KROHNE

4/2001

Vortex flowmeter

Installation and operating Instructions VFM 5090 (I)

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Part A System installation and Start-up

1. Description

KHRONE MARSHALL Vortex Flowmeter operate on the Karman vortex street principle to measure volumetric flow rate of gases / steam and liquids. VFM computes normalized volumetric and mass flow rates from operating Pressure and Temperature values, or from density values. Temperature sensor is standard & pressure sensor is optional to provide an on-line P&T compensation.

Items included with shipment

- Compact Vortex Flowmeter
- Installation and operating instructions
- Mounting bolts, washers, nuts
- Plastic cover wrench for electronic housing
- Optional upstream & downstream pipes
- Programming chart indicating factory configuration settings.
- Gaskets between primary head and pipeline.

Provided by customer

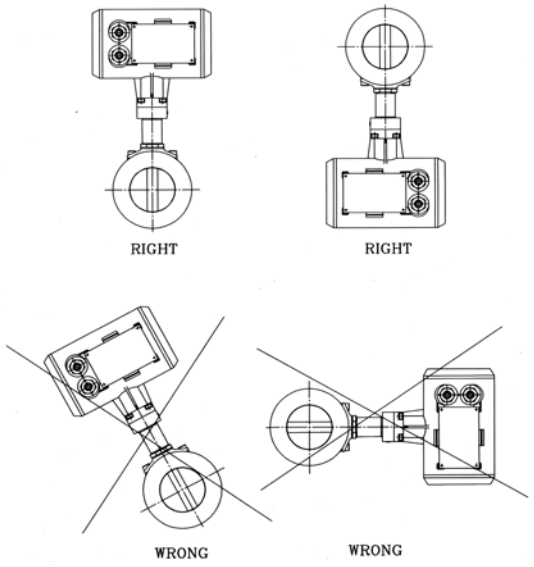
- All cables for electrical connections.

2. Installation in the pipeline

2.1 General

1. Flow direction and meter position

- Flow must always be in the direction of arrow, bluff side of vortex-shedding body facing incoming flow i.e. upstream side.
- Vertical pipe run : upward flow direction
- Horizontal pipe run : see below



2. Difference between inside diameter of primary head and pipeline

DN Meter size of primary head in mm or inches.
Φ Inside diameter of primary head in mm or inches.

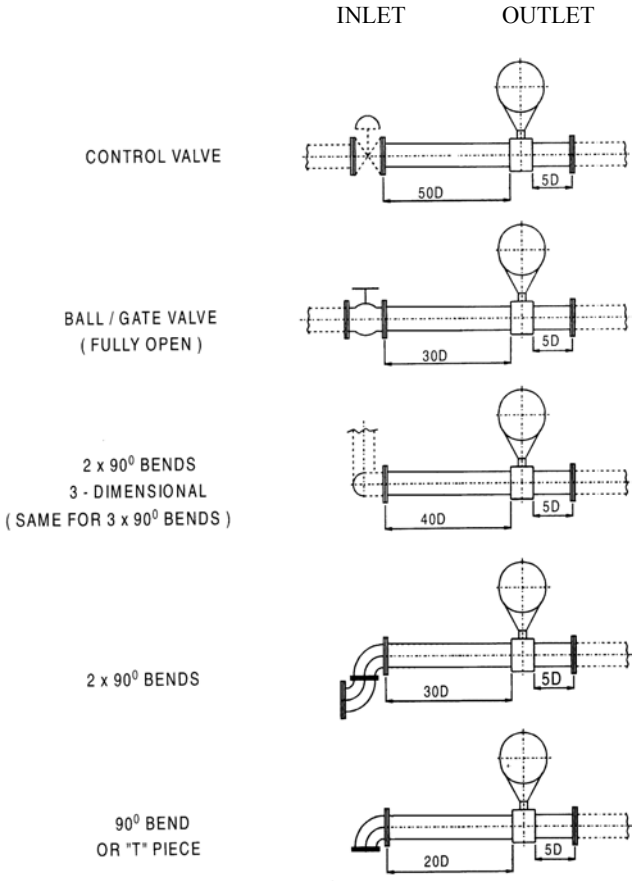
ΔΦ Max. allowable difference between inside diameters of primary head and pipeline.

