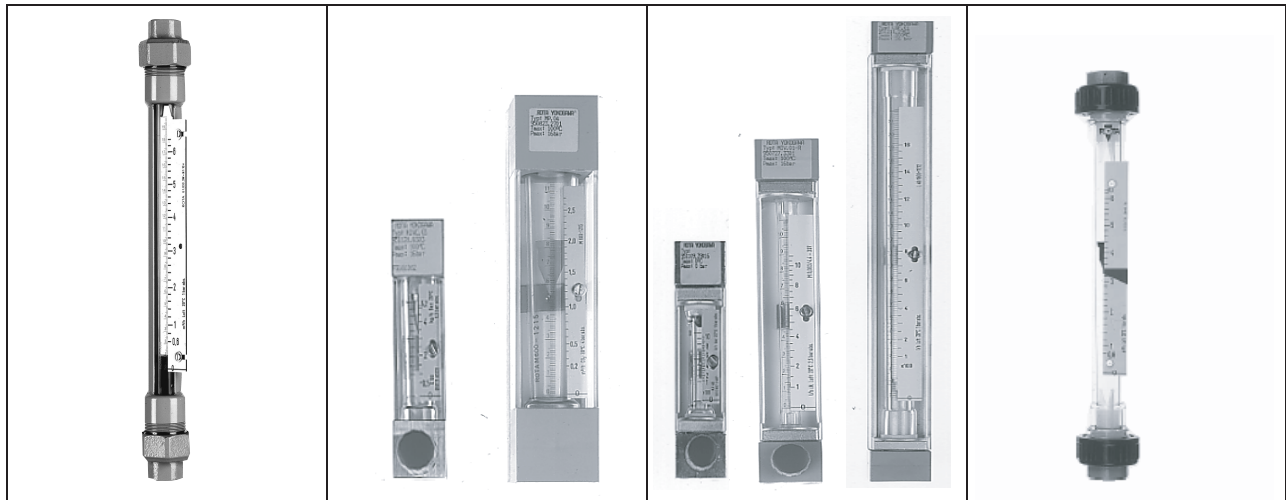




OVERVIEW ROTAMETER



Type	RAMC Metal short stroke Rotameter	RAKD Mini Rotameter	RAGG Housing Rotameter
Measurable flow rates Water (20°C)	min. 2.5 l/h max. 130 m ³ /h	0,1 l/h 250 l/h	1.6 l/h 10 m ³ /h
Air (20°C) (1bar absolute)	min. 0.075 m ³ /h max. 1400 m ³ /h	4 l/h 8 m ³ /h	25 l/h 250 m ³ /h
Tubes	Tube and process connection one unit	Tube and process connection one unit	G-tube 300 mm long
Accuracy class acc. VDE/VDI 3513 Bl. 2	1.6 2.5 with PTFE lining	4	1.6
max. Process pressure	40 bar, higher on request	160 bar without valve 100 bar with valve	depends on tube 6 - 10 bar
max. Process temperature Standard with option /MV	370 °C (with option /A2)	150°C	100°C 130°C
Process connection	Flange acc. EN 1092-1 Form B1 or acc. ASME B 16.5 Thread neck DIN 11851 Tri clamp Inner thread NPT; G	Inner thread RP Inner thread NPT Cutting ring thread Nozzle ; Flange acc. EN 1092-1 Form B1 or acc. ASME B 16.5	Flange acc. EN 1092-1 Form B1 Inner thread Rp Thread neck acc. DIN 11851-SC
Materials : Process connection	1.4404 (AISI 316L) / PTFE	1.4571 (AISI 316TI)	1.4571 (AISI 316TI) / PTFE
Fitting	Indicator housing 1.4301 (AISI 304) / Alu / PA	Indicator housing 1.4301 (AISI 304)	Steel / Plastic
Tube	1.4404 (AISI 316L) / PTFE	1.4571 (AISI 316TI)	Glass (Duran 50)
Type (valve)	without	with valve possible (installed in head)	without
Approx. installation length Process connections	250 mm with flange vertical	125 mm with inner thread vertical or horizontal	500 mm vertical
Power supply	2/3 wire; 13.5 - 30VDC und 4 wire, 115 VAC, 230 VAC	2 wire ; 13.5 - 30 VDC	without
Output signal	0-20mA; 4-20mA	4-20mA	without
Options:			
Limit switch	/K1 to /K10	/K1 to/K8	/GM1; /GM2
Pulse output	Only 4-wire type	/CP	without
Ex- type	ATEX	ATEX	ATEX
Controller	without	/R1 to /R4	without
Accessories	Transformer isolated barrier Power supply for transmitter	Transformer isolated barrier Power supply for transmitter	Transformer isolated barrier



