# MANNESMANN REXROTH

4/2- and 4/3-way proportional directional valves, direct operated, without electrical position feedback Models 4WRA and 4WRAE, Series 2X

RA 29 058/06.98

Replaces: 06.97

Size 10 [1]	**... 4600 PSI (315 bar)**	**... 37.0 GPM (140 L/min)**

Characteristics:

– Valve for closed loop control of direction and volume of a flow

– Operation with proportional solenoids with central thread and removeable coil

– For subplate mounting:
 Mounting pattern to DIN 24 340 Form A,
 ISO 4401 and CETOP-RP 121 H,
 NFPA T3.5.1M R1 and ANSI B93.7 **D 05**

 Subplates to data sheet
 RA 45 054 (separate order), see pages 8 and 9

– Spring-centered control spool

– Model WRAE with integral valve electronics

– Control electronics for model WRA:
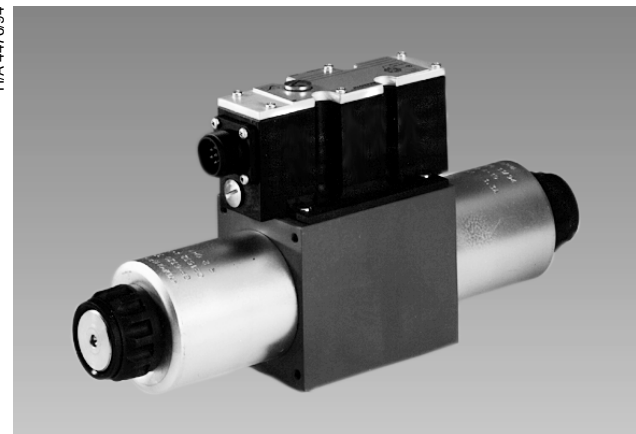 Electronic amplifier VT-VSPA2-2-1X/… in Eurocard format (separate order), see page 10

[1] Size 6 (Series 2X) see RA 29 055

H/A 4381/94
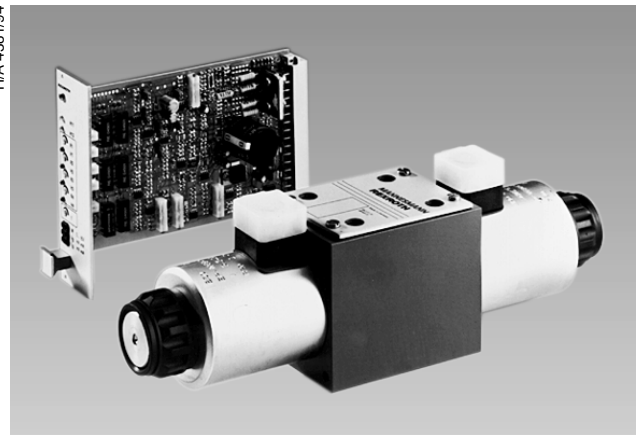
Model 4WRA10...-2X/G24N9K4/VR
with associated control electronics (separate order)

H/A 4476/94

Model 4WRAE10...-2X/G24N9K31/VR

List of contents

Symbols

Model WRA10…

Model WRA10.**A**…

Model WRA10.**B**…

Structure and function description, section

The 4/2- and 4/3-way proportional directional valves are designed as direct operated units for subplate mounting. They are operated via proportional solenoids with central thread and removeable coil. The control of the solenoids is optionally by means of external control electronics (model WRA) or integral valve electronics (model WRAE).
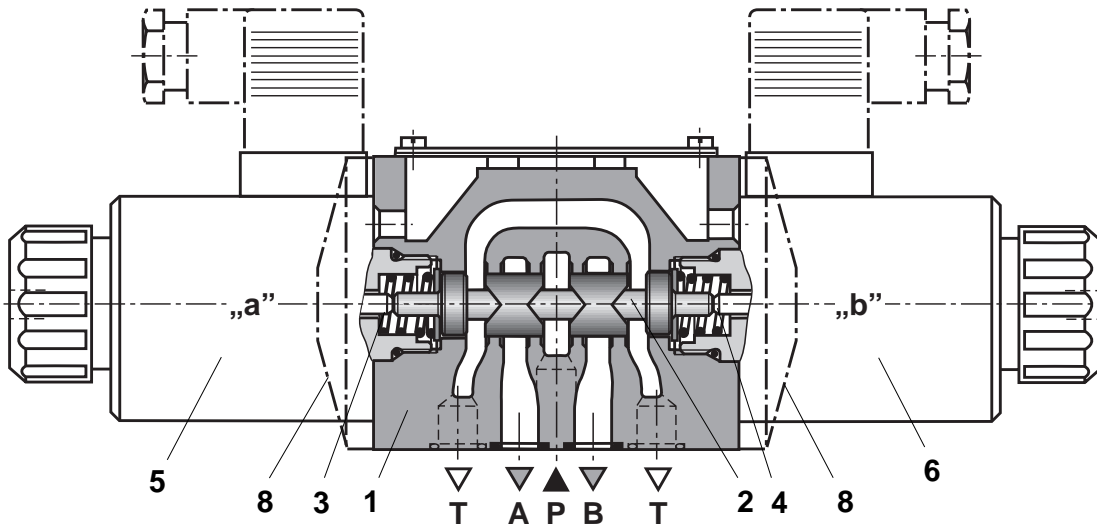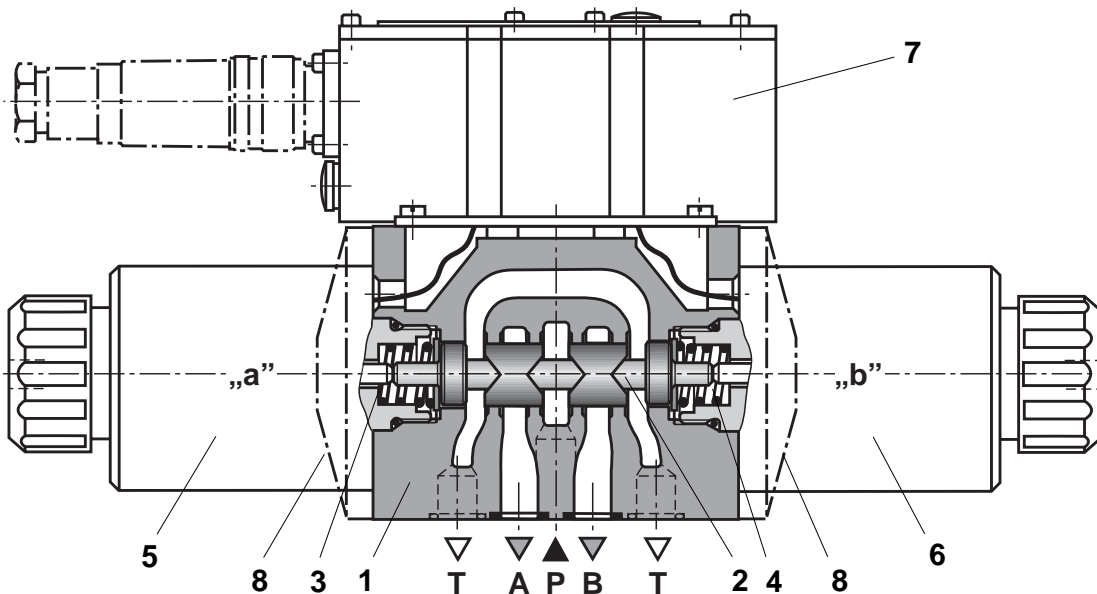
Structure:

The valve mainly consists of:
– Housing (1) with mounting surface
– Control spool (2) with compression springs (3 and 4)
– Solenoids (5 and 6) with central thread
– Optionally integrated valve electronics (7)

Function description:

– With solenoids (5 and 6) de-energized, the control spool (2) is held in the center position by compression springs (3 and 4)
– Direct operation of control spool (2) by energizing a proportional solenoid
  e.g. control solenoid "b" (6)
  → Moving of control spool (2) to the left proportionally to electrical input signal
  → Flow from P to A and B to T via orifice-like cross sections with progressive flow characteristics
– De-energizing of solenoid (6) → control spool (2) is returned to the center position by compression spring (3)

Model 4WRA10...-2X/…

Model 4WRAE10...-2X/…

Valve with 2 spool positions:
(Model 4WRA..**A**… or 4WRA..**B**…)

The function of this valve structure is principally the same as with the valve with 3 spool positions. However, the 2-spool position valves are only equipped with solenoid "a" (5) **or** solenoid "b" (6). Instead of the 2nd proportional solenoid there is an end cap (8).

Note:

Emptying of the tank line is to be avoided. With such conditions, check valve (≥ 29 PSI (2 bar)) can be installed in the tank line.

Ordering code

4WRA	10		– 2X / G24		/	VR	*

W/o integral
control electronics **= w/o code**
With integral
control electronics **= E**

Size 10 **= 10**

Symbols

= E
E1-

= E3-

= W
W1-

= W3-

= EA

= WA

= EB

= WB

With symbols E1- and W1-:

P → A: $q_{V\,max}$ B → T: $q_V/2$

P → B: $q_V/2$ A → T: $q_{V\,max}$

With symbols E3- and W3-:

P → A: $q_{V\,max}$ B → T: blocked

P → B: $q_V/2$ A → T: $q_{V\,max}$

Note:
With the spools W, WA and WB there is a
flow from A to T and B to T with approx. 3%
of the corresponding nominal cross section
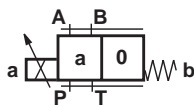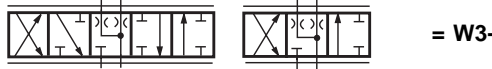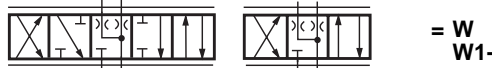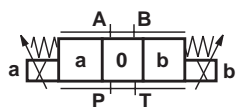in zero position.

Further details
in clear text

VR =   FPM-rectangular rings,
suitable for mineral oils
and phosphate ester

for WRAE:
w/o code. =   Command value input ± 10 VDC
C =   Command value input 4 to 20 mA

Electrical connection model
for WRA:
Z4 =   Plug-in connector to DIN 43 650
K4 =   w/o plug-in connector,
with protective cap
for WRAE:
Z31 =   Unit socket with plug
to DIN 43 563/6-pin + PE/Pg11
K31 =   Unit socket 6-pin +PE
w/o plug

w/o code =   w/o emergency operation
N9 =   with concealed emergency operation
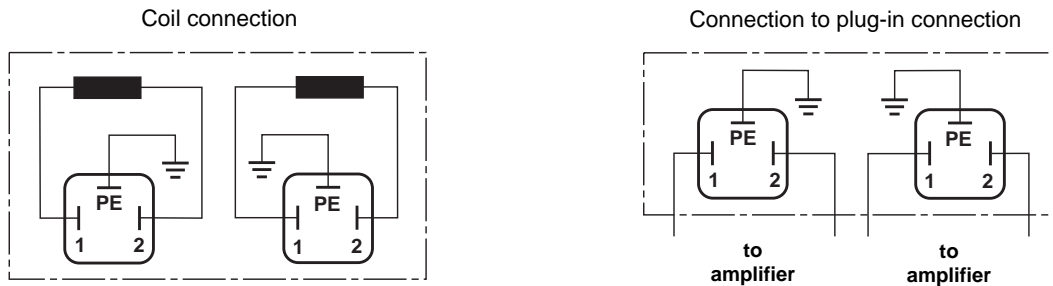
G24 =   Supply voltage 24 VDC

2X =   Series 20 to 29
(20 to 29: installation and connection dimensions unchanged)

Nominal flow at 145 PSI (10 bar) valve pressure difference
**30 =**   7.93 GPM (30 L/min)
60 =   15.9 GPM (60 L/min)