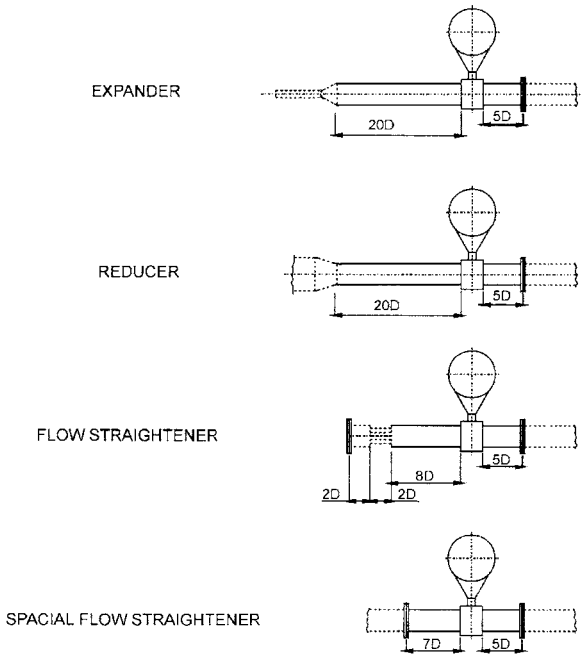
SIZE	ϕ	Δϕ	SIZE	ϕ	Δϕ
DN (mm)	mm (inch)	mm (inch)	DN (inch)	mm (inch)	mm (inch)
10S	8.9 (0.35)	0.4 (0.016)	3/8"S	8.9 (0.35)	0.4 (0.016)
10	12.6 (0.50)	0.4 (0.016)	3/8"	12.6 (0.50)	0.4 (0.016)
15	14.9 (0.59)	0.4 (0.016)	1/2"	14.9 (0.59)	0.4 (0.016)
20	20.9 (0.82)	0.4 (0.016)	3/4"	20.9 (0.82)	0.4 (0.016)
25	28.5 (1.12)	0.4 (0.016)	1"	26.7 (1.05)	0.4 (0.016)
40	43.1 (1.70)	0.4 (0.016)	1/5"	40.9 (1.61)	0.4 (0.016)
50	54.5 (2.15)	0.6 (0.024)	2"	52.6 (2.07)	0.6 (0.024)
80	82.5 (3.25)	0.6 (0.024)	3"	78 (3.07)	0.6 (0.024)
100	107.1 (4.22)	0.6 (0.024)	4"	102.4 (4.03)	0.6 (0.024)
150	159.3 (6.27)	0.8 (0.031)	6"	154.2 (6.07)	0.8 (0.031)
200	206.5 (8.13)	1 (0.039)	8"	202.7 (7.98)	1 (0.039)

Ensure that the bore of locating pipes are smooth and without deposits or scaling of welding beads.

3. Straight, unimpeded inlet and outlet runs

D=Meter size (Nominal Dia. DN)





With flow straightener the inlet pipe length may be halved e.g. for a control valve the inlet length is 25D instead of 50D. The minimum inlet pipe length including flow straightner must always be 12 D.

4. Pipe vibration

Pipe Vibration caused, for example, by the action of pumps, valves, etc., will falsify measurements particularly at low flow velocities. Support the pipeline on both sides of the flowmeter, in the direction perpendicular to both the pipeline & bluff body axis.

- Pipe vibration limit is 0.2g _peak to peak upto 8-500 Hz crossover frequency..(which equals 0.75 mm)

5. Pipeline along a wall

Where possible, the distance between the pipe centerline and wall should be greater than 0.5 m(20”). If it is less, first connect all cables to terminals in the connection compartment (power supply and outputs) and run them via an intermediate connection box (see also Section 3) before installing the flowmeter.