RAGH Tube ROTAMETER	RAGK Mini-ROTAMETER	RAGL Laboratory-ROTAMETER	RAQN Plastic-ROTAMETER
0.002 l/h 10 m ³ /h	0.002 l/h 600 l/h	0.002 l/h 110 l/h	10 l/h 10 m ³ /h
0.1 l/h 210 m ³ /h	0.2 l/h 6300 l/h	0.1 l/h 3500 l/h	0.16 m ³ /h 250 m ³ /h
L- and G-tubes 300 mm long	K- and M-tubes 75 mm / 150 mm long	K-, M- and L-tubes (75, 150 und 300) mm long	Q-tubes 350 mm long
1.6	4 / 2.5	4; 2.5 und 1.6 depends on tube length	4 (2.5)
depending on tube 6-16 bar	16 bar	16 bar	10 bar
80°C 130°C	100°C 130°C	100°C 130°C	Polyamid 60°C Polysulfon 120°C
Inner thread Rp Inner thread NPT Nozzle Glue socket Flange acc. EN 1092-1 Form B1	Inner thread NPT Cutting ring thread Nozzle Swagelok- connection	Inner thread NPT Cutting ring thread Nozzle Swagelok- connection	Inner thread Rp Glue socket
1.4571 (AISI 316TI) / Steel / PVC	1.4571 (AISI 316TI) / Steel / Polypropylen	1.4571 (AISI 316TI) / Steel / Polypropylen / PTFE	Steel / PVC
1.4571 (AISI 316TI) / Steel	1.4571 (AISI 316TI) / Polypropylen	1.4580 / Polypropylen / PTFE- lining	Polyamid / Polysulfon
Glass (Duran 50)	Glass (Duran 50)	Glass (Duran 50)	Polyamid / Polysulfon
with valve possible (installed to instrument)	with valve possible (installed in head)	with valve possible (installed in head)	with valve possible (installed to instrument)
310 mm - 404 mm vertical	90 mm - 175 mm horizontal	100 mm - 325 mm horizontal	400 mm - 432 mm vertical
without	without	without	without
without	without	without	without
/GM1; /GM2	/GI1 to /GI4 + /GM1; /GM2	/GI1 to /GI4	/GM1; /GM2
without	without	without	without
ATEX	ATEX	ATEX	ATEX
without	/R1 to /R4	/R1 to /R4	without
Transformer isolated barrier Bench stand (only with hose connection)	Transformer isolated barrier Bench stand Panel installation	Transformer isolated barrier Bench stand Panel installation	Transformer isolated barrier

GENERAL

Rotameters work on the principle of VA-meters and are used to measure the flow of liquids and gases in pipes and sheathed lines.

FEATURES

- Simple measurement principle
- Uncomplicated design
- Local indicator without additional power supply
- Low maintenance
- Suitable for continuous operation
- Cost effective
- High efficiency
- High accuracy
- Precise measurement at very low flow rates
- Replaceable floats
- Visual evaluation of measured substance possible
- Minimal pressure possible