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

General

Installation position			optional, preferrably horizontal
Ambient temperature range	WRA...	°F (°C)	– 4 to + 158 (– 20 to + 70)
	WRAE...	°F (°C)	– 4 to + 140 (– 20 to + 60)
Weight	WRA...	lbs (kg)	14.6 (6.6)
	WRAE...	lbs (kg)	15.0 (6.8)

Hydraulic (measured at v = 150 SUS (32 mm^2/s) and t = 104 °F (40 °C))

Operating pressure	Port A, B, P	PSI (bar)	up to 4600 (315)
	Port T	PSI (bar)	up to 3046 (210)
Nominal flow $q_{V\,N}$ bei Δp = 145 PSI (10 bar)		GPM (L/min)	7.93 (30) 15.9 (60)
Flow (max. permissible)		GPM (L/min)	19.8 (75) [37 (140) with double flow]
Pressure fluid			Mineral oil (HL, HLP) to DIN 51 524 Phosphate ester (HFD-R)
Fluid cleanliness			Maximum permissible degree of contamination of pressure fluid to NAS 1638 Class 7 to 9. We therefore recommend a filter with a minimum retention rate of $\beta_{10} \geq 75$.
Pressure fluid temperature range	WRA...	°F (°C)	– 4 to + 158 (– 20 to + 70)
	WRAE...	°F (°C)	– 4 to + 158 (– 20 to + 70)
Viscosity range		SUS (mm^2/s)	78 to 1760 (15 to 380)
Hysteresis		%	≤ 5
Reversal span		%	≤ 1
Response sensitivity		%	≤ 0.5
Frequency response (– 90°, signal 50 % ± 40 %)		Hz	10

Electrical

Insulation to DIN 40 050			exceeds NEMA Class B (IP 65)
Voltage model			Direct voltage
Signal model			analog
Command signal	Voltage input	V	± 10
	Current input	mA	4 to 20
Input impedance	Voltage input	Ω	20K or higher
	Current input	Ω	100
Max. current per solenoid		A	2.5
Solenoid coil resistance	Cold value at 68 °F (20 °C)	Ω	2
	Max. warm value	Ω	3
Duty cycle		%	100
Coil temperature		°F (°C)	up to 302 (150)
Electrical connection	WRA...		Plug-in connection to DIN 43 650/2-pin + PE/Pg11
	WRAE...		Plug-in connection to DIN 43 563/6-pin + PE/Pg11
Supply voltage	Nominal voltage	VDC	24
	Lower limiting value WRA… V Lower limiting value WRAE… V		22 19
	Upper limiting value	V	35
Current consumption of amplifier	I_{max}	A	1.8
	Impulse current	A	4
Control electronics	WRA...		Amplifier model VT-VSPA2-2-1X/… in Euro-card format (separate order), see page 10 or data sheet RA 30 112
	WRAE...		Integrated into valve, see page 5

Electrical connection with model WRA

Coil connection

Connection to plug-in connection

to amplifier

to amplifier

Integral valve electronics with model WRAE

Pin allocation unit plug
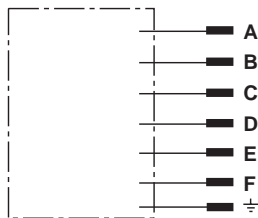
Integral electronics (see below)

	Pin	Signal
Supply voltage	A	24 VDC (19 to 35 VDC)
	B	GND (0 V)
	C	do not connect (0 V)
Differential input	D	Command value (± 10 V / 4 to 20 mA)
	E	Reference potential
	F	do not connect
PE	$\perp$	Protective ground

Command value: Reference potential at E and positive command value (or 12 to 20 mA) at D causes flow from P to A and B to T.

Reference potential at E and negative command value (or 4 to 12 mA) at D causes flow from P to B and A to T.

With valve with 1 solenoid on side A (spool variations **EA** and **WA**) reference potential at E and positive command value at D cause flow from P to B and A to T.

Conn. cable: Recommendation: – up to 80 ft (25 m) cable length stranded 18 AWG (LiYCY 5 x 0.75 mm^2)
– up to 160 ft (50 m) cable length stranded 16 AWG (LiYCY 5 x 1.0 mm^2)

External diameters 0.26 to 0.44 inches (6.5 to 11.2 mm)

Only connect shield to earth ground PE on supply side.

Block circuit diagram/terminal connection of integral valve electronics

Command value
±10 V or
4 to 20 mA
Reference potential

do not connect

Differential amplifier

Ramp generator

Step function generator

Summation

Low voltage detection

Output stage[1]

Output stage[1]

0 V

Power supply unit

24 V

Supply voltage:

0 V

Protective ground

+ V$_i$
0 V
– V$_i$
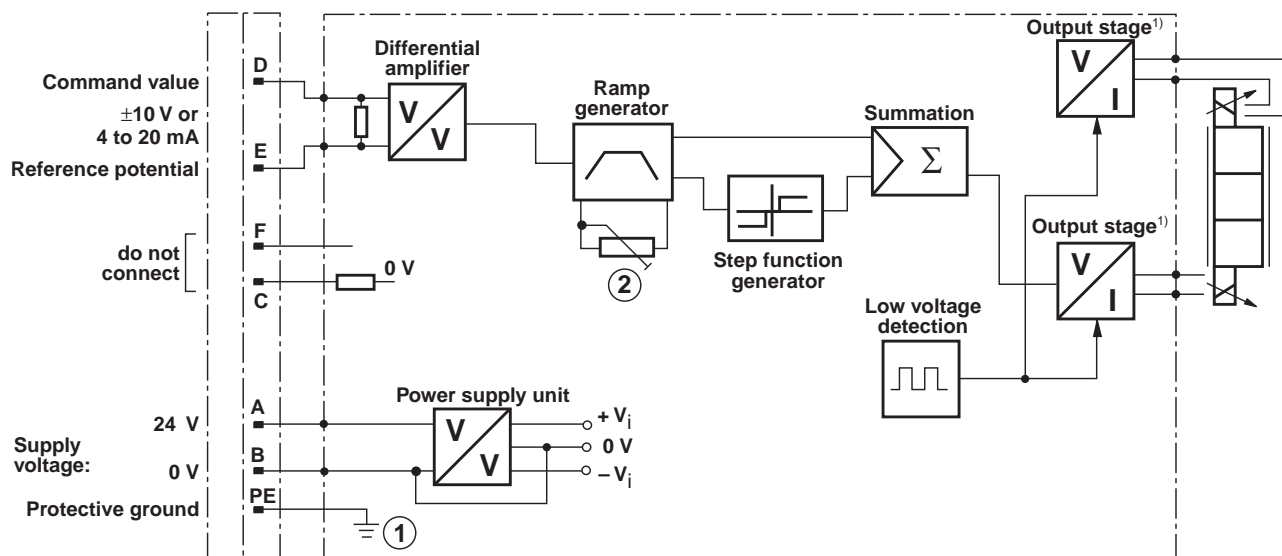
① **Protective gound attached to valve housing and cover**

