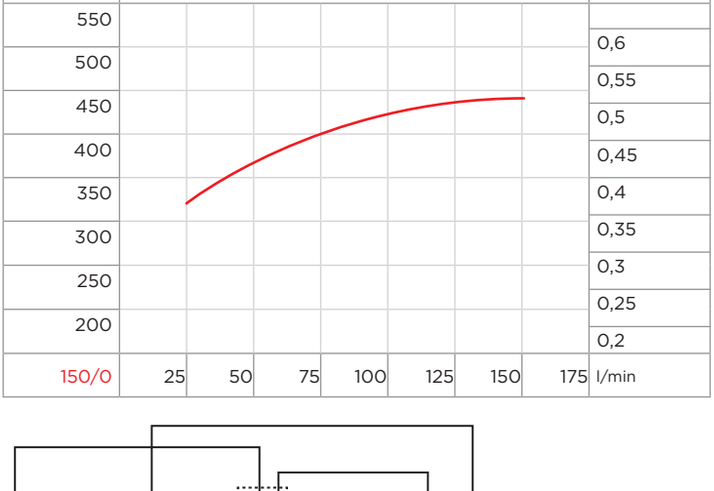
PURCHASE CODES

APL 430 12/24V without thermo switch	3RL43012 / 3RL43024
APL 430 12/24V with thermo switch	3RL43012T247 / 3RL43024T247 3RL43012T260 / 3RL43024T260

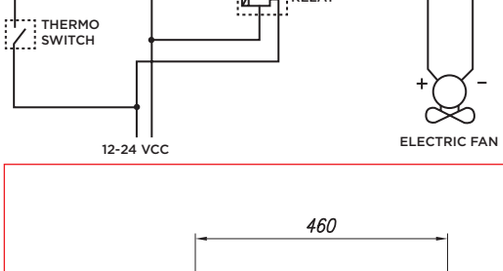
SPARE PARTS

Thermo-switch 47-36 12V IP 67	1TRM47-36/12V
Thermo-switch 47-36 24V IP 67	1TRM47-36/24V
Thermo-switch 60-49 12V IP 67	1TRM60-49/12V
Thermo-switch 60-49 24V IP 67	1TRM60-49/24V
Cooling element	3RNL430
Frame	1430LCNV
12VDC Electric fan	1VNAPL43012C
24VDC Electric fan	1VNAPL43024C

PERFOMANCE DIAGRAM



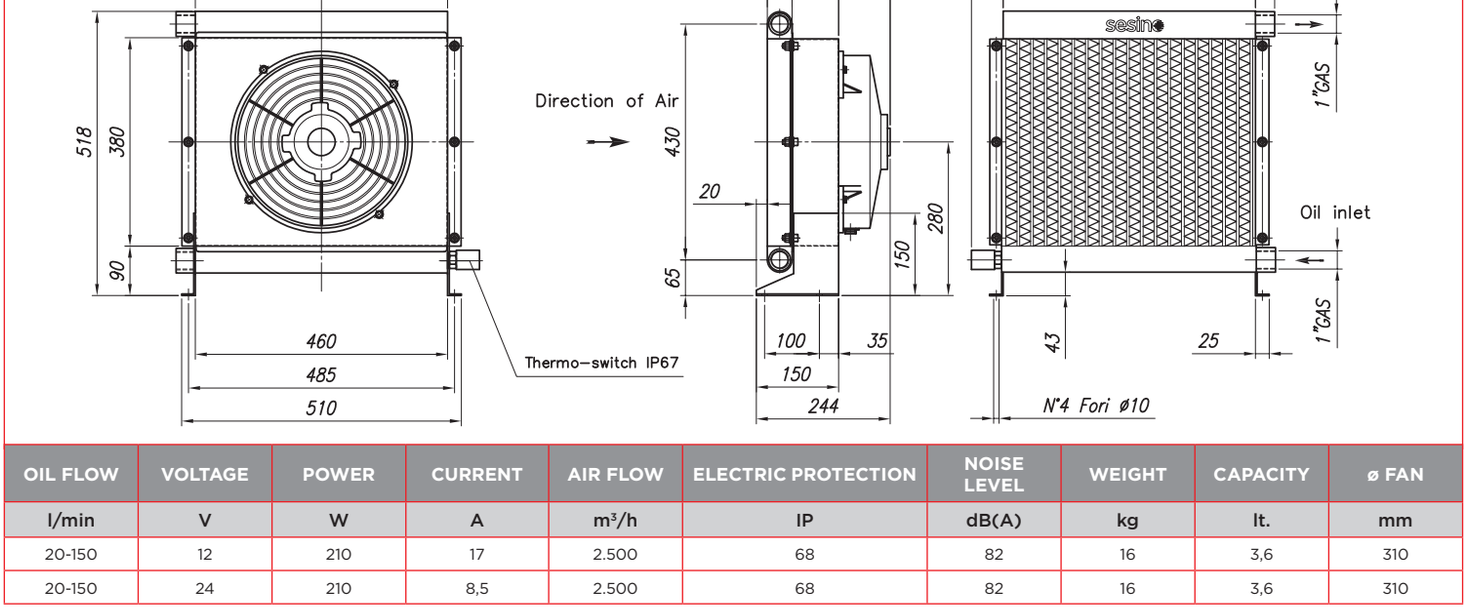
PRESSURE DROP DIAGRAM



CORRECTION FACTOR

cSt	22	30	46	68	100	150	220
f	0,6	1	1,5	2,3	3,5	5	7

- Dimensions and technical characteristics are not binding



OIL FLOW	VOLTAGE	POWER	CURRENT	AIR FLOW	ELECTRIC PROTECTION	NOISE LEVEL	WEIGHT	CAPACITY	ø FAN
l/min	V	W	A	m³/h	IP	dB(A)	kg	lt.	mm
20-150	12	210	17	2.500	68	82	16	3,6	310
20-150	24	210	8,5	2.500	68	82	16	3,6	310

sesino

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