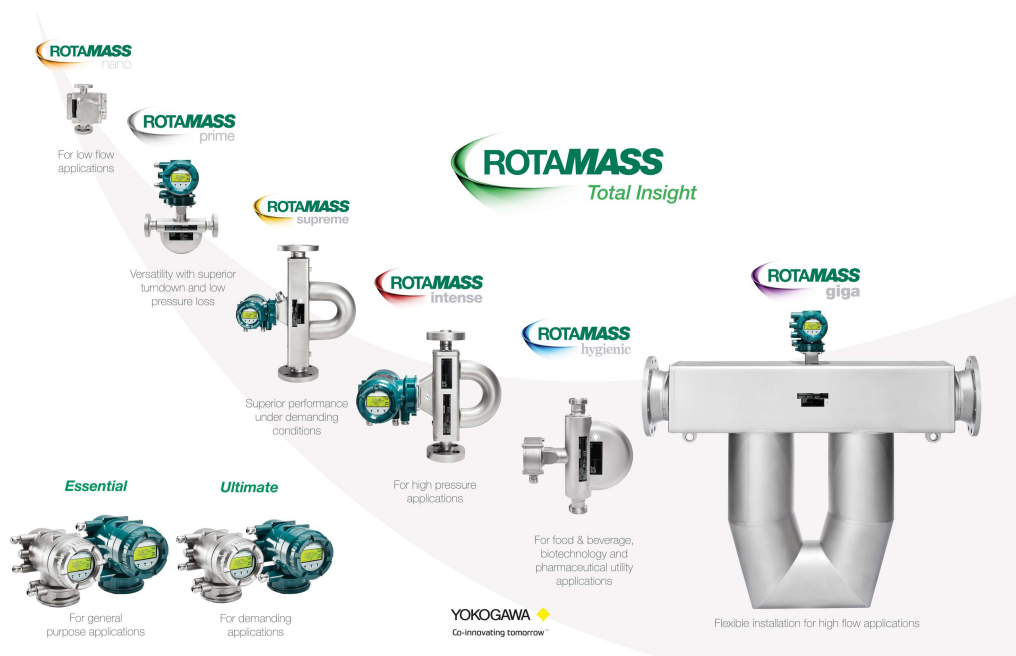


General Specifications

ROTAMASS Total Insight Coriolis Mass Flow and Density Meter Specification Overview



GS 01U10B00-00EN-R



Rotamass TI - Total Insight throughout the entire product lifecycle

- Wide Rotamass sensor range for precise mass flow, density, volume flow measurements over wide flow range of liquids and gases, including multi-phase fluids or liquids with gas content or slurries
- In-line concentration (solutions or emulsions) measurements, Net Oil Computing function, viscosity function, batching function, dynamic pressure compensation input and gas density measurement, with Rotamass Ultimate transmitter
- From low flow (1 kg/h - 1/4 inch) Rotamass Nano to high flow (1100 t/h - 10 inch) Rotamass Giga applications
- Superior turndown & low pressure loss with Rotamass Prime, Rotamass Hygienic for sanitary applications
- Superior performance with Rotamass Supreme for demanding applications from -196 °C for cryogenic fluids to very high temperatures +350 °C, combined with customer or factory-fitted, sensor insulation and heat tracing to serve high temperature, viscous or molten fluids
- For high pressure applications up to 10.000 psi (700 bar) with Rotamass Intense
- Optimum decoupling of core measuring tubes from any external influences & stresses by proven in use design
- In compliance with Namur NE95 and SIL functional safety requirements IEC 61508:2010



- Meter Performance under wide process conditions
- Meter Verification in line by Tube Health Check function

Some specifications are not sold in all regions. Please ask your sales representative for details.

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1 Introduction

This specification provides overview about Rotamass Total Insight portfolio. Complete specification is available per product line.

1.1 About this General Specification

All available properties of the Rotamass Total Insight Coriolis Mass Flow and Density Meter are specified by means of a model code.

One model code position may include several characters depicted by means of dashed lines.

The positions of the model code relevant for the respective properties are depicted and highlighted in blue. Please refer to further applicable documents for detailed specification per product line. Any values that might occupy these model code positions are subsequently explained.