6. Orientation

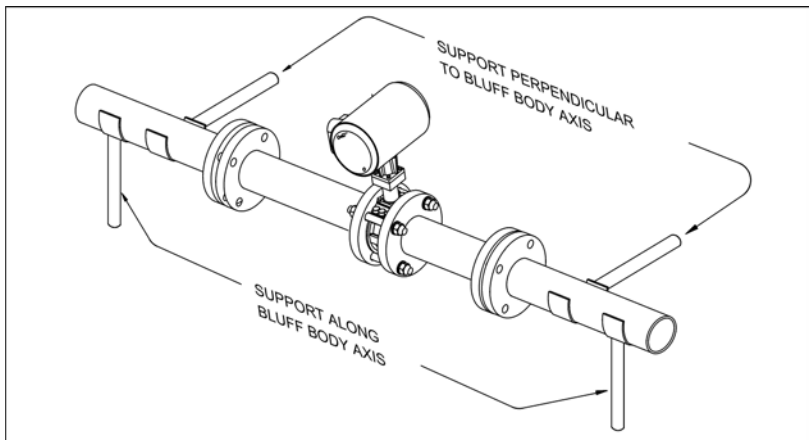
- Turn the display board through ±90° or 180° to obtain horizontal positioning of the display.
- Turn the signal converter housing through ±90° should that be more suitable for the location of the installation.

7. State of Medium

- Ensure single phase flow. Liquid droplets in gas/ vapour, solid particles in gas/liquid & gas bubbles in liquid are not permitted.
  In Liquid application e.g. water, to prevent cavitation, minimum D/S pressure is given by the relation:
  Pds(bar _g) > =(2.9*DP) + (1.3*Ps)-1.013
  where
  DP= pr. drop of VFM in Bar from sizing program
  Ps=Sat.pr. in Bar at op.temp.

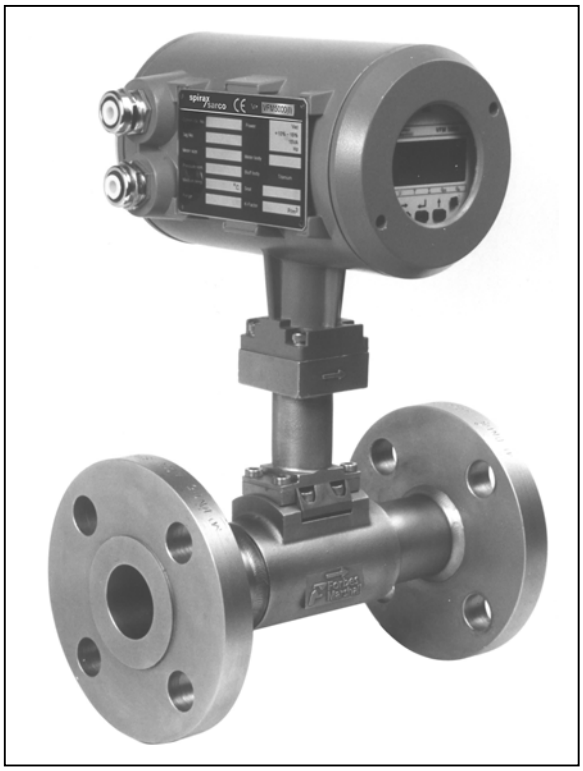
- In case of steam or compressed gas, a moisture separator may be used 50D upstream of the meter if the dryness fraction is less than 95%.

- For any fluid, a filter or strainer may be used to remove solid particles. This is specially important for meter sizes below 1” where a filter or strainer is a must.



