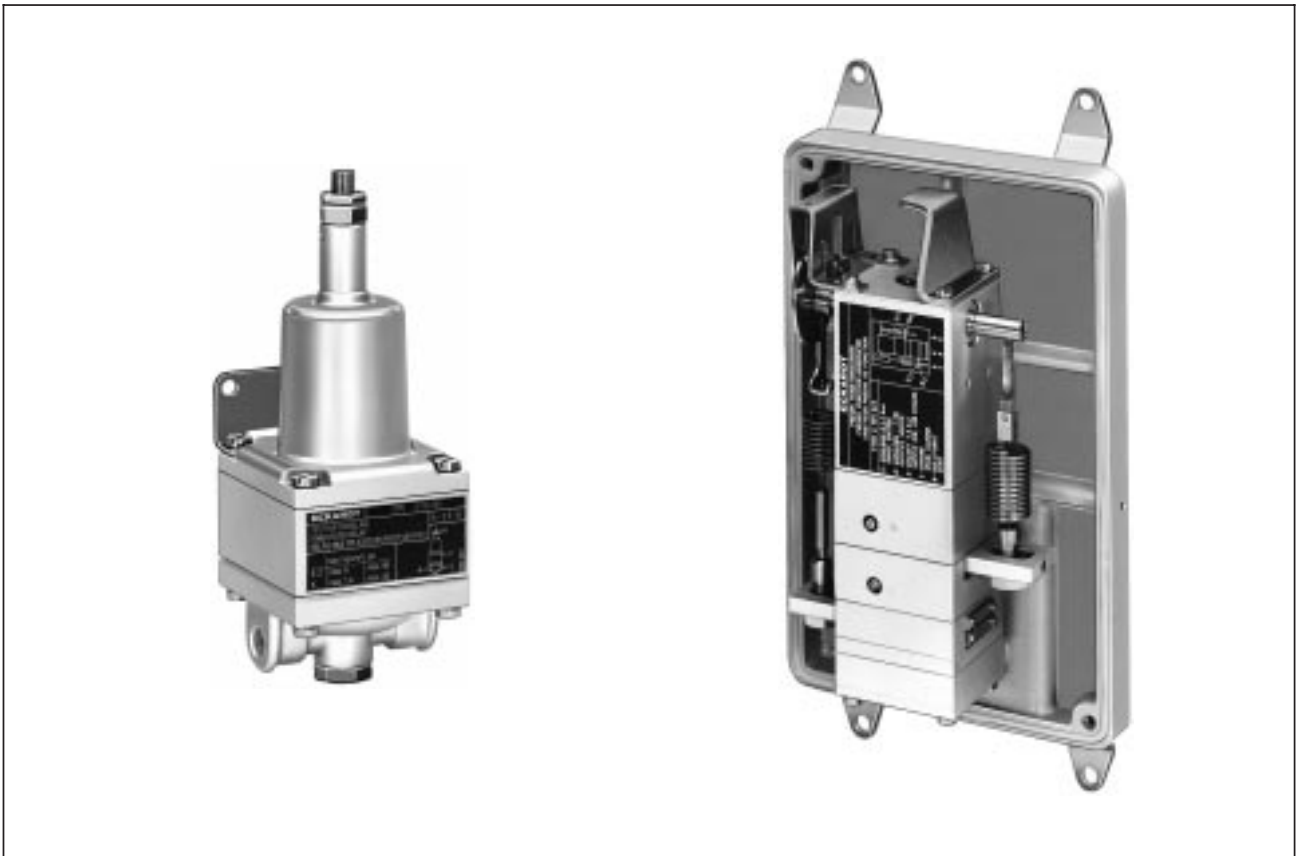


## PC191 Pneumatic Computing Relays



In different areas of process control there are problems which can easily be solved with special pneumatic limit signal, time or computing relays. For instance: signal monitoring, signal selection, signal adaption, safety control, etc.

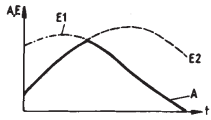
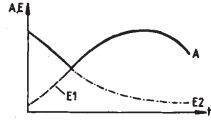
### Computing relays

- Booster relay
- Selector relay
- Reversing relay
- Adding relay
- Averaging relay
- Subtraction relay
- Fixed ratio relay
- Square root extractor
- Function generator

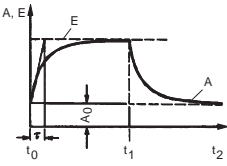
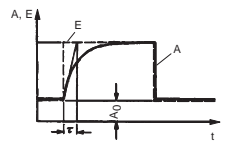
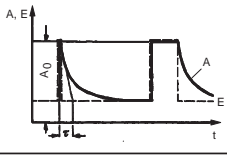
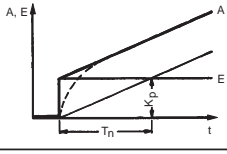
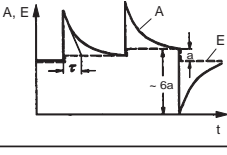
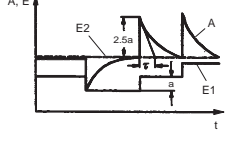

### Time function relays

- Delay relay
- Delay element
- PI-relay
- PD-relay
- Trend relay

## Computing Relays

Version		Function diagram	Application	Model Code PC191	
<b>Booster relay</b>	without calibration adjustment	$A = E$	Increase in airflow rate	-100	
	with calibration adjustment			-113	
<b>Min.-selector relay 2 inputs</b>	Input E1, E2		Selection of lowest input pressure	-101	
<b>Max.-selector relay 2 inputs</b>	Input E1, E2		Selection of highest input pressure and simultaneously increase in airflow rate	-102	
<b>Reversing relay</b>	Input E	$A = K - E$	Reversal of input pressure signal in 1:1 ratio and simultaneously increase in airflow rate	-110	
<b>Adding relay</b>	Input E1, E2	$A = E1 + E2 - K$	Addition of two input pressures, minus an adjustable bias value K and simultaneously increase in airflow rate	-121	
<b>Averaging relay</b>	Input E1, E2	$A = \frac{E1 + E2}{2}$	Averaging and simultaneously increase in airflow rate	-130	
<b>Subtraction relay</b>	Input E1, E2	$A = E1 - E2 + K$	Subtraction of two input pressure, plus an adjustable bias value K and simultaneously increase in airflow rate	-140	
<b>Fixed ratio relay</b>	Input E	$A = 0.5 E - K$	Multiplicaton of an input signal by a factor with takes into consideration an adjustable bias value and simultaneously increase in airflow rate	-221	
		$A = 0.5 E + K$		-231	
		$A = 2 E - K$		-261	
		$A = 3 E - K$		-281	
<b>Square root extractor</b>	Input E	$x = 0.8 (E - 0.2)$	For square root extraction of pneumatic signal	0.2 ... 1 bar	-611
				3 ... 15 psi	-612
<b>Function generator</b>	Input E	$A = f(x) + 0.2$ $x = 0.8 (E - 0.2)$	To perform any required constant function	0.2 ... 1 bar	-621
				3 ... 15 psi	-622

**Time function relays**

Version	Function diagram	Application	Model Code PC191
Delay relay symmetrical		Delay of signal increase and decay time	-900
Delay element (without booster)		Passive generation of delay (Restriction and capacity)	-913
Delay relay signal increase		Delay of signal increase time only	-901
Delay relay signal decrease		Delay of signal decay time only	-902
PI relay		Combined effect of proportional and reset action. Within the period of the reset time $T_n$ , the reset change reaches the values of the proportional change.	-905
PD relay		Combined effect of derivative and proportional action. On change of input pressure a transient overshoot of output takes place, followed by a gradual decay to the new input value.	-910
Trend relay $V = 2.5$		With a change of input pressure, a transient rise of output pressure takes place, followed by a gradual return to the working point of, for instance, 0.6 bar.	-920