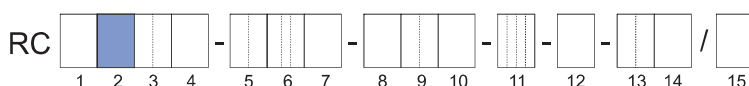


Fig. 1: Highlighted model code positions

1.2 Further applicable documents

The following documents supplement this specification:

Document title	Document number
General Specifications:	
▪ General Specifications Rotamass Nano	GS01U10B01-00__-R ¹⁾
▪ General Specifications Rotamass Intense	GS01U10B05-00__-R ¹⁾
▪ General Specifications Rotamass Prime	GS01U10B04-00__-R ¹⁾
▪ General Specifications Rotamass Hygienic	GS01U10B06-00__-R ¹⁾
▪ General Specifications Rotamass Supreme	GS01U10B02-00__-R ¹⁾
▪ General Specifications Rotamass Giga	GS01U10B03-00__-R ¹⁾
▪ General Specifications Rotamass Spare Transmitter	GS01U10B21-00__-R ¹⁾

¹⁾ The "_" symbols are placeholder for the corresponding language version of the document (EN, DE, etc.).



The complete product documentation is stored on the microSD card delivered with the device and is available at:

- Yokogawa Customer Portal (<http://myportal.yokogawa.com/s/documents>)
- Yokogawa Device Lifecycle Management app

Please enter the serial number of the device or scan the QR code on the device.

1.3 Measuring principle

The measuring principle is based on the generation of Coriolis forces. For this purpose, two measuring tubes are excited in their first resonance frequency. Both pipes vibrate inversely phased, similar to a vibration fork.

Mass flow

The fluid flow through the vibrating measuring tubes deflects the tubes direction additionally and leads to phase shift between in- and outlet tube section. Detected overlying phase shift is directly proportional to the mass flow, which is calculated in the transmitter.

Density measurement

Measuring tubes are operated in their resonance frequency f , a function of tube geometry, material properties tube and fluid mass. At given tubes volume altering mass results in altering resonance frequency and density can be calculated in the transmitter.

Temperature measurement

The measuring tube temperature is measured with dedicated temperature sensor inside the measuring system which is approximately equal to the fluid temperature. Provided as additional measurement value it is also used to compensate flow meter temperature dependencies.

1.4 Product overview

Rotamass Total Insight Coriolis mass flow and density meters are available in various product families distinguished by their applications. Each product family includes several product alternatives and additional device options that can be selected.

Rotamass Nano 	For low flow rate applications ▪ Flat specification from 2.5 kg/h (0.1 lb/min) ▪ Repeatable mass flow measurement under high aeration conditions ▪ Batching function for precise dosing tasks
Rotamass Intense 	For high pressure applications ▪ For high pressure applications with process pressures up to 700 barg (10.000 psig) ▪ Capability to handle process fluid temperatures up to 350 °C (+662 °F) ▪ Ability to handle gas with Gas Void Fraction from 0-100 % ▪ Dynamic Pressure compensation for accurate measurement
Rotamass Prime 	Superior turndown and low pressure loss ▪ Excellent turndown for flat mass flow accuracy over a wide flow range ▪ Low pressure loss design ▪ Short face-to-face length and customized installation length options ▪ Viscosity function and capability to handle high viscous process fluids
Rotamass Hygienic 	For food and beverage, biotechnology and pharmaceutical utility applications ▪ Hygienic design and various sanitary approvals and compliances ▪ Batching function for precise dosing tasks ▪ Advanced concentration measurement options ▪ Viscosity function and capability to handle high viscous process fluids
Rotamass Supreme 	Superior performance under demanding conditions ▪ Robust sensor construction and box-in-box design ▪ Usage for low temperatures -196 °C (-321 °F) or high temperatures +350 °C (+662 °F) ▪ Gas Void Fraction and Net Oil Computing functions ▪ Factory-fitted insulation and heat tracing
Rotamass Giga 	Flexible installation for high flow applications ▪ Multivariable measurements with flow rates up to 1100 t/h (40000 lb/min) ▪ High power management for optimal gas content detection ▪ Capability to handle process fluid temperatures up to 350 °C (+662 °F) ▪ From DN100 (4") to DN250 mm (10"), up to PN100 (600 lbs)