Sandwich Version

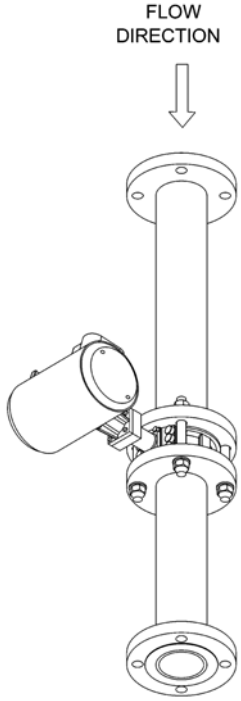
Flanged Version



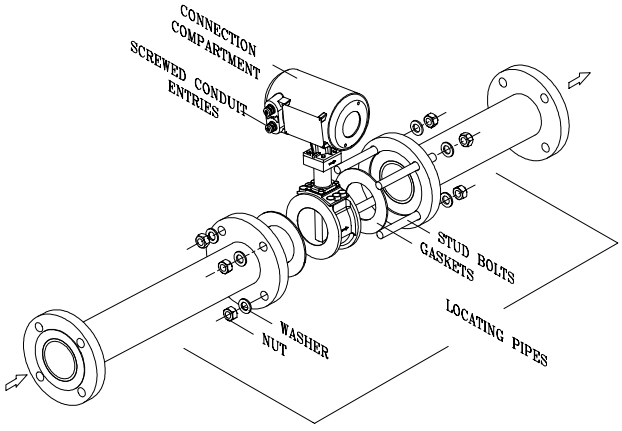
2.2 Sandwich type to DIN19205 / ANSI

- Meter sizes DN 25, 40, 50, 80,100 and 150 (1"to 6")
- Pipe flanges
  (Pressure ratings
  to DIN :- DN25/PN40, 100; DN40/PN40, 100; DN50/PN40, 64, 100; DN80/PN40, 64, 100; DN100/PN16, 40, 64 and DN 150 / PN16, 40
  to ANSI : 1" to 6"/ # 150, 300 SORF)
- Gaskets inside diameter must be greater than the inside diameter ϕ of the primary head. e.g. use flat gaskets to DIN 2690. Gaskets must not project into the effective pipe cross sectional area.
- Bolts, nuts and washers are supplied.
- Check flange connections for leak-tightness after flowmeter installation.

Installation in Vertical Pipe Run



Assembly Diagram of Sandwich Units



2.3 Flanged type to DIN 2501/ANSI B 16.5(SCH40)

- Meter sizes DN 10S, 10, 15, 20, 25, 40, 50, 80 100, 150 and 200 (3/8"S to 8")
- Pipe flanges
  to DIN : DN 25/PN 40, 100; DN 40/PN 40, 100; DN 50/PN 40, 64, 100; DN 80/PN 40, 64, 100; DN 100/PN 16, 40, 64; DN 150/PN 16, 40; DN 200/PN 10, 16 and
  to ANSI : 1/2" to 8" / # 150, 300 SORF)

Gaskets are supplied by us with flanged units.

- Center the flowmeter by sight.
- Check flange connections for leak-tightness after flowmeter installation.

2.4 Temperature and pressure measurements

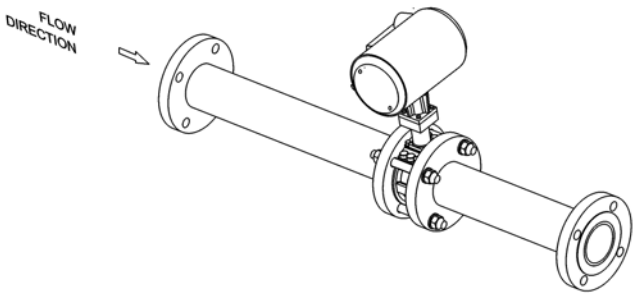
2.4.1 Temperature measurement

VFM 5090(I) is always supplied with a temperature sensor. This sensor is RTD (PT1000 type) and is located within the Vortex bluff body. See figure given for location of Temperature sensor. This sensor provides an accurate measurement of temperature of the medium **at the vortex sensor**.