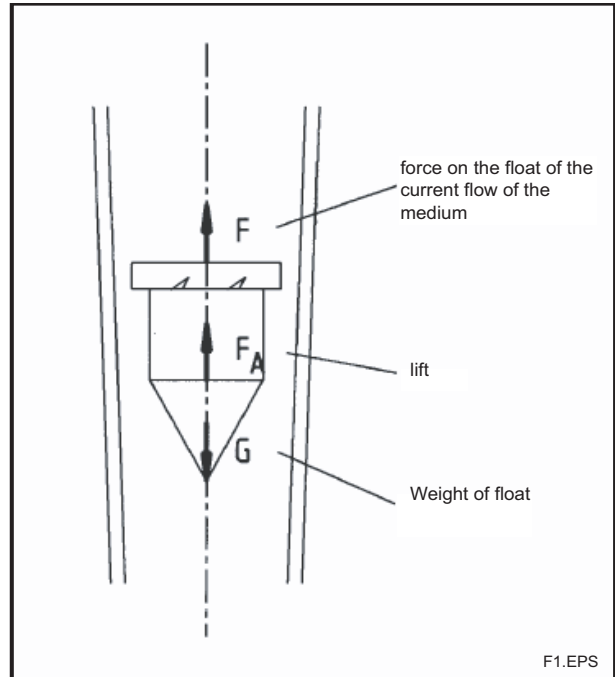
MEASUREMENT PRINCIPLE

A float is installed in a vertical tube whose diameter gradually widens towards the top. The measured substance flows vertically around the float. The float is raised according to the flow rate, leaving a certain gap between it and the tube wall. Under a constant flow rate, the position of the float stabilizes. The sum of the forces then operating on the float are zero and the flow rate can be determined from the height of the float.

Because of the prevailing physical relationships, the measurement technique is dependent on the density, viscosity and temperature of the medium. Exact results can be expected only if the characteristics of the medium remain constant. In the case of metal rotameters of type RAMC, the special shape of the float results in less dependence on viscosity at lower viscosities.

The calculation procedure for rotameters is described in VDE/VDI3513 as a factor of medium characteristics such as density, viscosity, pressure and temperature, and relative gas humidity. This standard also contains useful advice on installation conditions, maintenance, etc.

In the case of metal tubes, the height of the float is relayed by a magnet built into the float to an external auxiliary magnet. The latter is movable and is attached to a pointer which translates the height of the float directly into flow rate units. In the case of glass tubes, the flow rate at the upper edge of the float is read on the tube scale or an attached scale



Measurement principle

INFLUENCE OF TEMPERATURE ON THE FLOAT POSITION

In Instruments with glass tubes the different coefficients of thermal expansion between the glass tube and the float change the position of the float at same flow rate. Therefore the indicator must be calibrated in the following way :

$$\Delta h = \frac{(\alpha_R - \alpha_S) \cdot \Delta t \cdot H}{\sqrt{m_{Max} + 1} - \sqrt{m_{Min} + 1}}$$

$$\Delta t = t_B - t_S$$

Meaning :

t_B = new operating temperature

t_S = temperature on scale or in calculation

Δh = change of float position

(Negative Δh means that Δh must be subtracted from the indicated height of the float in order to read flow rate force accurately.)

From the flow rate label (Option /PT):

H = Length of scale from m_{Min} to m_{Max}

m_{Min} = smallest gap

m_{Max} = largest gap

α_R = expansion coefficient of the tube
(for Duran = 3.25×10^{-6})

α_S = expansion coefficient of the float

for PP = $160 \times 10^{-6} \text{ K}^{-1}$

PTFE = $120 \times 10^{-6} \text{ K}^{-1}$

PVDF = $100 \times 10^{-6} \text{ K}^{-1}$

PVC = $90 \times 10^{-6} \text{ K}^{-1}$

Aluminium = $23 \times 10^{-6} \text{ K}^{-1}$

1.4571 = $16,5 \times 10^{-6} \text{ K}^{-1}$

In instruments with metal tube (RAMC and RAKD) the tube and the float are made of the same material. Therefore no correction is necessary.

GLASS TUBES

Additional to the local indication of flow rate glass tubes allow a visual assessment of the process medium.

M-, L- and G- tubes have a mm-scale per default. With that each instrument can be recalculated to different operating conditions by the optional flow table with calculation documents (/PT).

If an additional scale is not wanted a recalculation to different operating conditions is not possible and in model code the option /MM must be selected.

K-tubes have a direct scale or a 1- 10 scale and are marked with a factor for the process medium.

The general measuring range dynamics (ratio of end to starting value of the measurement range) is 10 : 1 for K- and G- tubes and 20 : 1 for M- and L- tubes.