② **Ramp can be externally adjusted from 0 to 5 s ($T_{up} \cong T_{down}$)**
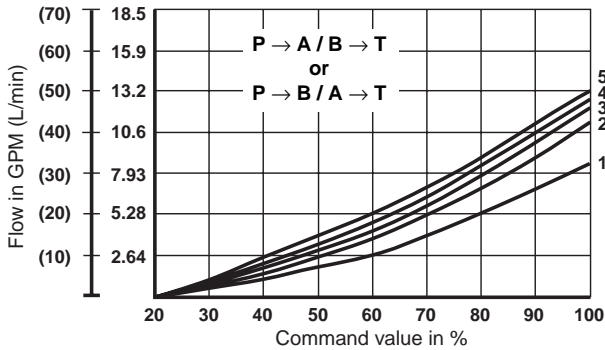
[1] Output stages current-regulated

Transition functions with electrical step input signals

Signal change in %

Time *t* in ms
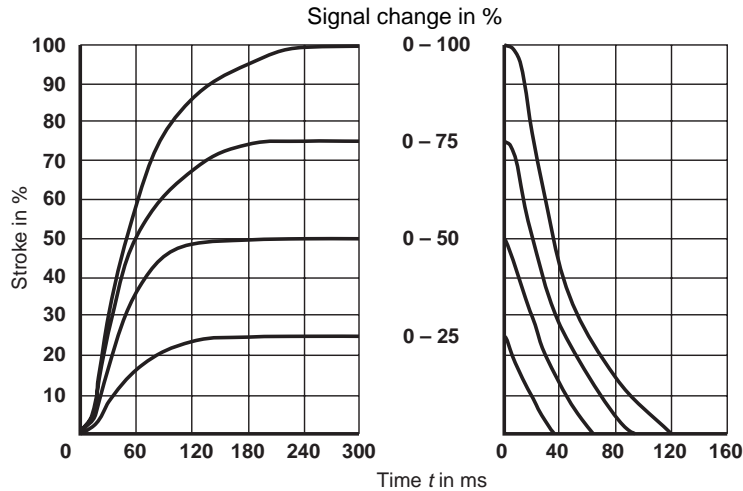
Operating curves (measured at v = 150 SUS (32 mm²/s) and t = 104 °F (40 °C))

7.93 GPM (30 L/min) Nominal flow at 10 bar valve pressure difference   **30**

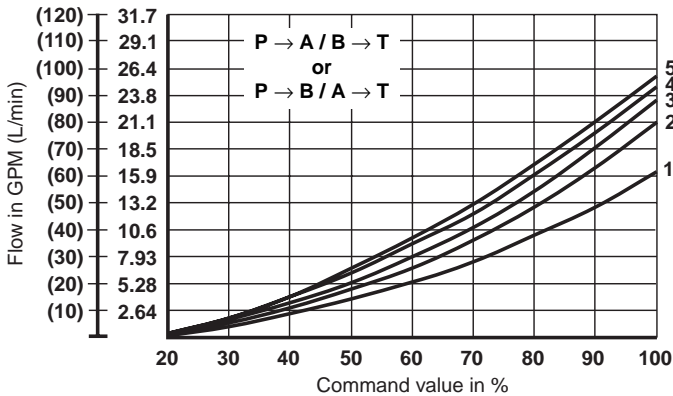|		
1	$\Delta p =$	145 PSI (10 bar) constant
2	$\Delta p =$	290 PSI (20 bar) constant
3	$\Delta p =$	435 PSI (30 bar) constant
4	$\Delta p =$	725 PSI (50 bar) constant
5	$\Delta p =$	1450 PSI (100 bar) constant

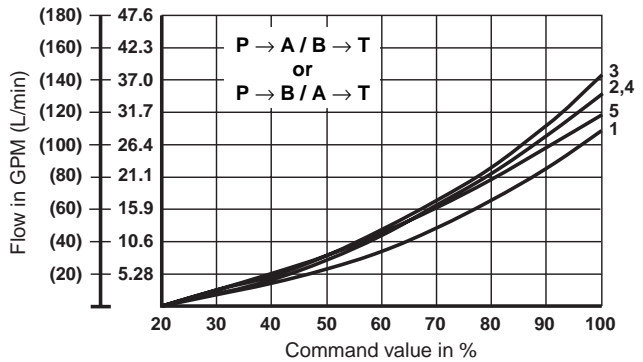**15.9 GPM (60 L/min) Nominal flow at 10 bar valve pressure difference**   **60**
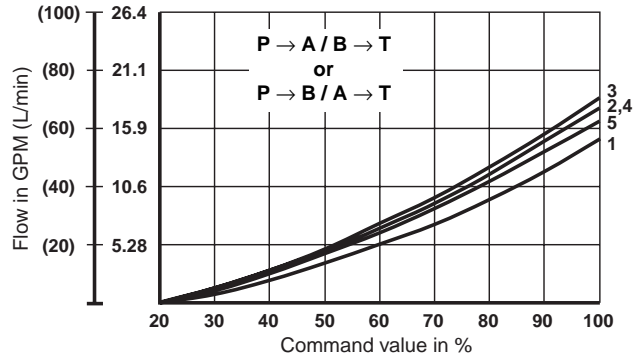
$\Delta p =$ Valve pressure difference to DIN 24 311
(Input pressure minus load pressure
and minus return pressure)