**General Technical Data**

Input <sup>1)</sup> } ..... 0.2 to 1 bar / 3 to 15 psi  
 Output <sup>1)</sup> } ..... / 20 to 100 kPa  
 max. 6 bar / 90 psi / 600 kPa  
 Supply air ..... 1,4 ± 0,1 bar / 20 ± 1,4 psi  
 / 140 ± 10 kPa to max. 6 bar /  
 90 psi / 600 kPa  
 Air consumption <sup>1)</sup> ..... 10 l/h  
 Air delivery <sup>1)</sup> ..... 3 000 l/h  
 Air exhaust <sup>1)</sup> ..... 1 800 l/h  $\Delta p = 1$  bar

**Local conditions**

Location class ..... D1 acc. to IEC 654/1  
 Ambient temperature range. -25 to +70 °C  
 Storage temperature range . -30 to +70 °C  
 Admissible rel. humidity. . . . ≤ 75 %, no condensation  
 permissible  
 Protection class. . . . . IP 53 acc. to DIN 40 050

**Mounting**

Type of mounting ..... for wall mounting  
 with mounting angles  
 Mounting orientation ..... vertical  
 Pneumatic connections. . . . internal thread 1/8-NPT <sup>2)</sup>

**Materials**

Housing ..... Aluminium, finish  
 Internal components ..... Al, St, Brass, Silicone,  
 Polyamid, Neopren,  
 Perbunan, PTFE

2) For Tube fittings see Product Specifications PSS EOO9001 A-(en)

1) Exeptions are outlined

Technical data obtained from measurements made under standard reference conditions. Supply air 1.4 bar / 20 psi / 140 kPa.

**Model Codes**

<b>Pneumatic Computing Relay</b>	<b>PC191</b>
<b>Function and Formula</b>	
Booster relay $A = E$ . . . . .	-100
Booster relay $A = E$ with calibration adjustment . . . . .	-113
Min.-selector relay 2 inputs . . . . .	-101
Max.-selector relay 2 inputs . . . . .	-102
Reversing relay $A = K - E$ . . . . .	-110
Adding relay $A = E1 + E2 - K$ . . . . .	-121
Averaging relay $A = (E1 + E2) / 2$ . . . . .	-130
Subtraction relay $A = E1 - E2 + K$ . . . . .	-140
Fixed ratio relay $A = 0.5 E - K$ . . . . .	-221
Fixed ratio relay $A = 0.5 E + K$ . . . . .	-231
Fixed ratio relay $A = 2 E - K$ . . . . .	-261
Fixed ratio relay $A = 3 E - K$ . . . . .	-281
Square root extractor $A = A = \sqrt{E}$ , 0.2 - 1.0 bar . . . . .	-611
Square root extractor $A = A = \sqrt{E}$ , 3 - 15 psi . . . . .	-612
Function generator $A = F(E)$ 0.2 - 1.0 bar . . . . .	-621
Function generator $A = F(E)$ 3 - 15 psi . . . . .	-622
Delay relay symmetrical . . . . .	-900
Delay relay signal increase . . . . .	-901
Delay relay signal decrease . . . . .	-902
Delay element (without booster) . . . . .	-913
PI-relay . . . . .	-905
PD-relay . . . . .	-910
Trend relay $V = 2.5$ . . . . .	-920
<b>Options</b>	
working on cams with given function (only for -621 / -622) . . . . .	-A

Example: PC191 -100

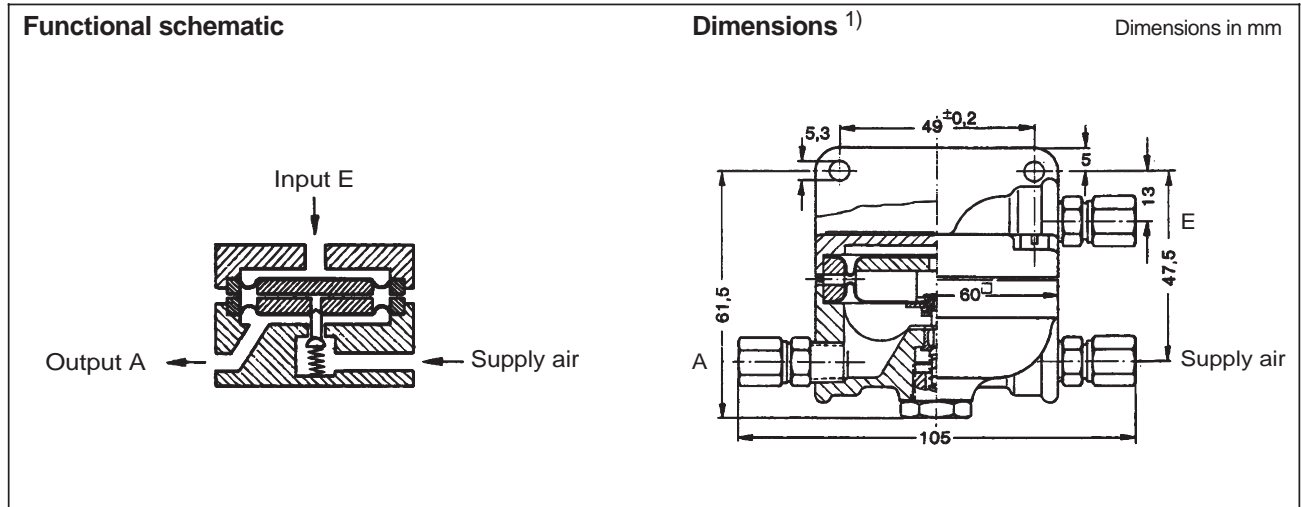
For Tube fittings see Product Specifications PSS EOO9001 A-(en)