Flowmeter will continuously measure medium temperature -

- To display medium temperature
- To provide on-line T compensation for mass and normalized flow computations.
- To monitor whether the medium temperature remains within the user specified operating temperature limits.

Installation in Horizontal Pipe Run

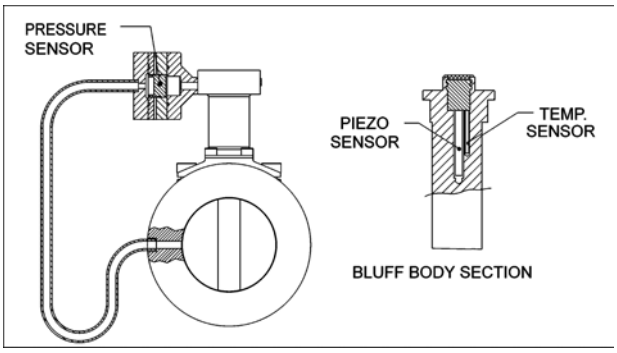


2.4.2 Pressure measurement with built-in sensor

VFM 5090(I) may be supplied with an optional pressure sensor. This sensor is typically a strain gauge type and located in the primary assembly as shown in the figure below. Thus the sensor also provides an accurate measurement of pressure **of the process fluid.**

Flowmeter will continuously measure medium pressure -

- To display the medium pressure value
- To provide an on-line P&T compensation along with T sensor for mass and normalized volumetric flow computation.
- To monitor whether the medium pressure is within the user specified operating pressure limits.



2.4.3 Pressure measurement by external means

To determine the pressure of the medium (e.g. to feed the pressure value in VFM for an off-line P&T compensation for mass or normalized flow computations), suitable measuring point must be provided near the flowmeter.

Location upstream of flowmeter

Min. distance : 20*DN (DN = meter size)

Location downstream of flowmeter

Min. distance : 5*DN (DN = meter size)

Allowance must be made for the pressure drop in the flowmeter as correction value for operating conditions prevailing upstream of the flowmeter.

3. Electrical connection

3.1 Installation location and cable diameter

Location

- Do not expose the compact flowmeter to direct sunlight. Install a sunshade if necessary.
- Do not expose to intense vibration. If necessary support the pipeline to the left & right of the flow meter.
- The rotating design of the housing makes it easier to connect the two cables for power and outputs to the terminals in the rear terminal box.

Cable diameter

To conform to protection category requirements, observe the following recommendations

- Cable diameter : 8 to 13 mm (0.31" to 0.51")
- Enlarge the inside diameter of the Screwed conduit entry by removing the appropriate onion ring(s) from the seal,only if cables have extremely tight fit.
- Fit blanking plug PG 16 and apply sealant to unused cable entries.
- Do not kink cables at conduit entries.
- Provide water drip point (U bend in cable).

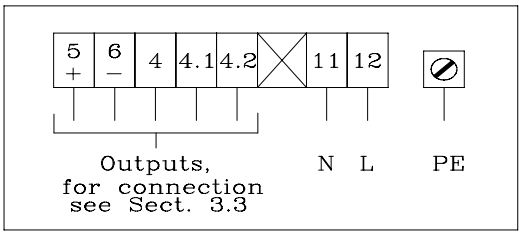
Conduit Installation, general wiring considerations

- When electrical codes require conduit, it must be installed in such a manner that the meter connection compartment remains **dry** at all times.
- Power and output wiring should be run in a separate conduit.
- Use twisted pair for output wiring.

WARNING Power wiring should utilize a grounded conductor to avoid possible shock hazard and damage to component parts.