Double flow with 7.93 GPM (30 L/min) nominal flow spool

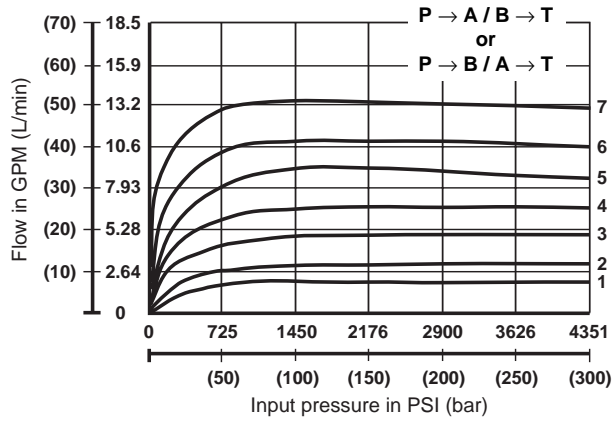|		
1	$\Delta p =$	72.5 PSI (5 bar) constant, single edge
2	$\Delta p =$	145 PSI (10 bar) constant, single edge
3	$\Delta p =$	218 PSI (15 bar) constant, single edge
4	$\Delta p =$	363 PSI (25 bar) constant, single edge
5	$\Delta p =$	725 PSI (50 bar) constant, single edge

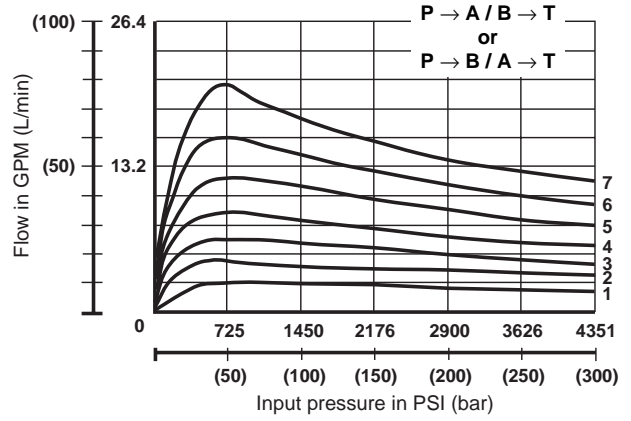**Double flow with 15.9 GPM (60 L/min) nominal flow spool**

$\Delta p =$ Valve pressure difference to DIN 24 311
(input pressure minus load pressure
and minus return pressure)

Power limit (measured at v = 150 SUS (32 mm²/s) and t = 104 °F (40 °C))

Nominal flow 7.93 GPM (30 L/min)   30

Flow in GPM (L/min)

(70) 18.5
(60) 15.9
(50) 13.2
(40) 10.6
(30) 7.93
(20) 5.28
(10) 2.64
0

P → A / B → T
or
P → B / A → T

7
6
5
4
3
2
1

0   725   1450   2176   2900   3626   4351
(50)   (100)   (150)   (200)   (250)   (300)
Input pressure in PSI (bar)

Nominal flow 15.9 GPM (60 L/min)   60

Flow in GPM (L/min)

(100) 26.4

(50) 13.2

0

P → A / B → T
or
P → B / A → T

7
6
5
4
3
2
1

0   725   1450   2176   2900   3626   4351
(50)   (100)   (150)   (200)   (250)   (300)
Input pressure in PSI (bar)

Double flow with 7.93 GPM (30 L/min) nominal flow spool

Flow in GPM (L/min)

(120) 31.7
(100) 26.4
(80) 21.1
(60) 15.9
(40) 10.6
(20) 5.28
0

P → A / B → T
or
P → B / A → T

7
6
5
4
3
2
1

0   725   1450   2176   2900   3626   4351
(50)   (100)   (150)   (200)   (250)   (300)
Input pressure in PSI (bar)

Double flow with 15.9 GPM (60 L/min) nominal flow spool

Flow in GPM (L/min)

(180) 47.6
(160) 42.3
(140) 37.0
(120) 31.7
(100) 26.4
(80) 21.1
(60) 15.9
(40) 10.6
(20) 5.28
0