**PC191-100 Booster relay without calibration adjustment**

**Technical data**

Non-linearity . . . . . < 1 %

Weight . . . . . 0.3 kg

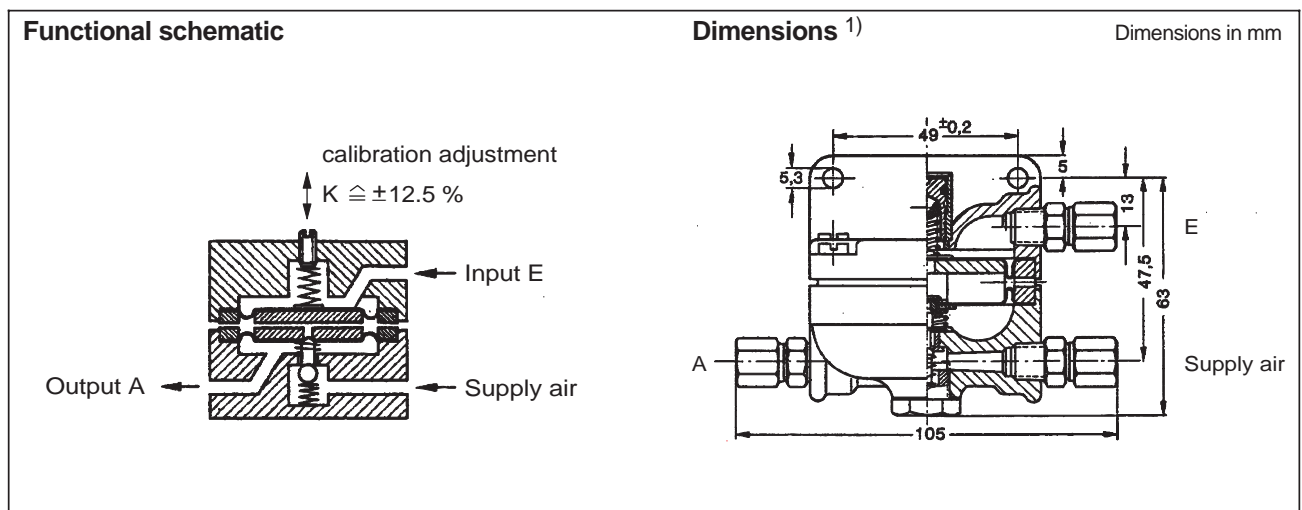


**PC191-113 Booster relay with calibration adjustment**

**Technical data**

Non-linearity . . . . . < 0.25 %

Weight . . . . . 0.3 kg



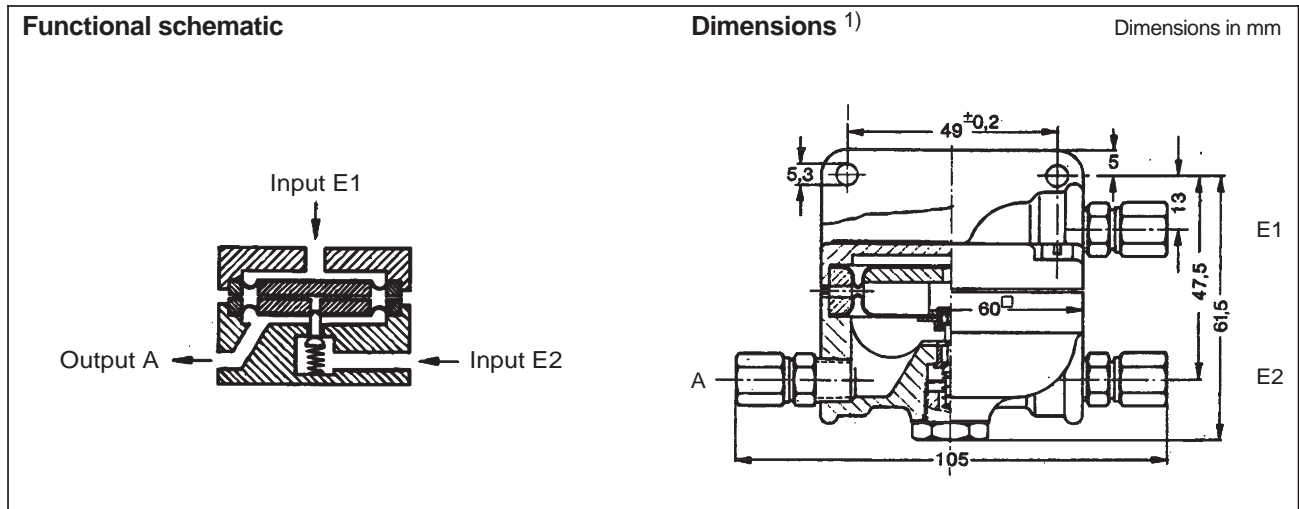
1) Dimensional drawing shows tube fittings 1/8-NPT for pipe 6 x 1. These are not supplied with the relays, the tube fittings should be ordered separately.

**PC191-101 Min.-selector relay 2 inputs**

**Technical data**

Min. pressure difference  
between E1 and E2 . . . . .  $\pm 4$  mbar

Weight . . . . . 0.3 kg

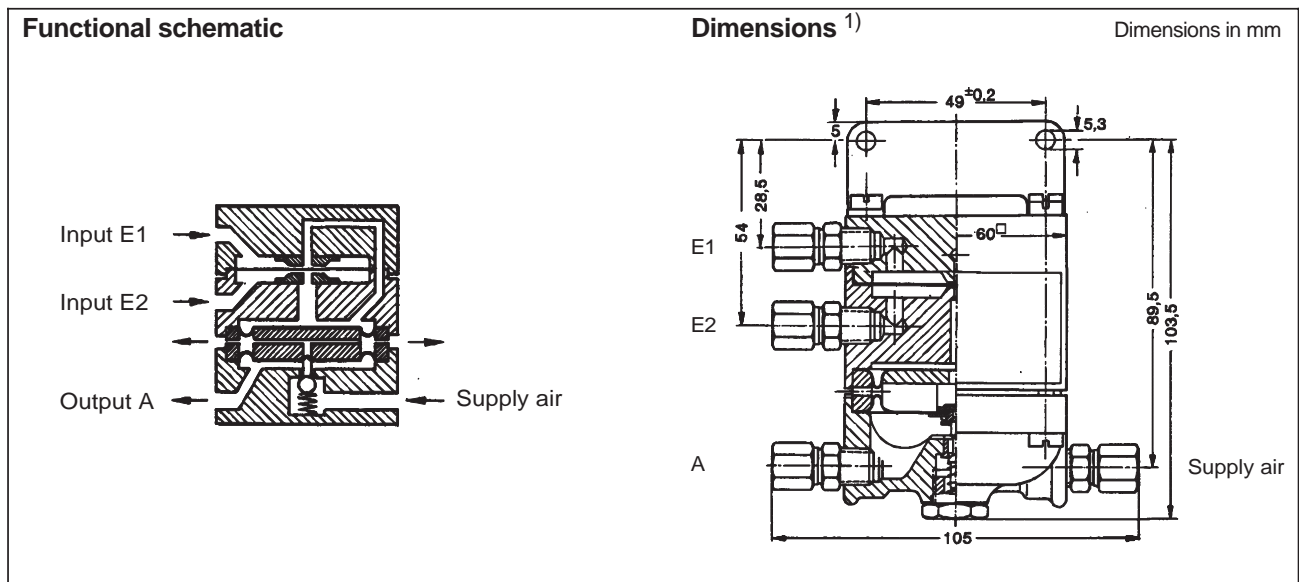


**PC191-102 Max.-selector relay 2 inputs**

**Technical data**

Non-linearity . . . . .  $< 0.25\%$   
Min. pressure difference  
between E1 and E2 . . . . .  $\pm 4$  mbar

Weight . . . . . 0.5 kg



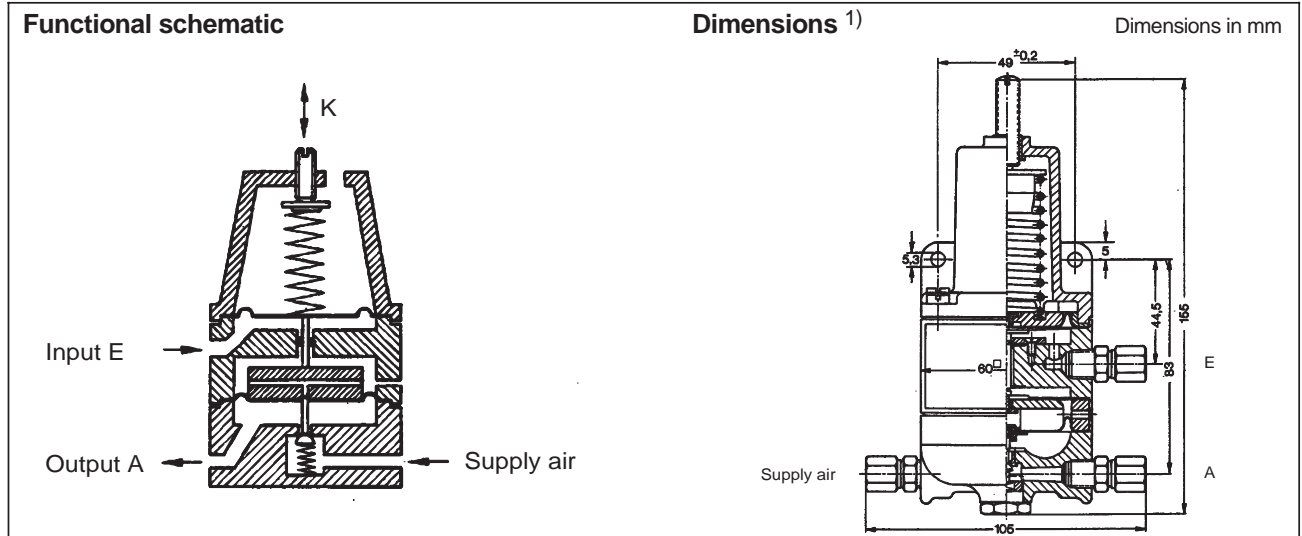
1) Dimensional drawing shows tube fittings 1/8-NPT for pipe 6 x 1. These are not supplied with the relays, the tube fittings should be ordered separately.