3.2 Connection to power

- Note information given on the instrument name plate (voltage, frequency)!
- Electrical connection in conformity with VDE 0100 "Regulations governing heavy-current installations with rated voltages up to 1000V" or equivalent national standard.
- The **PE protective ground conductor** for supply power must be connected to the separate U-clamp terminal in the terminal box of the signal converter.
- Do not cross or loop cables in the terminal box of the signal converter. Use separate PG or NPT screwed conduit entries for power and output cables.
- Ensure that the **screw thread of the round cover** on the terminal box is well greased at all times.
- **Connection to power, VFM 5090(I)**



3.3 Outputs

3.3.1 Abbreviations

Abbreviation	Stands for	Programming via Fct. No...	Description See Sect....
EC	Electronic counter	---	---
EMC	Electro-mechanical counter	---	---
F	Frequency (Pulse) output	1.4.X	6.1 + 6.2.9
$F_{100\%}$	Pulses for Q = 100 % flow rate or pulse value	1.4.2	6.1 + 6.2.9
I	Current (analog) output	1.3.X	6.1 + 6.2.8
$I_{0\%}$	Current at 0/4 mA flow	1.3.3	6.1 + 6.2.8
$I_{100\%}$	Current at 20 mA flow	1.3.4	6.1 + 6.2.8
$Q_{0\%}$	0% flow rate		-
$Q_{100\%}$	Full - Scale range, 100 % flow rate.	1.1.2	6.1 + 6.2.4

3.3.2 Current (analog) output I

- **The current output is galvanically isolated** from all input and output circuits but **not** from frequency output F. Therefore only one grounded receiver instrument may be connected to either current output I or frequency output F.
- **All functions and operating data are programmable,** see sections 5, 6.1 & 6.2.8.
- Factory-set data and functions are listed in the enclosed 'Configuration Sheet' on settings.
  This can also be used to record any changes made to the operating parameters.
- **Max load at terminals** 5/6 for $I_{100\%}$ **(*Fct. 1.3.4*)** :

$$\text{Max. load Kohms} = \left[\frac{14V}{I_{100\%}[mA]}\right] \text{(e.g. 0.7 K ohms for } I_{100\%} = 20 \text{ mA)}$$

- **Error annunciation** programmable to 2 mA or 22 mA **(*Fct. 1.3.2*)**
- **Connection diagram** ① Refer to Section 3.3.4

3.3.3 Frequency (pulse) output F

- **The frequency output is galvanically isolated** from all input and output circuits but **not** from current output I. Therefore only one grounded receiver instrument may be connected to either frequency output F or current output I.
- **All functions and operating data are programmable,** see Section 5, 6.1 & 6.2.9.
- **Factory - set data and functions** are listed in the enclosed report on settings. This can also be used to record any changes made to the operating parameters.
- **Active frequency output** for electromechanical totalizers **EMC** (terminals 4.1/4.2) or for electronic totalizers **EC** (terminals 4.1/4.2 or 4/4.1/4.2), 10 to 36000000 pulses/hr (0.0028 to 10000 Hz), amplitude max. 30 V, selectable pulse widths and load rating see below.
- **Passive frequency output,** open collector for connection of active electronic counters EC or switchgear, input voltage 5 to 30V, load current max. 100 mA, R_i = 100 ohms, selectable pulse widths see below.
- **Pulse width (*Fct. 1.4.3*)** as a factor of frequency f (pulse rate) and **maximum permissible load for active output** (term. 4.1/4.2 or 4/4.1/4.2), see also Sect. 6.2.9.

Pulse width	Frequency f = $F_{100\%}$	Load rating of active output	
		Load current	Load
500 ms	0.0028 Hz < f 1 Hz	< 150 mA	⌑160 Ohm
200 ms	0.0028 Hz < f 2 Hz	< 150 mA	⌑160 Ohm
100 ms	0.0028 Hz < f 3 Hz	< 150 mA	⌑160 Ohm
100 ms	3 Hz < f 5 Hz	< 60 mA	⌑400 Ohm
50 ms	0.0028 Hz < f 5 Hz	< 150 mA	⌑160 Ohm
50 ms	5 Hz < f 10 Hz	< 60 mA	⌑400 Ohm
30 ms	0.0028 Hz < f 6 Hz	< 150 mA	⌑160 Ohm
30 ms	6 Hz < f 10 Hz	< 80 mA	⌑300 Ohm
Pulse duty cycle 1:1*	10 Hz < f 1000 Hz	< 25 mA	⌑1000 Ohm
160 µs*	1000 Hz < f 2547 Hz	< 25 mA	⌑1000 Ohm
50 µs*	2547 Hz < f 10000 Hz	< 25 mA	⌑1000 Ohm