2 Specification overview

2.1 Measuring ranges

Product family	Mass flow range		Density range for fluids in kg/l (lb/ft ³)
	Q _{nom} in t/h (lb/min)	Q _{max} in t/h (lb/min)	
Nano	0.021 – 0.95 (0.77 – 35)	1.5 (55)	0 – 5 (0 – 312)
Intense	0.045 – 32 (1.7 – 1200)	50 (1800)	0 – 5 (0 – 312)
Prime	1.6 – 170 (59 – 6200)	255 (9400)	0 – 5 (0 – 312)
Hygienic	1.6 – 51 (59 – 1900)	76 (2800)	0 – 5 (0 – 312)
Supreme	3 – 100 (110 – 3700)	170 (6200)	0 – 5 (0 – 312)
Giga	250 – 900 (9200 – 33000)	1100 (40400)	0 – 2 (0 – 125)

2.2 Accuracy

Best supported accuracy per product family; depending on further model code

Product family	Mass flow liquids in %	Density liquids in g/l (lb/ft ³)	Mass flow gas in %	Temperature in °C (°F)
Nano	+/-0.1	+/-0.5 (0 – 0.03)	+/-0.50	+/-0.5 (33)
Intense	+/-0.1	+/-0.5 (0 – 0.03)	+/-0.50 ¹⁾	+/-0.5 (33)
Prime	+/-0.1	+/-0.5 (0 – 0.03)	+/-0.35	+/-1.0 (34)
Hygienic	+/-0.1	+/-0.5 (0 – 0.03)	+/-0.35	+/-1.0 (34)
Supreme	+/-0.1	+/-0.5 (0 – 0.03)	+/-0.35	+/-0.5 (33)
Giga	+/-0.1	+/-2.0 (0 – 0.13)	+/-0.35	+/-0.5 (33)

¹⁾ available on demand

2.3 Process conditions

Product family	Process fluid temperature ranges in °C (°F)				Process pressure in barg (psi) up to
	Low	Standard	Medium	High	
Nano	-	-50 – 150 (-58 – 302)	-50 – 260 (-58 – 500)	-	285 (4134) / 460 (6672) ¹⁾
Intense	-	-70 – 150 (-94 – 302)	-70 – 230 (-94 – 446)	0 – 350 (32 – 662)	260 (3771)
Prime	-	-70 – 200 (-94 – 392)	-	-	100 (1450)
Hygienic	-	-70 – 140 (-94 – 284)	-	-	40 (580)
Supreme	-196 – 150 (-321 – 302)	-70 – 150 (-94 – 302)	-70 – 230 (-94 – 446)	0 – 350 (32 – 662)	100 (1450)
Giga	-	-70 – 150 (-94 – 302)	-70 – 230 (-94 – 446)	0 – 350 (32 – 662)	100 (1450)

- not supported

¹⁾ available on demand

2.4 Sensor design and material

Product family	Nominal line sizes	
	in mm	in inch
Nano	DN15 – DN40	¼ - 1 ½
Intense	-	3/8 – 2
Prime	DN15 – DN125	3/8 – 5
Hygienic	DN25 – DN80	1 – 3
Supreme	DN15 – DN125	3/8 – 5
Giga	DN100 – DN250	4 – 10

- not supported

Product family	Material of wetted parts			Sensor design options		
	316L	HC	316L + HC	Rupture Disc	Insulation & Heat Tracing	Customized installation length
Nano	-	-	●	1)	●	●
Intense	●	●	-	●	-	-
Prime	●	-	-	-	-	●
Hygienic	●	-	-	-	-	-
Supreme	●	●	-	●	●	●
Giga	●	●	-	●	●	●