**PC191-110 Reversing relay  $A = K - E$**

**Technical data**

Bias value K ..... mech. continuously variable  
 equivalent to 0 to 1.4 bar  
 / 0 to 15 psi / 0 to 100 kPa

Weight ..... 0.4 kg

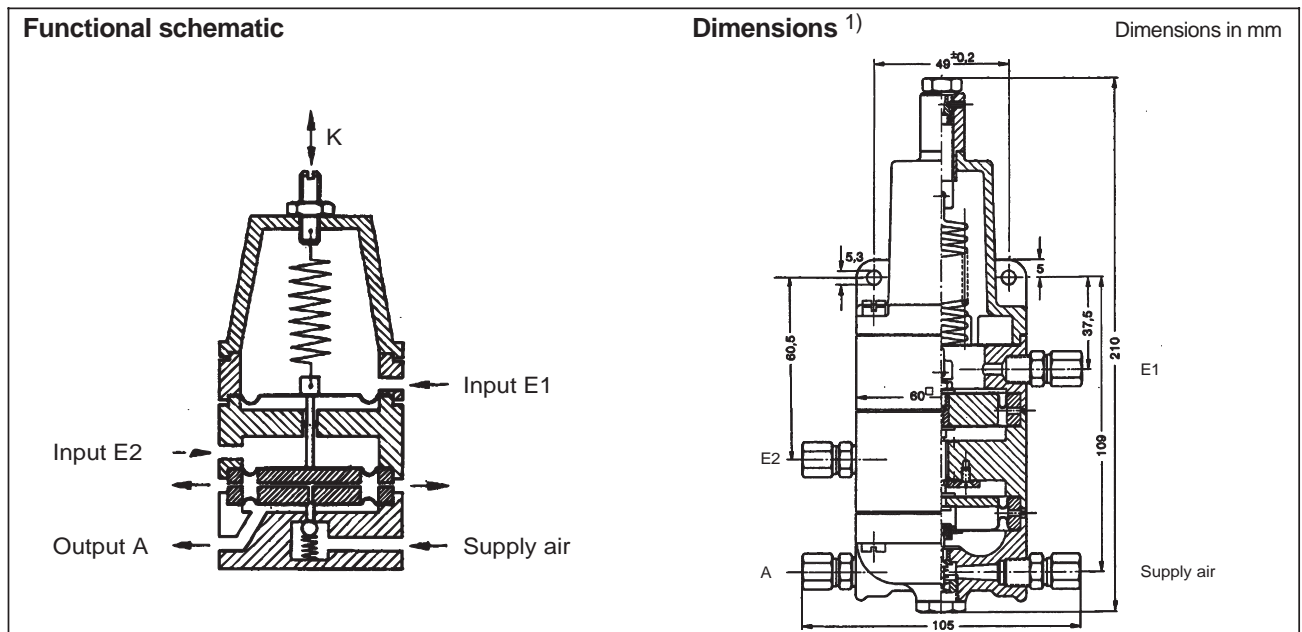


**PC191-121 Adding relay  $A = E1 + E2 - K$**

**Technical data**

Non-linearity .....  $< \pm 1\%$   
 Bias value K ..... mech. continuously variable  
 equivalent to 0 to 1.4 bar  
 / 0 to 15 psi / 0 to 100 kPa

Weight ..... 0.6 kg



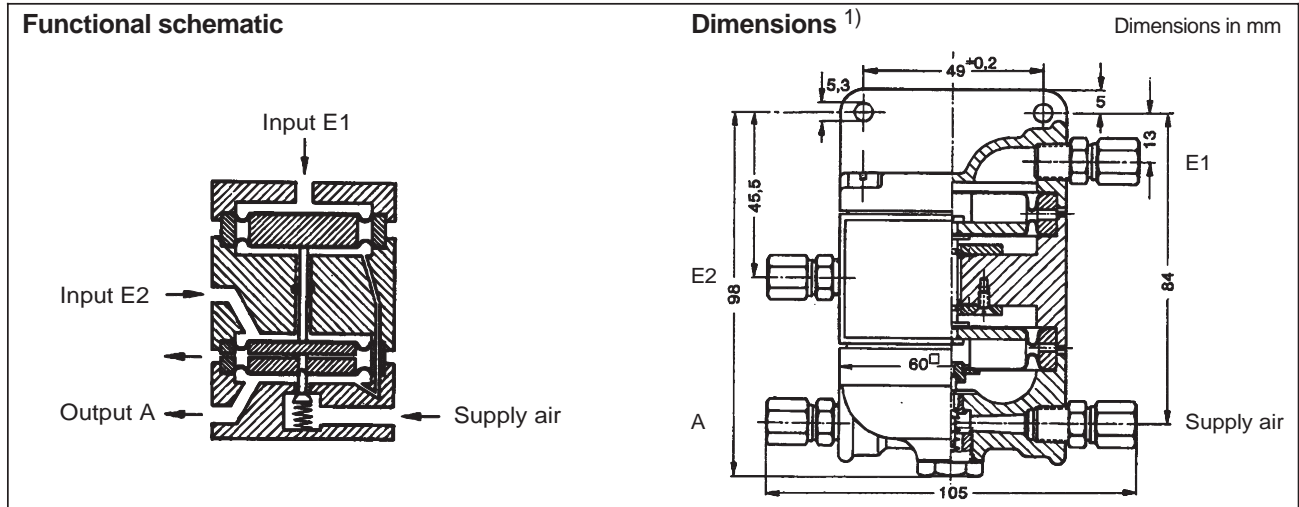
1) Dimensional drawing shows tube fittings 1/8-NPT for pipe 6 x 1. These are not supplied with the relays, the tube fittings should be ordered separately.

**PC191-130 Averaging relay  $A = (E1 + E2) / 2$**

**Technical data**

Non-linearity . . . . . < 1 %

Weight . . . . . 0.5 kg



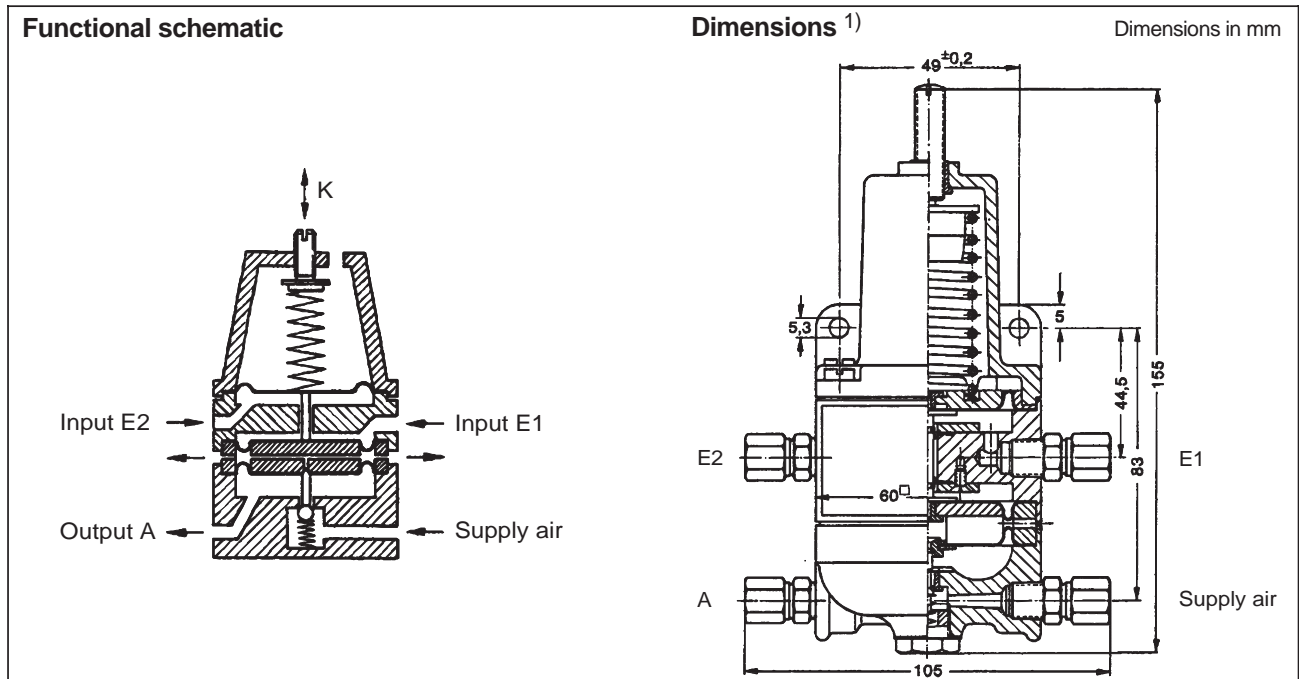
**PC191-140 Subtraction relay  $A = E1 - E2 + K$**