P → A / B → T
or
P → B / A → T

7
6
5
4
3
2
1

0   725   1450   2176   2900   3626   4351
(50)   (100)   (150)   (200)   (250)   (300)
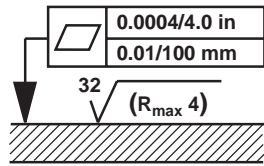Input pressure in PSI (bar)
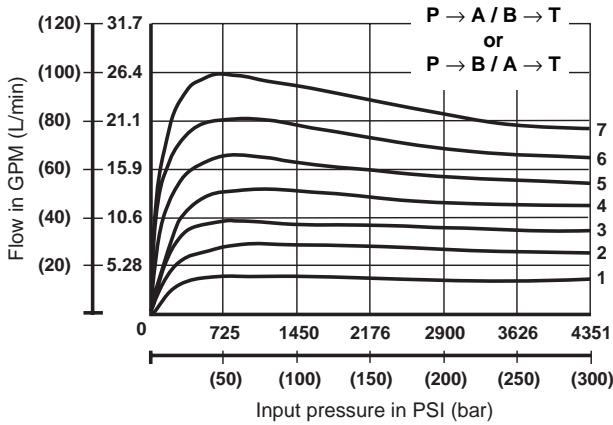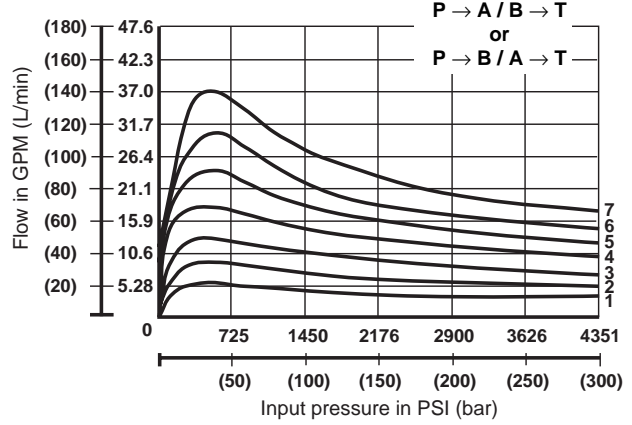
1 Command value =   40 %
2 Command value =   50 %
3 Command value =   60 %
4 Command value =   70 %
5 Command value =   80 %
6 Command value =   90 %
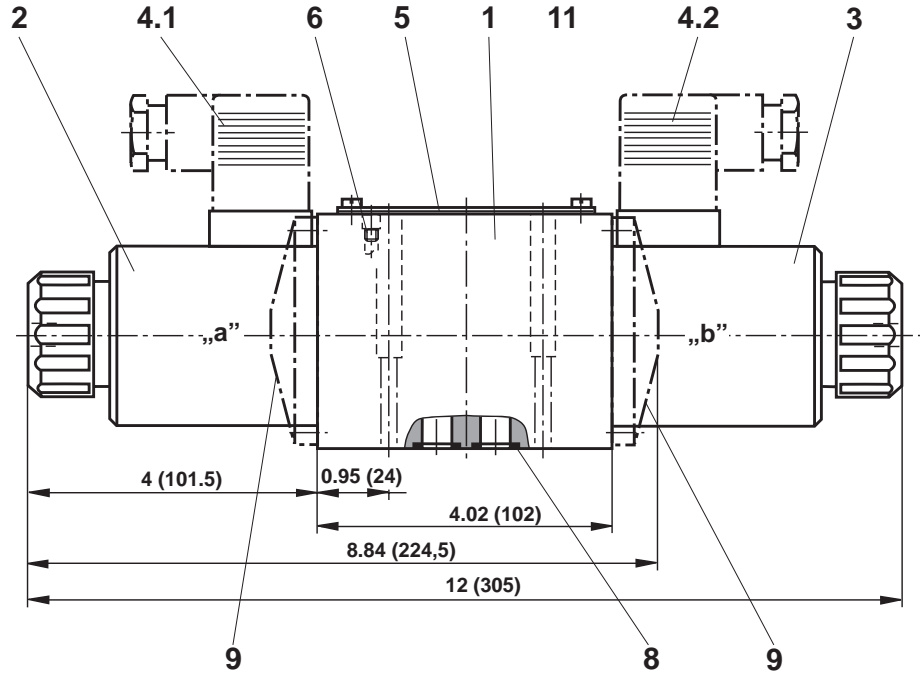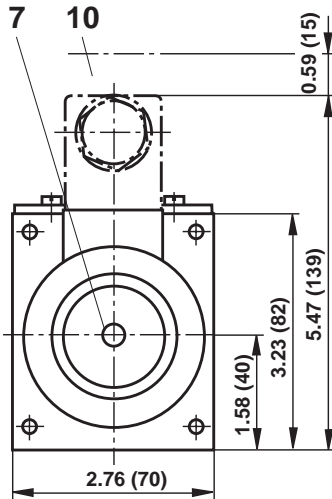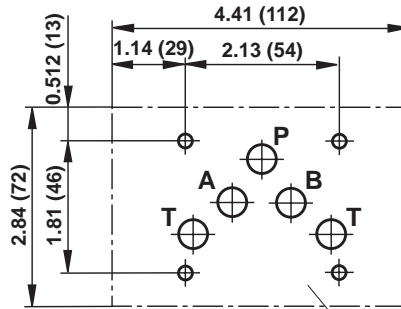**7** Command value = 100 %

Double-flow example

a
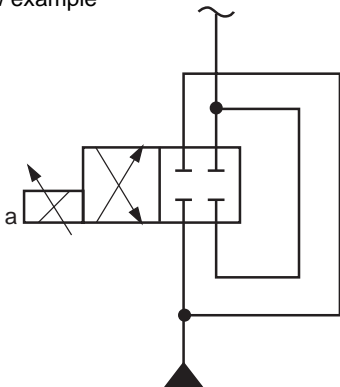
Unit dimensions model WRA10: dimensions in inches (millimeters)

0.0004/4.0 in
0.01/100 mm

32 (R_{max} 4)

Required surface finish
of mating piece

4.41 (112)
0.512 (13)
1.14 (29) 2.13 (54)
2.84 (72)
1.81 (46)
P
A B
T T

7 10
0.59 (15)
5.47 (139)
3.23 (82)
1.58 (40)
2.76 (70)

2 4.1 6 5 1 11 4.2 3

„a" „b"

4 (101.5)
0.95 (24)
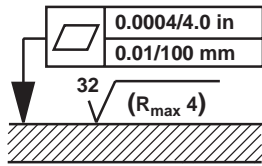4.02 (102)
8.84 (224,5)
12 (305)

9 8 9

1 Valve housing

2 Proportional solenoid "a"

3 Proportional solenoid "b"

4.1 Z4-plug "A", color grey; order no. **RR00 008 908**

4.2 Z4-plug "B", color black; order no. **RR00 008 909**

5 Nameplate

6 Valve bleed bolt
Note: Valves are bled before delivery.

7 Emergency operation N9

8 R-ring (13.0 x 1.6 x 2.0 mm); Ports A, B, P, T

9 Plug bolt for valve with one solenoid
(2 switching positions, models **EA, WA**, **EB** or **WB**)

10 Space requirement for removal of plugs

11 Machined valve mounting surface,
Position of ports to DIN 24 340 Form A,
ISO 4401 and CETOP-RP 121 H,
NFPA/ANSI **D 05**

Subplates to data sheet RA 45 054 and valve mounting bolts
must be ordered separately.