1) available on demand

● Supported / - not supported

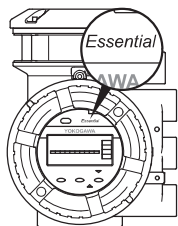
Product family	Flange process connections				Threaded process connections				Clamp process connections	
	EN	ASME	JPI	JIS	G	NPT	DIN 11851	SMS 1145	DIN 32676	JIS/ ISO 2852
Nano	●	●	●	●	●	●	●	-	-	-
Intense	-	-	●	-	-	●	●	-	-	-
Prime	●	●	●	●	●	●	●	-	-	-
Hygienic	-	-	-	-	-	-	-	●	●	●
Supreme	●	●	●	●	●	●	●	-	●	●
Giga	●	●	●	-	●	-	-	-	-	-

● Supported / - not supported

2.5 Transmitter

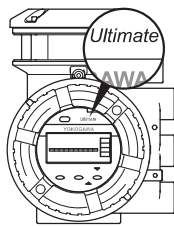
Essential Transmitter

For general purpose application



Ultimate Transmitter

For demanding and critical application



Transmitter type	Advanced functions & FOD ¹⁾	Total Health Check ²⁾	Dynamic Pressure Compensation	Wizard for easy setup	Event Management acc. NAMUR NE107
Essential	-	•	-	•	•
Ultimate	•	•	•	•	•

¹⁾ for details see chapter *Advanced functions and Features on Demand (FOD)* [► 9].

²⁾ Function is based on external software (FieldMate).

Transmitter type	Universal Power Supply (VDC and VAC)	Housing material		MicroSD card	Display 4 line dot matrix
		Aluminum	Stainless steel		
Essential	•	•	•	•	•
Ultimate	•	•	•	•	•

Transmitter type	Inputs		Outputs	
	Analog	Status	Analog	Pulse/frequency
Essential	-	•	•	•
Ultimate	•	•	•	•

Transmitter type	Communication			
	HART	Modbus	Profibus PA	FOUNDATION Fieldbus
Essential	•	•	-	-
Ultimate	•	•	•	•

• Supported / - not supported

3 Advanced functions and Features on Demand (FOD)

3.1 Overview

Rotamass Total Insight includes many dedicated application and maintenance functions that can be ordered simultaneously with the device or can be purchased and activated in a second time (Features on Demand).

	Transmitter		Communication type and I/O				
Functional scope	Essential	Ultimate	Available type				Mandatory I/O
			HART	Modbus	PROFIBUS PA	FOUNDA-TION Fieldbus	
Model code (pos.1 and pos.13)	E	U	J_	M_	G_	F_	
Standard concentration measurement	–	•	•	•	•	•	Not applicable
Advanced concentration measurement	–	•	•	•	•	•	
Net Oil Computing following API standard	–	•	•	•	•	•	
Tube Health Check	•	•	•	•	•	•	
Batching function	–	•	•	–	–	–	1 status output for one-stage batching 2 status outputs for two-stage batching
Viscosity function	–	•	•	–	•	•	1 analog input for J_
Measurement of heat quantity	–	•	•	•	•	•	1 analog input for J_ and M_

meaning of "–": not available;

meaning of "•": available

Functional scope	Advanced functions per product					
	Giga	Nano	Intense	Supreme	Prime	Hygienic
Standard concentration measurement	•	•	•	•	•	•
Advanced concentration measurement	•	•	•	•	•	•
Net Oil Computing following API standard	•	•	•	•	•	—
Tube Health Check	•	•	•	•	•	•
Batching function	•	•	•	•	•	•
Viscosity function	•	•	•	•	•	•
Measurement of heat quantity	•	•	•	•	•	•

meaning of "—": not available;
meaning of "•": available

3.2 Concentration and petroleum measurement

Standard concentration measurement

The standard concentration measurement (option CST) can be used for concentration measurements of emulsions or suspensions when density of the fluid involved depends only on temperature.

The standard concentration measurement can also be used for many low-concentration solutions if there is only minor interaction between the liquids or if the miscibility is negligible. For questions regarding a specific application, contact the responsible Yokogawa sales organization. The appropriate density coefficients must be determined prior to using this option and input into the transmitter. To do so, the recommendation is to determine the necessary parameters from density data using DTM in the Yokogawa FieldMate program or the calculation tool included in the delivery.

Petroleum measurement function NOC (option C52)

"NOC" is an abbreviation for the "Net Oil Computing" function that provides real-time measurements of water cut and includes "API" (American Petroleum Institute) correction according to API MPMS Chapter 11.1.