**Technical data**

Non-linearity . . . . . < 1 %

Bias value K . . . . . mech. continuously variable  
equivalent to 0 to 1.4 bar  
/ 0 to 15 psi / 0 to 100 kPa

Weight . . . . . 0.4 kg



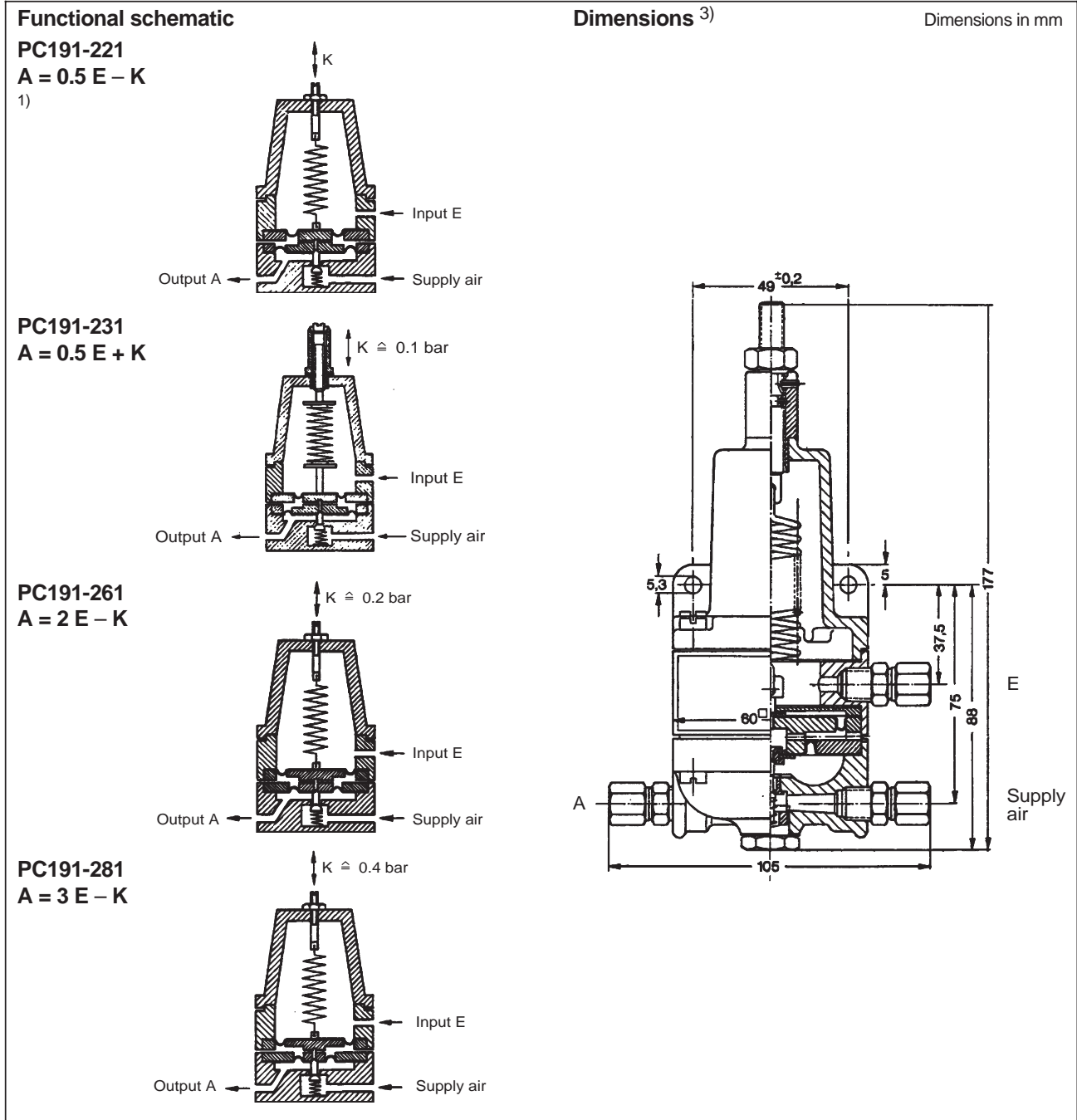
1) Dimensional drawing shows tube fittings 1/8-NPT for pipe 6 x 1. These are not supplied with the relays, the tube fittings should be ordered separately.



- PC191-221** Fixed ratio relay  $A = 0.5 E - K$  <sup>1)</sup>
- PC191-231** Fixed ratio relay  $A = 0.5 E + K$  (K = 0.1 bar) <sup>2)</sup>
- PC191-261** Fixed ratio relay  $A = 2 E - K$  (K = 0.2 bar) <sup>2)</sup>
- PC191-281** Fixed ratio relay  $A = 3 E - K$  (K = 0.4 bar) <sup>2)</sup>

**Technical data**

Output A	$V \cdot E - K$	Weight	0.4 kg
Non-linearity	< 1 %		
Bias value K	mech. continuously variable equivalent to 0 to 1.4 bar / 0 to 15 psi / 0 to 100 kPa		



1) Relay not usable over full standard signal range  
2) Basic adjustment

3) Dimensional drawing shows tube fittings 1/8-NPT for pipe 6 x 1. These are not supplied with the relays, the tube fittings should be ordered separately.

PC191-611 ... 622 see page 15

## PC191-900 Delay relay symmetrical

### Technical data

Amplification of air output

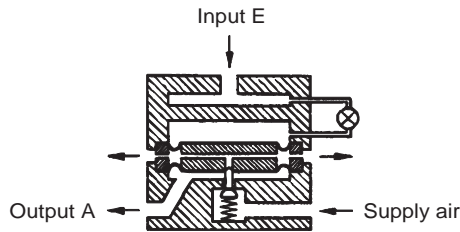
Non-linearity ..... < 1 %

Time setting

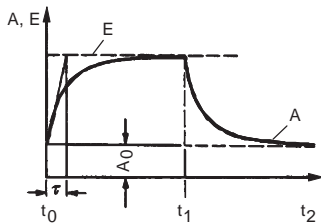
continuously variable ..... 0 to 50 min.