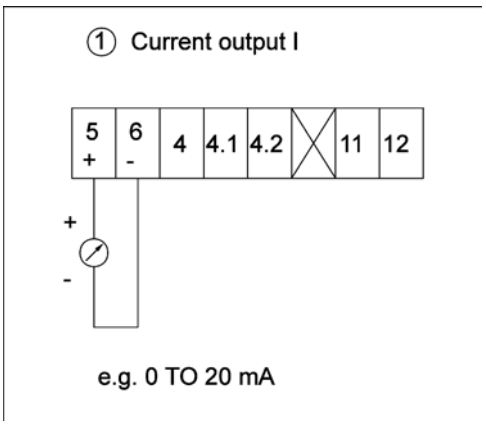
* fixed pulse width, independent of programming in ***Fct. 1.4.3***

- **Refer connection diagrams** ②, ③ and ④. Refer to Section 3.3.4
-

3.3.4 Connection diagram for outputs ① to ④

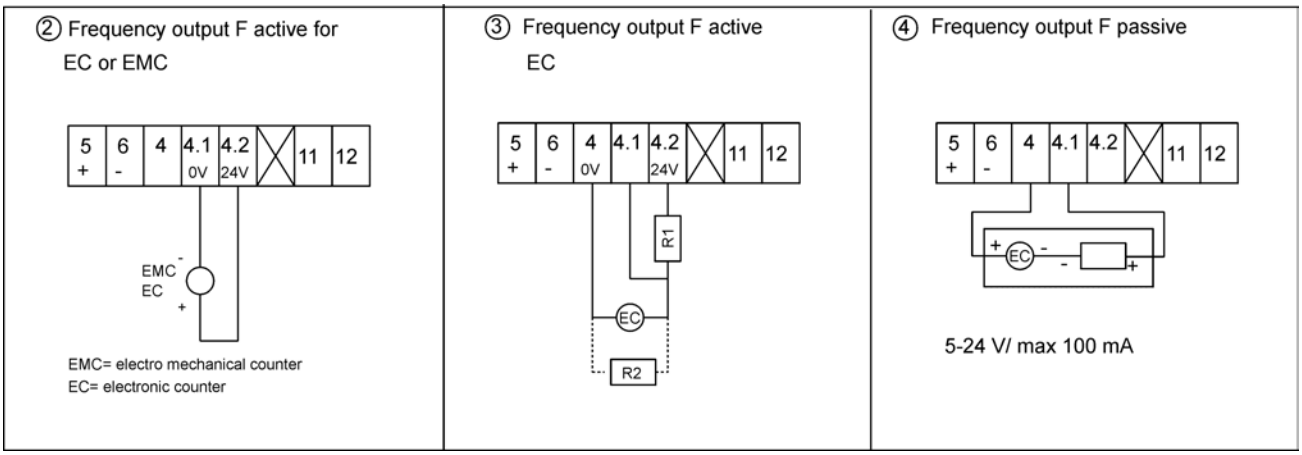
Output characteristics

Current output I: Diagrams I1 in Section 6.2.8



3. Frequency output F: Diagram F1 in Section 6.2.9
R1 & R2 when electronic counter is connected to terminals 4/4.1/4.2 connection diagram ③
R1 = 1 Kohm , 1W
R2 needed only for totalizer with input voltage Umax < 30 Volts.