Oil sometimes contains entrained gas. Rotamass Total Insight measures the density of the emulsion oil and gas which is lower than the oil density. If the measured density is used to calculate volume flow of oil, the result would not be correct. Therefore NOC function (option C52) includes also a Gas Void Fraction function (GVF). GVF may reduce the error in oil volume flow calculation at a minimum recognizing the occurrence of gas in the oil and using the oil density to calculate the volume flow.

Oil properties can be selected using Oil type's pre-settings or using "Alpha 60".

Oil and water types predefined in the functions	
Oil types	Water types
▪ Crude ▪ Refined Products: Fuel, Jet Fuel, Transition, Gasoline ▪ Lubricating ▪ Custom Oil	▪ Standard Mean Ocean Water ▪ UNESCO 1980 ▪ Fresh water density by API MPMS 11.4 ▪ Produced water density by API MPMS 20.1 Appendix A.1 ▪ Brine water density by El-Dessouky, Ettouy (2002) ▪ Custom

In addition to water cut, the function can calculate: Net oil mass flow, net water mass flow, net oil volume flow, net water volume flow and net corrected oil volume flow.

Advanced concentration measurement

The advanced concentration measurement (option AC_) is recommended for more complex applications, such as for liquids that interact.

Following is a table that lists possible pre-configured concentrations. The desired data sets must be requested by the customer to the Yokogawa sales organization at the time the order is placed. The customer is responsible to ensure chemical compatibility of the material of the wetted parts with the measured chemicals. For strong acids or oxidizers which attack steel pipes, a variant with wetted parts made of Ni alloy C-22/2.4602 is necessary.

Set	Fluid A / B	Concentration range	Unit	Temperature range in °C	Density range in kg/l	Data source for density data
C01	Sugar / Water	0 – 85	°Bx	0 – 80	0.97 – 1.45	PTB... Messages 100 5/90: "The density of watery sucrose solutions after the introduction of the international temperature scale of 1990 (ITS1990)" Table 5
C02 ¹⁾	NaOH / Water	0 – 54	WT%	0 – 100	0.95 – 1.58	D'Ans-Lax, Handbook for chemists and physicists Vol.1, 3rd edition, 1967
C03	KOH / Water	1 – 55	WT%	54 – 100	1.01 – 1.58	D'Ans-Lax, Handbook for chemists and physicists Vol.1, 3rd edition, 1967
C04	NH ₄ NO ₃ / Water	1 – 50	WT%	0 – 80	0.97 – 1.24	Table of density data on request
C05	NH ₄ NO ₃ / Water	20 – 70	WT%	20 – 100	1.04 – 1.33	Table of density data on request
C06 ¹⁾	HCl / Water	22 – 34	WT%	20 – 60	1.08 – 1.17	D'Ans-Lax, Handbook for chemists and physicists Vol.1, 3rd edition, 1967
C07	HNO ₃ / Water	50 – 67	WT%	10 – 60	1.26 – 1.40	Table of density data on request
C09 ¹⁾	H ₂ O ₂ / Water	30 – 75	WT%	4.5 – 43.5	1.00 – 1.20	Table of density data on request
C10 ¹⁾	Ethylene glycol / Water	10 – 50	WT%	-20 – 40	1.005 – 1.085	Table of density data on request
C11	Starch / Water	33 – 42.5	WT%	35 – 45	1.14 – 1.20	Table of density data on request
C12	Methanol / Water	35 – 60	WT%	0 – 40	0.89 – 0.96	Table of density data on request
C20	Alcohol / Water	55 – 100	VOL%	10 – 40	0.76 – 0.94	Table of density data on request
C21	Sugar / Water	40 – 80	°Bx	75 – 100	1.15 – 1.35	Table of density data on request
C30	Alcohol / Water	66 – 100	WT%	15 – 40	0.77 – 0.88	Standard Copersucar 1967
C37	Alcohol / Water	66 – 100	WT%	10 – 40	0.772 – 0.885	Brazilian Standard ABNT

¹⁾ We recommend using devices with wetted parts made of nickel alloy C22. Contact the Yokogawa sales organization about availability.