Weight ..... 0.5 kg

### Functional schematic



### Function diagram

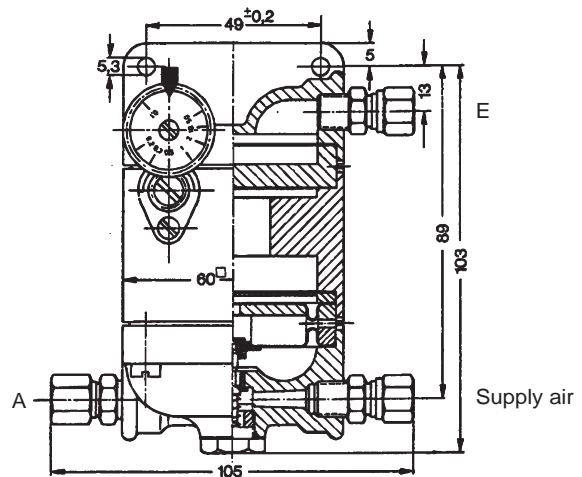


$$t_0 \rightarrow t_1 \quad A = (E - A_0) (1 - e^{-\frac{t}{\tau}}) + A_0 \quad (A_0 = 0.2 \text{ bar})$$

$$t_1 \rightarrow t_2 \quad A = (A_0 - E) e^{-\frac{t}{\tau}} + E \quad (A_0 = 1.0 \text{ bar})$$

### Dimensions <sup>1)</sup>

Dimensions in mm



A<sub>0</sub> = initial value

## PC191-901 Delay relay signal increase

### Technical data

Amplification of air output

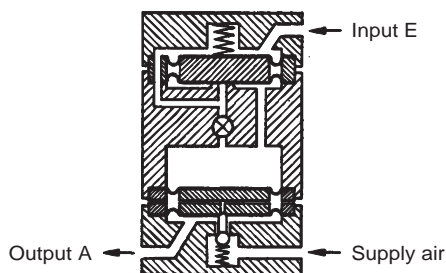
Non-linearity ..... < 1 %

Time setting

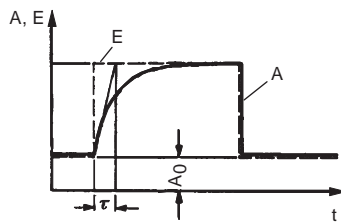
continuously variable ..... 0 to 50 min.

Weight ..... 0.5 kg

### Functional schematic



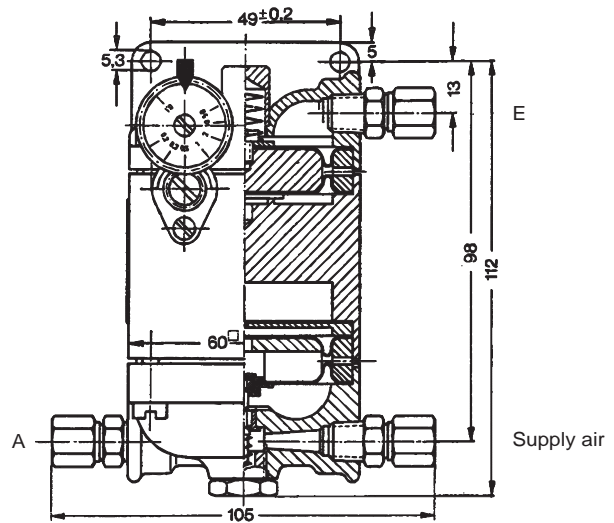
### Function diagram



$$A = (E - A_0) (1 - e^{-\frac{t}{\tau}}) + A_0 \quad A_0 = \text{initial value}$$

### Dimensions <sup>1)</sup>

Dimensions in mm



1) Dimensional drawing shows tube fittings 1/8-NPT for pipe 6 x 1. These are not supplied with the relays, the tube fittings should be ordered separately.

**PC191-902 Delay relay signal decrease**

**Technical data**

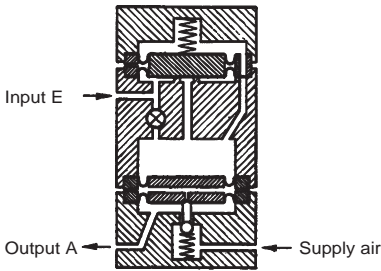
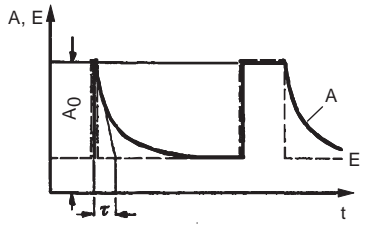
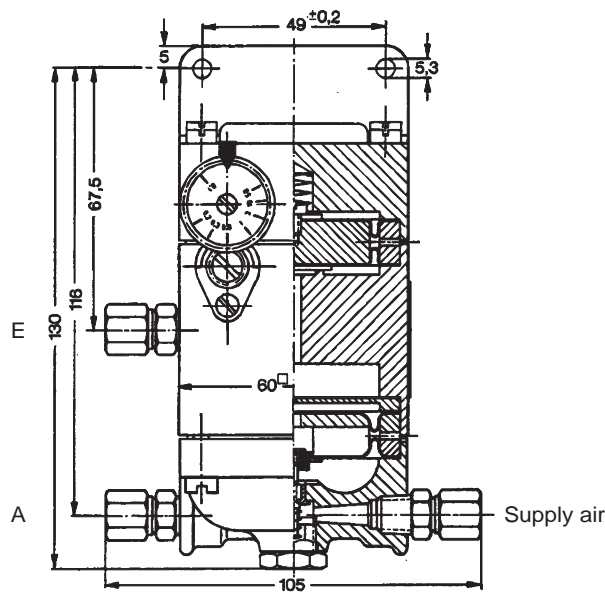
Amplification of air output

Non-linearity . . . . . < 1 %

Time setting

continuously variable . . . . . 0 to 50 min.

Weight . . . . . 0.6 kg

<p><b>Functional schematic</b></p>  <p><b>Function diagram</b></p>  <p style="text-align: center;"><math>A = (A_0 - E) e^{-\frac{t}{\tau}} + E</math>     <math>A_0 = \text{initial value}</math></p>	<p><b>Dimensions</b> <sup>1)</sup>     Dimensions in mm</p> 
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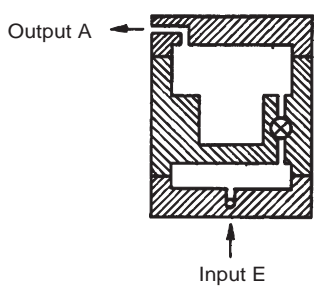
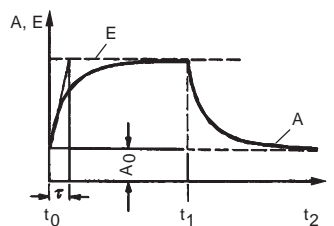
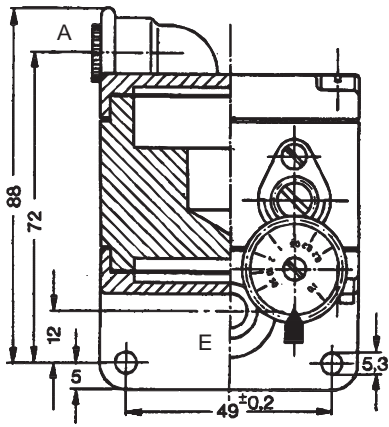
**PC191-913 Delay element (without booster)**

**Technical data**

Restriction and capacity without amplification

Time setting

continuously variable . . . . . 0.3 kg

<p><b>Functional schematic</b></p>  <p><b>Function diagram</b></p>  <p> <math>t_0 \rightarrow t_1 \quad A = (E - A_0) (1 - e^{-\frac{t}{\tau}}) + A_0 \quad (A_0 = 0.2 \text{ bar})</math>  <math>t_1 \rightarrow t_2 \quad A = (A_0 - E) e^{-\frac{t}{\tau}} + E \quad (A_0 = 1.0 \text{ bar})</math> </p> <p style="text-align: center;"><math>A_0 = \text{initial value}</math></p>	<p><b>Dimensions</b>     Dimensions in mm</p> 
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1) Dimensional drawing shows tube fittings 1/8-NPT for pipe 6 x 1. These are not supplied with the relays, the tube fittings should be ordered separately.