Subplates: G66/05 (3/8" NPT)
G67/05 (1/2" NPT)
G534/05 (3/4" NPT)
G66/12 (SAE-6; 9/16-18)
G67/12 (SAE-8; 3/4-16)
G534/12 (SAE-12; 1-1/16-12)

Valve mounting bolts: 4) 1/4-20 UNC x 1-1/2" (M6 x 40)
DIN 912-10.9, grade 8 or better
Torque M_A = 11.4 lb-ft (15.5 Nm)

Unit dimensions model WRAE10: dimensions in inches (millimeters)

```
┌─────────────────┐
│ 0.0004/4.0 in   │
│ 0.01/100 mm     │
└─────────────────┘
   32  (R_max 4)
```

Required surface finish
of mating piece

4.41 (112)
1.14 (29) 2.13 (54)
0.512 (13)
2.84 (72)
1.81 (46)
P, A, B, T, T

7 4 2 6 5 10 1 12 3

5.55 (141)
3.23 (82)
1.58 (40)
2.76 (70)

"a" "b"

4 (101.5) 0.95 (24)
4.02 (102)
8.84 (224.5)
1.97 (50)
12 (305)

11 9 8 9

1 Valve housing
2 Proportional solenoid "a"
3 Proportional solenoid "b"
4 Z31-plug, 6pin + PE; order no. **RR00 021 267**
5 Nameplate
6 Valve bleed bolt
   Note: Valves are bled before delivery.
7 Emergency operation N9
8 R-ring (13.0 x 1.6 x 2.0 mm); Ports A, B, P, T
9 Plug bolt for valve with one solenoid
   (2 switching positions, models **EA, WA**, **EB** or **WB**)
10 Space requirement for removal of plugs
11 Machined valve mounting surface,
   Position of ports to DIN 24 340 Form A,
   ISO 4401 and CETOP-RP 121 H,
   NFPA/ANSI **D 05**

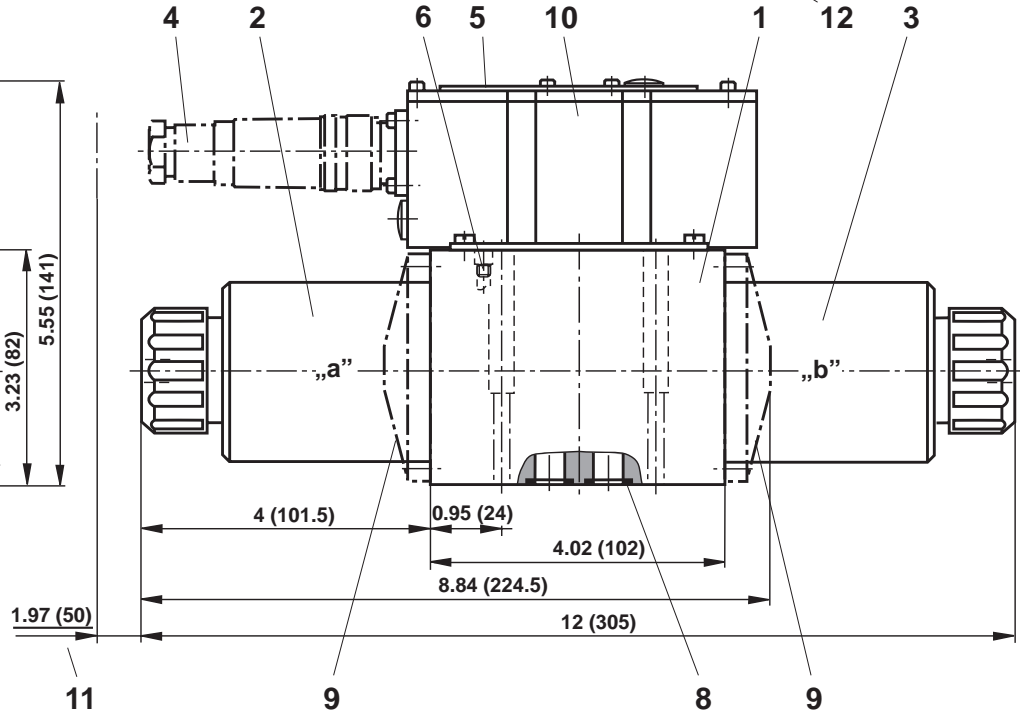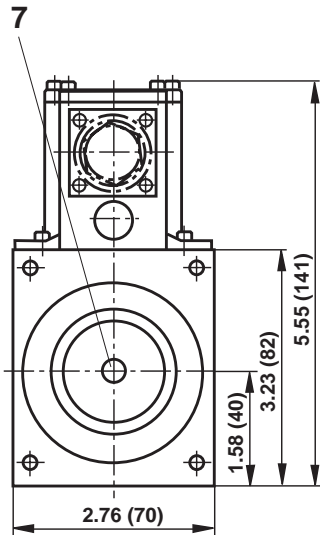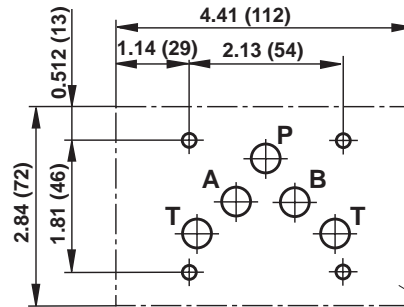Subplates to data sheet RA 45 054 and valve mounting bolts must be ordered separately.