Maximum 4 C__ option sets can be ordered for one device simultaneously.

3.3 Batching function

Batching and filling processes are typical applications in different industries as food and beverage, cosmetic, pharmaceutical, chemical and oil & gas.

Rotamass Total Insight offers an integrated "Batching function" to automatize the task. A "self-learning" algorithm optimizes the process and allows high accurate results.

The function supports two filling modes:

- one-stage mode with single valve
- two-stage mode to control two valves for accurate filling

Without using an external flow computer, data related to the process can be transmitted via communication protocol. The error management function allows the user to set alarms and warnings accordingly the application needs.

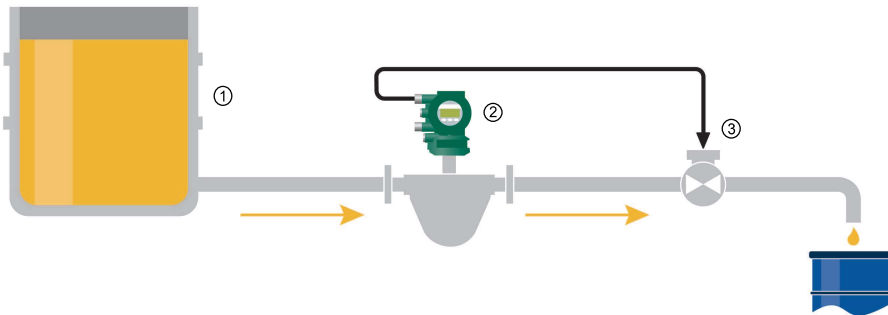


Fig. 2: One-stage mode (The above diagram illustrates the fundamental functionality for one of several combination possibilities)

- | | | | |
|---|------------------------|---|-------|
| ① | Storage tank | ③ | Valve |
| ② | Rotamass Total Insight | | |

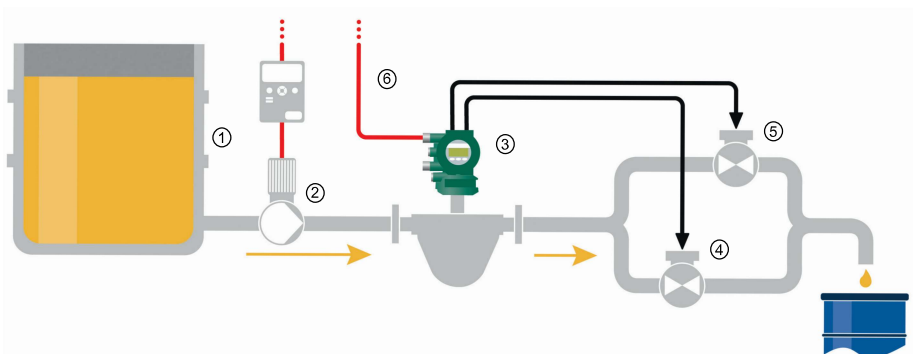


Fig. 3: Two-stage mode (The above diagram illustrates the fundamental functionality for one of several combination possibilities)

- | | | | |
|---|------------------------|---|-----------|
| ① | Storage tank | ④ | Valve "A" |
| ② | Pump | ⑤ | Valve "B" |
| ③ | Rotamass Total Insight | ⑥ | HART |

3.4 Viscosity function

The Viscosity function allows the user to have an estimation of the viscosity of the fluid.

The function can be used as redundant viscosity control or as reference value to activate other processes like for instance fluid heating systems.

The viscosity estimation is calculated based on a comparison between measured pressure loss Δp and a “calculated” Δp_{cal} between two points of the pipe nearby the flow meter (refer to related instruction manual for the correct installation).

In order to use the function a pressure measurement device (separate order) directly connected to the analog input of the Rotamass Total Insight is necessary. Based on iteration process, Rotamass Total Insight finds the value of viscosity μ that returns a Δp_{cal} closed to the measured Δp .