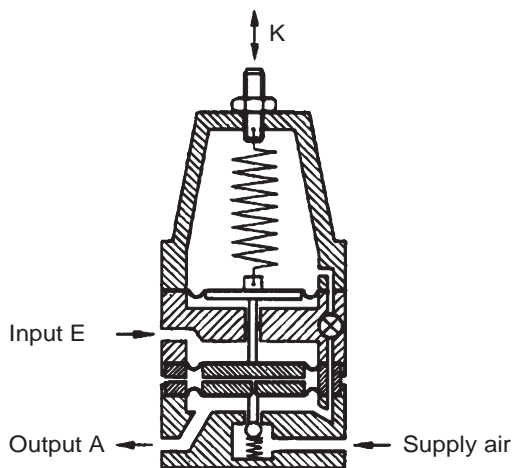
## PC191-905 PI relay

### Technical data

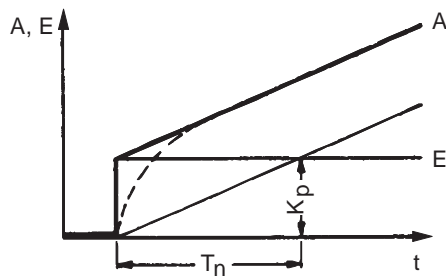
Working point K . . . . . mechanically adjustable  
 Reset time  $T_n$  . . . . . 0 to 50 min.  
 Proportional band . . . . . 100 %  
 Initial proport. band . . . . . < 1 % referred to 0.8 bar  
 Temperature effect . . . . .  $\leq 0,3 \%$ /10 K  
 Supply air dependency . . . . .  $\leq 0,1 \%$ /0.1 bar  
 Air consumption . . . . . 10 l/h

Load effect . . . . . +3 %  
 (measured at 0.6 bar) for exhausted flow 400 l/h  
 -3 % for delivered flow 400 l/h  
 Max. air output . . . . . +3 000 l/h  
 -1 800 l/h  $\Delta p = 1$  bar  
 Weight . . . . . 0.9 kg

### Functional schematic



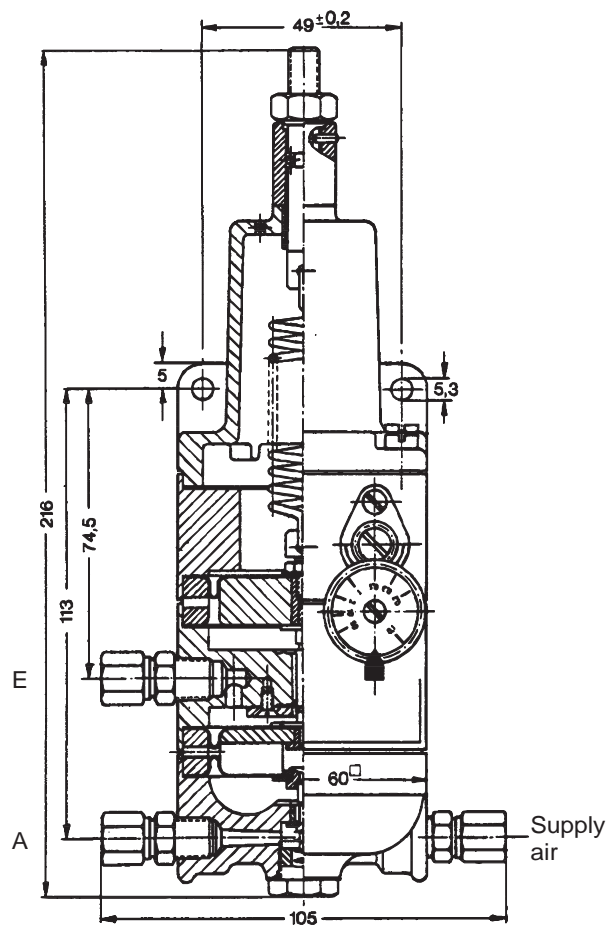
### Function diagram



$$F = \frac{A}{E} = \frac{K_p \left( 1 + \frac{1}{T_n \cdot p} \right)}{1 + \tau_p}$$

### Dimensions <sup>1)</sup>

Dimensions in mm



1) Dimensional drawing shows tube fittings 1/8-NPT for pipe 6 x 1. These are not supplied with the relays, the tube fittings should be ordered separately.

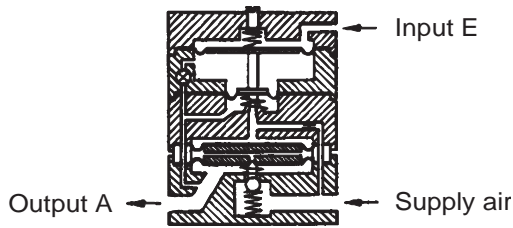
**PC191-910 PD relay**

**Technical data**

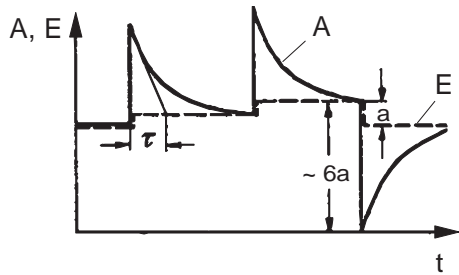
Derivative time  $T_V$  . . . . . 0 to 20 min.  
 Differential amplification  $V$  . . . ca. 6-fold  
 Proportional band . . . . . 100 %  
 Error limit . . . . .  $\leq 1$  % of final value  
 Hysteresis . . . . .  $\leq 0.3$  %  
 Temperature effect . . . . .  $\leq 0.3$  %/10 K  
 Supply air dependency . . . .  $\leq 0.2$  %/0.1 bar  
 Air consumption . . . . . 100 l/h

Load effect . . . . . +3 %  
 (measured at 0.6 bar) . . . . . for exhausted flow 700 l/h  
 . . . . . -3 %  
 . . . . . for delivered flow 700 l/h  
 Max. air output . . . . . +3 000 l/h  
 . . . . . -1 800 l/h  $\Delta p = 1$  bar  
 Weight . . . . . 0.5 kg

**Functional schematic**



**Function diagram**



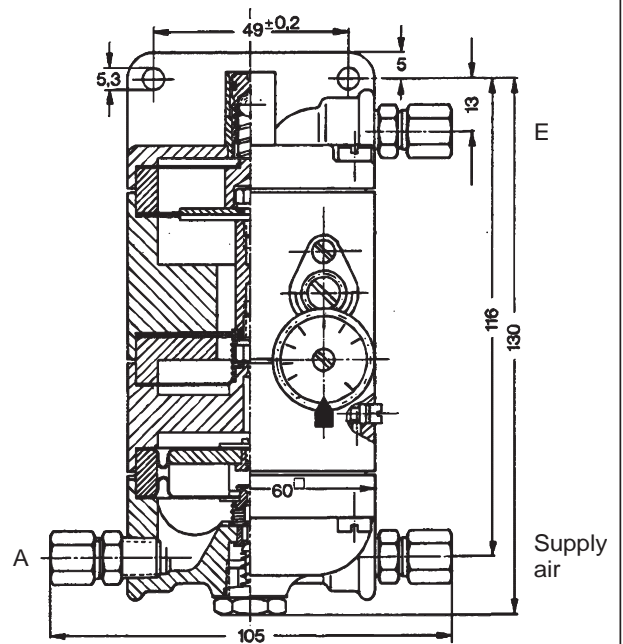
$$F = \frac{A}{E} = \frac{1 + T_V \cdot p}{1 + \frac{1}{V} \cdot T_V \cdot p}$$

$$A = E (V - 1) e^{-\frac{V \cdot t}{T_V + E}}$$

$$\tau = \frac{T_V}{V}$$

**Dimensions <sup>1)</sup>**

Dimensions in mm



1) Dimensional drawing shows tube fittings 1/8-NPT for pipe 6 x 1. These are not supplied with the relays, the tube fittings should be ordered separately.