According to the installation conditions different tubes with the following lengths and accuracy classes are used.

Glass tube	Length	Accuracy class acc. VDI/VDE 3513
K-Tube	75 mm	4 (for sphere 6)
M-Tube	150 mm	2.5 (better on request)
L-Tube	300 mm	1.6 (better on request)
G-Tube	300 mm	1.6 (better on request)

T1.EPS

To avoid of electrostatic charging at gas measurement which move the float to the tube wall the L-tubes are antistatic.

The pressure resistance of the glass tubes depends on the diameter and determines the maximum pressure.

Tube	K6; M6; L6; K7; M7; L7	G0; G1	G2	G4
P _{max} [bar]	16	10	8	6

T2.EPS

METAL TUBES

The cone of metal RAMC tubes are forged or, with larger sizes, mechanically turned. The process connections are welded firmly attached to the tube, therefore there is no difference between tube and housing.

Additional to the flow scale the RAMC has a mm-scale. Therefore the scale can be recalculated to different operating conditions by the sizing software „Durep_u”

In the case of RAKD tubes, the float is cone-shaped or an orifice is incorporated in the tube.

Model	Accuracy class acc. VDI/VDE 3513
RAMC without lining	1.6 (better on request)
RAMC with PTFE- lining	2.5 (better on request)
RAKD	4 (better on request)

T3.EPS

FLOATS

Floats of different materials and shapes are used depending on corrosion-resistance requirements and other installation conditions.

Spherical floats are used for straightforward measurement of low flow rates in liquids and gases.

Wedge-shaped floats with sloping notches are used for greater accuracy. The notch causes the float to rotate and thereby eliminates friction.

The number of notches varies for gases and liquids in order to guarantee even rotation.

Low-density floats are used with gases in order to avoid compressive oscillation. Units with valves should also be used under these conditions or, if no valve design exists, a valve should be installed at the inlet (or, if the input pressure is constant, at the outlet) of the flowmeter.

Metal floats do not rotate freely in the tube but are driven. Their special design ensures, however, that their height matches the flow rate without hysteresis.

To avoid compressive oscillation in RAMC with gases the float can be equipped with a damping (also available as retrofit kit).

SCALES

After the tubes have been calibrated, the scales are matched to the usage conditions specified by the user.

The scale is applied directly to the tube in the case of glass tubes, or an external scale is provided.

In the case of metal tubes, the scale is contained in a housing which protects the magnetic follower system from environmental influences.

Any unit which has a tube calibrated in mm can be ordered with an Option /PT flow rate table from which flow rates can be read and other operating conditions calculated. This design is best suited to changing operating conditions.

The scale or flow rate table can be designed to be referenced to a standard reference (eg, standard 0 °C and 1.013 bars) for volume or mass flow rate and, in the case of gases, for volumetric flow rate.

Note

If the operating data change (density and/or viscosity), a new scale or flow rate table must be calculated.

MAINTENANCE

Glass tubes can be checked visually to see if the float has become dirty or damaged. If it has, the tube is demounted and cleaned. If sign of tear is present, the tube and float should be replaced.

Ferrometallic materials are to be avoided in the medium with magnetic floats (instruments with limit switches or with metal tube) because they could attach themselves to the float. If Rotameter with metal tubes are contaminated, the instrument should be disassembled and cleaned. If the float is damaged, it should be replaced or the instrument should be sent to ROTA YOKOGAWA. for servicing

LIMIT SWITCHES

All Rotameters with metal tube are available with limit switches. In Rotameters with glass- or plastic-tubes special floats (with magnet or from ferromagnetic material) must be used.