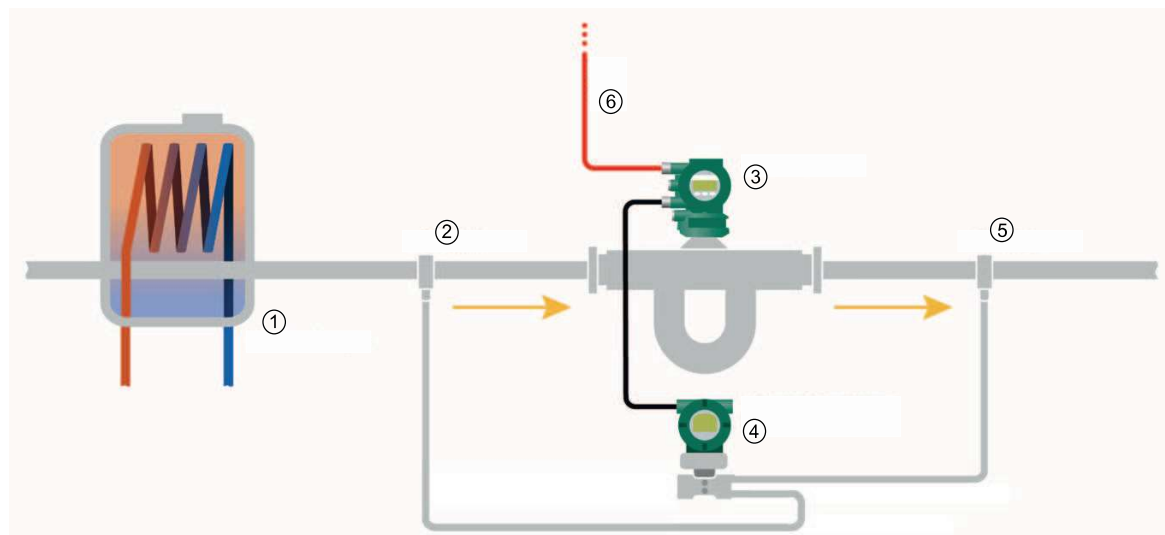


Fig. 4: Positioning of pressure taps

- | | | | |
|---|------------------------|---|-----------------------------------|
| ① | Heat exchanger | ④ | Differential pressure transmitter |
| ② | Pressure tap 1 | ⑤ | Pressure tap 2 |
| ③ | Rotamass Total Insight | ⑥ | HART |

Application example:

In this application example the Viscosity function returns a reference value used to activate a heating system and the Rotamass Total Insight is using HART communication.

3.5 Tube Health Check

General

The Tube Health Check function is a valuable diagnostic function to evaluate the status of the measuring tubes of Rotamass Total Insight.

Tube integrity

The function is able to measure periodically the change of the stiffness of the measuring tubes and gives the possibility to set up a real predictive maintenance system or to detect corrosion or clogging of the measuring tubes. The measurement values can be stored in the internal microSD card or transmitted via HART, Modbus, PROFIBUS PA or FOUNDATION Fieldbus protocol and therefore integrated in the customers condition monitoring system.

An alarm or an external event can be activated directly from Rotamass Total Insight in case the measured value exceeds a threshold defined by the user. The single measurements can be plotted in a diagram and printed in a report for quality and maintenance documentation by using the Yokogawa Device Management Software FieldMate.

Dry Verification for Russia

With Rotamass Total Insight and the Tube Health Check function customers in Russia can benefit from the Dry Verification procedure. The Dry Verification procedure is described in the verification method document (МП 208-053-2019). It determines the error of the flow measurement of the device. When Dry Verification test (tube stiffness change) results are within the required specifications it is not necessary to dispatch the flow meter to an external flow laboratory for verification. For Dry Verification please order Tube Health Check in combination with option VR.

3.6 Measurement of heat quantity

The function allows to evaluate the total fuel calorific value of the measured fluid.

The function can work with a constant value of the calorific value of the fluid, but in order to have a precise evaluation we suggest to use an additional device like a gas chromatograph (not included in the supply). The external device that supplies the instantaneous calorific value is connected with the current input of the transmitter. Based on the mass flow, the total calorific energy of the fluid is calculated as below:

Formula for total calorific energy

$$\sum E_{cal} = \sum (Q_m \times H_i \times \Delta t)$$

E_{cal} Calorific energy

Q_m Mass flow rate

H_i Calorific value variable

Δt Time interval between two measurements

Other formula based on volume and corrected volume are included in the function and can be set using the display or the configuration PC software FieldMate.