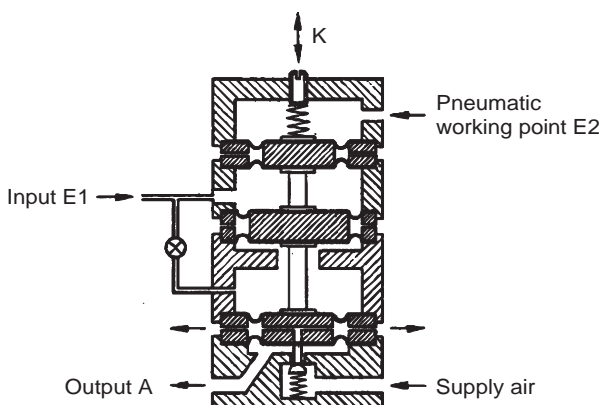
**PC191-920 Trend relay V = 2.5**

**Technical data**

Timing restrictor adjustment 0 to 20 min.  
 Amplification V . . . . . 2.5-fold  
 Error limit . . . . . ≤ 1 % of final value  
 Hysteresis . . . . . ≤ 0.3 %  
 Temperature effect . . . . . ≤ 0.5 %/10 K  
 Supply air dependency . . . . . ≤ 0.2 %/0.1 bar  
 Air consumption . . . . . 100 l/h

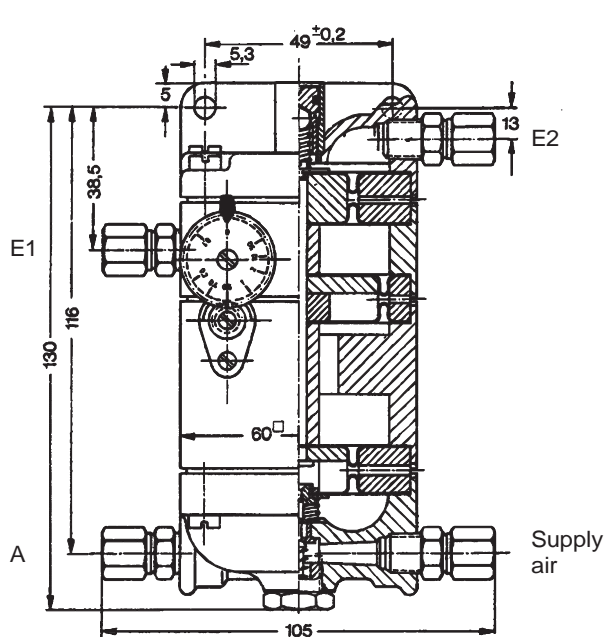
Load effect . . . . . +3 %  
 (measured at 0.6 bar) for exhausted flow 100 l/h  
 -3 %  
 for delivered flow 200 l/h  
 Max. air output . . . . . +3 000 l/h  
 -1 800 l/h Δp = 1 bar  
 Weight . . . . . 0.0 kg

**Functional schematic**

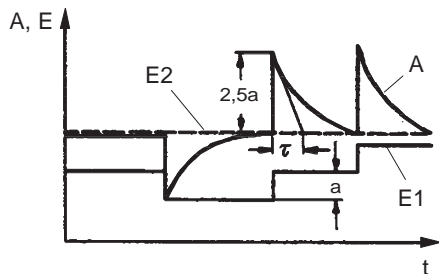


**Dimensions <sup>1)</sup>**

Dimensions in mm



**Function diagram**



$$F = \frac{A}{E} = \frac{T_V \cdot p}{1 + T_V \cdot p} \cdot V$$

$$A = V \cdot E \cdot e^{-\frac{t}{T_V}}$$

$$\tau = T_V$$

1) Dimensional drawing shows tube fittings 1/8-NPT for pipe 6 x 1. These are not supplied with the relays, the tube fittings should be ordered separately.

- PC191-611 Square root extractor  $A = \sqrt{E}$ , 0.2 - 1 bar**
- PC191-612 Square root extractor  $A = \sqrt{E}$ , 3 - 15 psi**
- PC191-621 Function generator  $A = f(E)$ , 0.2 - 1 bar**
- PC191-622 Function generator  $A = f(E)$ , 3 - 15 psi**

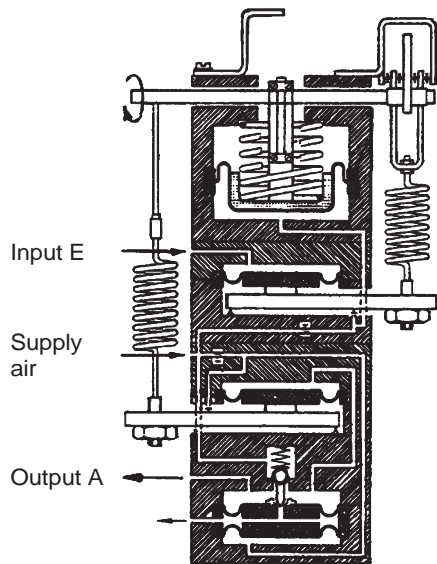
**Technical data**

Relative instrument error  
 terminal based adjustment . . . ≤ 0.5 % above 10 % output  
 Hysteresis . . . . . ≤ 0.3 % above 10 % output  
 Sensitivity . . . . . ≤ 0.4 mbar  
 Temperature effect . . . . . ≤ 0.2 % / 10 K  
 (meas. at 50 % output signal)  
 Supply air dependency . . . . . ≤ 0.15 % / 0.1 bar  
 (meas. at 50 % output signal)  
 Air consumption . . . . . 220 l/h

Load effect . . . . . + 3 %  
 (measured at 0.6 bar) for exhausted flow 600 l/h  
 -3 %  
 for delivered flow 600 l/h  
 Max. air output . . . . . ± 2 000 l/h  
 Weight . . . . . 0.4 kg

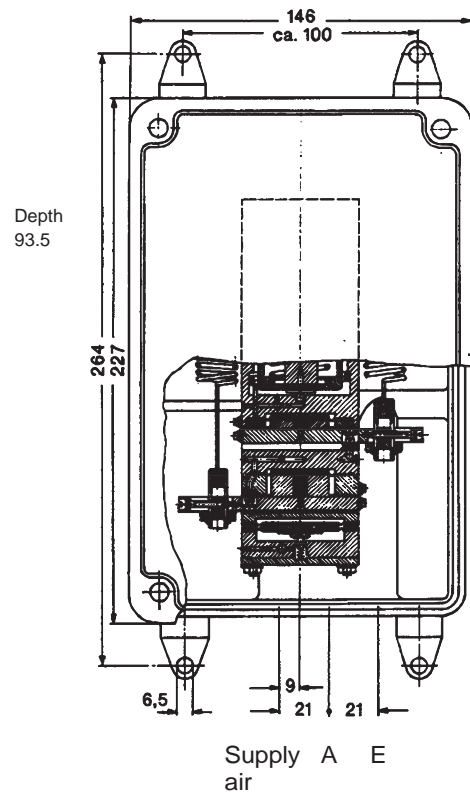
Am Ausgang ist eine Leitung von mindestens 1,5 m Länge vorzusehen.

**Functional schematic**



**Dimensions**

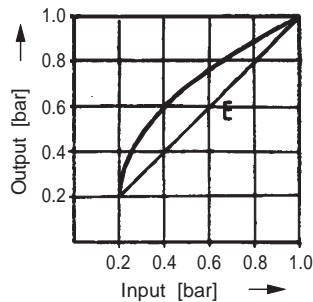
Dimensions in mm



**Function diagram**

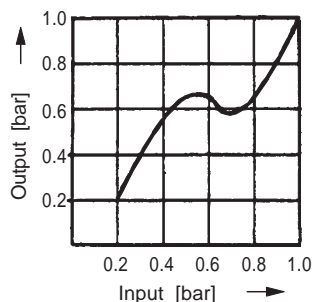
**Square root extractor**

$A = \sqrt{x} + 0.2$   
 $x = 0.8 (E - 0.2)$



**Function generator**

$A = f(x) + 0.2$   
 $x = 0.8 (E - 0.2)$



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