Subplates: G66/05 (3/8" NPT)
G67/05 (1/2" NPT)
G534/05 (3/4" NPT)
G66/12 (SAE-6; 9/16-18)
G67/12 (SAE-8; 3/4-16)
G534/12 (SAE-12; 1-1/16-12)

Valve mounting bolts: 4) 1/4-20 UNC x 1-1/2" (M6 x 40)
DIN 912-10.9, grade 8 or better
Torque M_A = 11.4 lb-ft (15.5 Nm)

Control electronics for model 4WRA10.-2X/…: amplifier VT-VSPA2-2 (separate order)

Technical data

Operating voltage V_{DC}:   24 VDC
– upper limiting value $V_{DC}(t)_{max}$:   35 V
– lower limiting value $V_{DC}(t)_{min}$:   22 V
Solenoid current I_{max}:   2.5 A
Pulse frequency (output stage) f: 130 to 140 Hz
Card dimensions: Euro-card 3.94 x 6.3 inches
                              (100 x 160 mm)
                              DIN 41 494
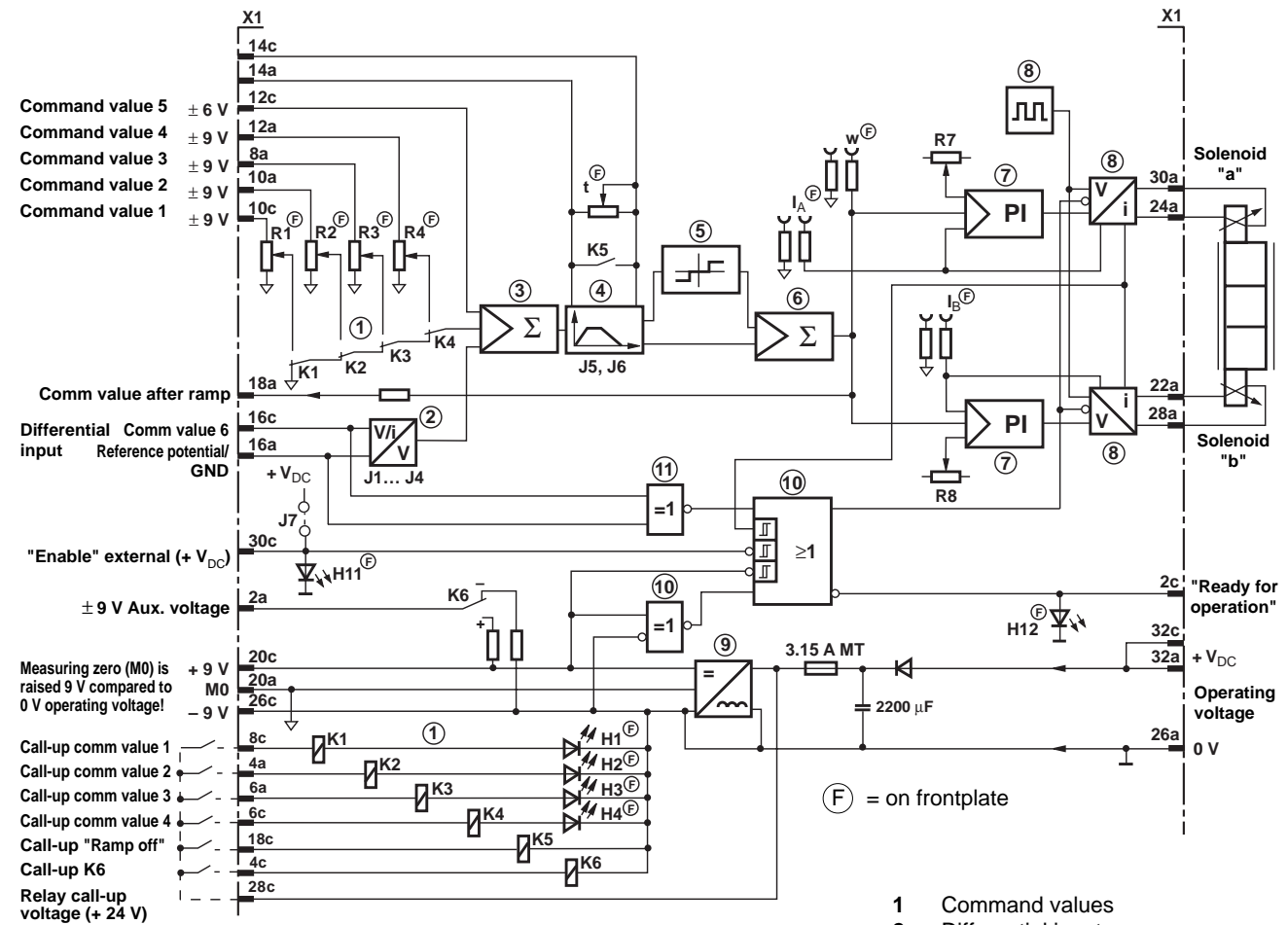
Frontplate dimensions
– Height: 3 U (5.06 inches (128.4 mm)
– Width soldering side: 1 HP (0.2 inches (5.08 mm)
– Width component side: 7 HP

Detailed information: Data sheet RA 30 112

Block circuit diagram/terminal connection

Positive command value (or 12 to 20 mA)
controls solenoid "b"
Negative command value (or 4 to
12 mA) controls solenoid "a"

H1 to **H4** = LED-indication for comm value call-ups
K1 to **K6** = Call-up relay
R1 to **R4** = Command values
R7   = Biasing current solenoid "a"
R8   = Biasing current solenoid "b"
t   = Ramp time

1 Command values
2 Differential input
3; **6** Summation
4 Ramp generator
5 Step function
7 PI current controller
8 Output stage with pulse generator
9 Power supply
10 Monitorings
11 Monitoring cable break
     (only with 4 to 20 mA)

Ordering code

VT-VSPA2	– 2	– 1X/		*

Amplifier for proportional directional valve 4WRA10-2X **= 2**			Further details in clear text
Series 10 to 19 **= 1X**	**T1 =**		1 ramp time
(10 to 19: technical data and terminal connection unchanged)	**T5 =**		5 ramp times

Ordering code

Notes

MANNESMANN REXROTH