3.7 Features on Demand (FOD)

In combination with the “Ultimate” transmitter, the functions can be purchased and activated later as “Features on Demand”.

After the order, the user receives a KeyCode for input in the transmitter. To activate the desired functions, refer to related software instruction manual (IM01U10S0_-00_-R).

FOD availability depend on the main SW revision (device firmware) and the transmitter I/O configuration as described in below table. In addition not all functions are available for all models. Please refer to chapter *Overview* [9]

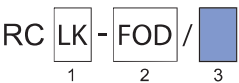
Option category	Options	Description	Valid from main Software rev. ¹⁾			
			Modbus	HART	PROFIBUS PA	FOUNDATION Fieldbus
Concentration and petroleum measurement	CST	Standard concentration measurement	R1.01.01	R1.01.02	R1.01.01	R2.01.01
	AC0	Advanced concentration measurement, customer settings				
	C52	Net Oil Computing (NOC) following API standard				
Batching function	BT	Batching and filling function	-	R3.01.01	-	-
Viscosity function	VM	Viscosity computing function for liquids			R1.01.01	R2.01.01
Measurement of heat quantity	CGC	Measurement of the total transported energy content of a fuel in connection with a sensor for determining the fuel's calorific value (e.g. a gas chromatograph, not included in scope of delivery).	R1.01.01	R1.01.02	R1.01.01	R2.01.01
Tube Health Check	TC	Tube Health Check	R1.01.01	R1.01.02 ²⁾	R1.01.01	R2.01.01

¹⁾ Main software revision is given by the transmitter for which the FODs are intended for. For details refer to software instruction manual (IM01U10S0_-00_-R).

²⁾ From HART software rev. R3.01.01 Tube Health Check includes trend line report (by FieldMate) and the possibility to store the data on microSD card.

Please be sure that your device is compatible with the selected function and in case of doubts please contact Yokogawa Service Department providing the serial number or the model code of the target device.

3.8 FOD ordering information

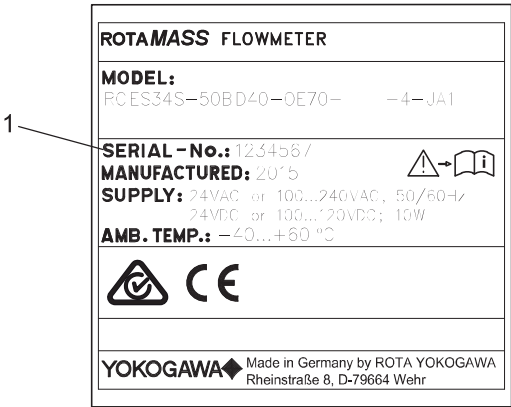


Model Code Pos. 3	Description
CST	Standard concentration measurement
AC0	Advanced concentration measurement
C52	Net Oil Computing following API standard
TC	Tube Health Check
BT	Batching function
VM	Viscosity function
CGC	Measurement of heat quantity

Ordering instructions

Please provide the “Serial number” when ordering FOD. The “Serial number” is indicated on the main transmitter nameplate or it can be showed on the display as “Complete device serial number”.

Main transmitter nameplate



1 Serial number

TRADEMARKS

HART:	registered trademark of FieldComm Group, Inc., US
Modbus:	registered trademark of SCHNEIDER ELECTRIC USA, INC.
PROFIBUS:	registered trademark of PROFIBUS Nutzerorganisation e.V., Karlsruhe, DE
FOUNDATION Fieldbus:	registered trademark of FieldComm Group
FieldMate:	registered trademark of YOKOGAWA ELECTRIC CORPORATION
ROTAMASS:	registered trademark of Rota Yokogawa GmbH & Co. KG, DE
QR code:	registered trademark of DENSO WAVE INCORPORATED

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Manufacturer:

Rota Yokogawa GmbH & Co. KG
Rheinstr. 8
D-79664 Wehr
Germany

For the actual manufacturing location of your device refer to the model code and/or serial number.

**COMPANY WITH
QUALITY SYSTEM
CERTIFIED BY DNV GL
= ISO 9001 =**