Tube	Option	Principle
K; M; L	GI1 – GI4	Inductive ring sensor
G; M3	GM1; GM2	Reed contact
RAMC RAKD	K1 – K10 K1 – K8	Inductive slot sensor

T4.EPS



F2.EPS

Limit switch with inductive ring sensor

TECHNICAL DATA OF OPTIONS

Limit switch : (Option /GI1 to /GI4)

(For floats of Mumetall or PVDF with Fe-core only and $Q_{min} > 0.004$ l/h water or 0.3 l/h air)

Type : Bistable inductive ringsensor
Power supply : 4.5 V to 15 V DC
Consumption : acc. DIN EN 60947-5-6 (NAMUR)
 For float below ring sensor : < 1mA
 above ring sensor : > 2.2 mA
Temperature range : -25°C bis +70°C not Ex-type
Protection : IP 67
Electrical connection : 2 x 0.14 mm²,
 with shield 0.4 mm², 2 m long

Limit switch : (Option /GM1 and /GM2)

(For metering tube M3 and floats with magnet only)

Type : reed contact with bistable switching
Max. switching voltage : 230 V
Max. switching current : 0.6 A
Max. switching capacity : 12 VA or 12 W
Temperature range : -10 °C to +70 °C
Protection : IP 65
Internal capacity : 0 nF
Internal inductivity : 0 mH
Electrical connection : LIYY 2 x 0.34mm²; 1 m long
Housing : Polystyrol
Weight : 35 g

Power supply for limit switch : (Option: /W xx)

Each limit switch needs an own supply.

Type : Transformer isolated barrier
 acc. DIN 19234 (NAMUR)

Power supply : 230V AC (/W2_)
 24V DC (/W4_)

Switching capacity : max. 250 V AC; max. 4A
 or max. 500 VA

Relay output : 1 or 2 potential free changeover contacts

Explosion proof : Intrinsic safe [Ex ia] II C

Controller (Option: /R1 to R4)

(not for tube M3)

Differential pressure controller for a constant flow during fluctuations of back pressure.

These are no pressure limiting valves.

The controller /R1 and /R2 for liquids with variable inlet or outlet pressure and for gases with variable inlet pressure and constant back pressure.

The controller /R3 and /R4 for gases with fluctuations of the back pressure.

Max. liquid flow : 100 l/h

Max. gas flow : 3000 l/h

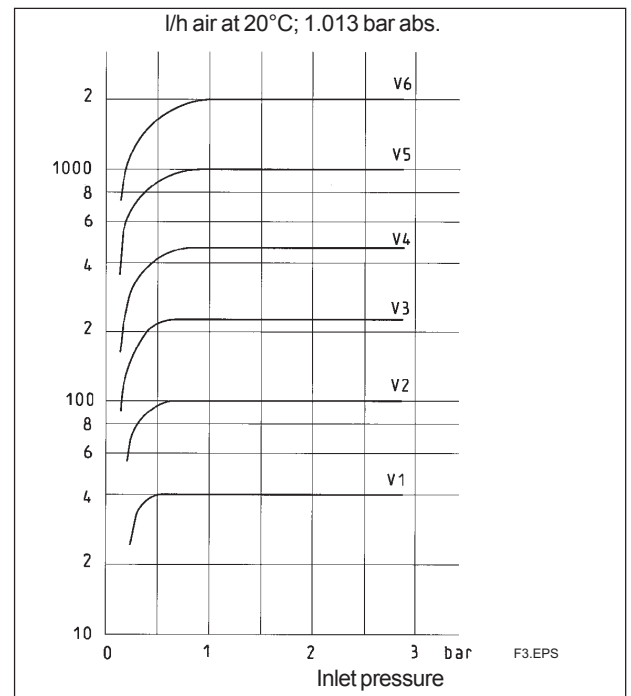
Max. pressure : 40 bar

Recommended differential pressure : > 400 mbar

Materials

Housing	Membrane	Springs
CrNi-Steel	PTFE	CrNi-Steel
Brass	Buna	CrNi-Steel

T5.EPS



F3.EPS

Diagram controller characteristic

The curves V1 to V6 show how the flow depends on the inlet pressure for different valve settings. The back pressure at the outlet (ambient pressure) is 1bar.

MEASURING ACCURACY

The accuracy of Rotameters are defined in VDE/VDI 3513 page 2 for different accuracy classes.

The following table gives the permissible overall error for measured values and final values in percent as a factor of the flow rate for various accuracy classes.

Accuracy class	1		1.6		2.5		4		6	
	Meas val.	End val.	Meas val.	End val.	Meas val.	End val.	Meas val.	End val.	Meas val.	End val.
% of flow rate										
100	1.000	1.000	1.600	1.600	2.500	2.500	4.000	4.000	6.000	6.000
90	1.028	0.925	1.644	1.480	2.569	2.313	4.111	3.700	6.167	5.550
80	1.063	0.850	1.700	1.360	2.656	2.125	4.250	3.400	6.375	5.100
70	1.107	0.775	1.771	1.240	2.768	1.938	4.429	3.100	6.643	4.650
60	1.167	0.700	1.867	1.120	2.917	1.750	4.667	2.800	7.000	4.200
50	1.250	0.625	2.000	1.000	3.125	1.563	5.000	2.500	7.500	3.750
40	1.375	0.550	2.200	0.880	3.438	1.375	5.500	2.200	8.250	3.300
30	1.583	0.475	2.533	0.760	3.958	1.188	6.333	1.900	9.500	2.850
20	2.000	0.400	3.200	0.640	5.000	1.000	8.000	1.600	12.000	2.400
10	3.250	0.325	5.200	0.520	8.125	0.813	13.000	1.300	19.500	1.950

T6.EPS

STANDARD CALIBRATION

The calibration of standard tubes is carried out by comparing the number of test samples with the results of other high-precision flow (master units).

The accuracy of the master tubes is better than 0.5%.

PRECISION CALIBRATION

A weighing system is used as standard for recalibrating the master units and for all other calibrations where a high degree of accuracy is required. Here, accuracies of 0.1% are achieved.

CUSTOMER SPECIFIC TUBES

Aside from the standard tubes in our units, we also offer a large number of customer-specific tubes for installation by customers in their own housings or instrumentation.

GLASS TUBES FOR CHLORINE GAS METERING

Water for domestic use is disinfected with chlorine gas in many parts of the world.

Glass tubes for chlorine gas 20°C; 0.95 bar abs.

Float	: glass sphere
Connections	: FE
Tube length	: 71mm
Outer diameter	: 13mm
Seal	: rear or external
Metering range	: 13 ranges from 1 – 10 g/h to 200 – 4000 g/h

GLASS TUBE FOR MEDICAL AIR, NITROUS OXIDE AND OXYGEN METERING

Oxygen and nitrous oxide, especially, are metered for medical purposes. The tubes have a gold rim inside and outside to prevent static loadings.

Float	: anodized aluminium
Rube length	: 228.9 mm (9 inch)
Inner diameter	: 11.2mm
Outer diameter	: 15.1mm
Conditions	: 20°C; 1 bar abs.
Metering range	
Air	: 0.2 – 15 l/min
Oxygen	: 6 ranges 0.1 – 15 l/min
Nitrous oxid	: 0.1 – 15 l/min

Calibration center of the GERMAN CALIBRATION SERVICE - DKD-for the measurement of flow rate at ROTA YOKOGAWA, registration number 3901

The possible values for mass flow rates and volume flow rates of fluids range from 0.007 kg/min to 5000 kg/min for iterative method and 0.33 kg/min to 15000 kg/min for comparing counter.

The calibration center provides standards for mass, volume, density and time tested by the Physikalisch-Technische Bundesanstalt (PTB). The calibration center is monitored by the PTB. Flowmeters from other manufacturers can be calibrated at the calibration center.

PLASTIC TUBES FOR OXIGENE AND AIR METERING

In both the medical and welding professions gases are metered manually and measured using small plastic rotameters.

Float	: sphere, glass or stainless steel
Tube	: PA or PS
Tube length	: 115mm
Outer diameter	: 13mm
Conditions	: 20°C; 1 bar abs.
Metering range	: 20 ranges 20 – 2200 l/h

GLASS TUBES WITH METAL FLANGE

These days, small production plants are made from glass for especially high quality products. Glass rotameters are particularly suited for flow measurement in these cases because no metal ions are introduced into the product.

Float	: PTFE
Installation length	: 350mm
Process connection	: spherical flange
Tube	: Duran Glas
Metring range	
Water	: 0.002 l/h – 16 m ³ /h
Air	: 0.1 l/h – 400 m ³ /h
Limit switch	: /GM1; /GM2

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