Umax	24 V	12 V	5 V
R2	3.9 Kohm	680 ohm	180 ohm



4. Start-up

- Check that the system has been correctly installed as described in Sect. 1, 2 and 3.
- Before initial start-up check that the following details on the nameplate agree with the data specified in the report of settings for the signal converter. If not, reprogramming will be necessary.

  Meter size ***Fct. 3.1.1*** Sect. 6.1, 6.2.5.

  K-Factor ***Fct. 3.1.2*** Sect. 6.1, 6.2.5.
- The flowmeter is ready for service 15 minutes (waiting time) after switching on the power source. Increase flow velocity slowly and steadily.
- Avoid abrupt changes in pressure in the pipeline.
- If the process product is steam, condensate may form initially and cause faulty measurements when the system is started up for the first time.
- When powered, the signal converter normally operates in the measurement mode. The power-on sequence to measurement mode is as follows :

  '*TEST*' is displayed for approx. 3 seconds followed by

  '*VFM 5090*' the instrument type followed by

  '*Ver x.xx*' the software version of the instrument.

  Then instrument operates in measurement mode where it displays the parameter being measured or '***FATAL ERROR*** ' if there are one or more critical errors detected (For description on errors refer Sect 5.5)

Part B Signal Converter VFC 090

5. Operation of the signal converter

5.1 General

5.1.1 Starting up signal converter

When power is switched ON to signal convertor it displays ***TEST, VFM 5090 & Ver x.xx*** and then goes to measurement mode. In this initial sequence VFM 5090(I) carries out self diagnostics to check its own functional elements and loads the configuration data from non-volatile memory. If any error(s) are detected in power-ON diagnostics, the converter displays ***FATAL.ERROR*** since instrument has critical error(s) and is not able to carry out normal measurements. If no start-up errors are detected the first measured parameter displayed is the one being displayed when power supply was removed last time.

5.1.2 Measurement Mode

In measurement mode, the parameters that the converter measures/computes are shown on the display in the appropriate units. (See Sect. 5.2 for display details). As per the configuration, display can be either in non-cyclic/cyclic mode. In non cyclic mode of display, use ↑ key to see the next parameter on display. In cyclic mode display shows all the parameters one after another, wherein each parameter is displayed for about 6 seconds.

5.1.3 Programming or menu mode

All the configurations/settings/test functions are grouped in the form of menu tree structure (see Sect. 5.3.1 for details) and are accessible in the programming mode. Operator can view or alter the present settings and data values by the use of functions available in this mode.

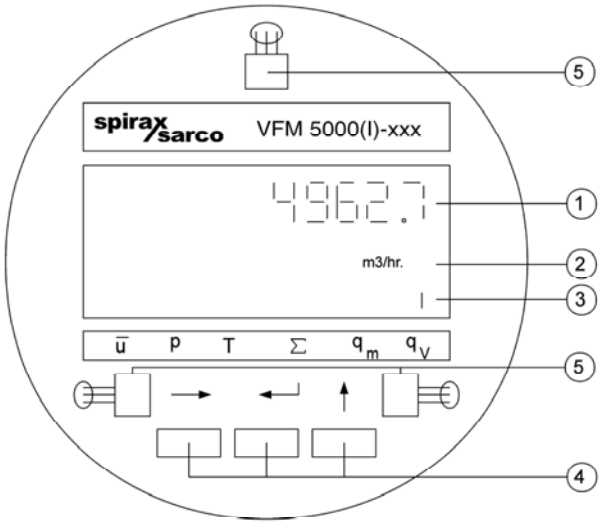
- All changes made in the programming mode are stored temporarily until the operator quits to the measurement mode and responds ***YES*** to an '***UPDATE***' prompt. Only then the new changes are saved in non-volatile memory and have appropriate effect on the operation of signal converter.
- Even in the programming mode the converter "keeps working" as per present configuration. Simply stated, the converter continues to measure (flow rate, totalizing of flow, P, T etc.) and control outputs (current and frequency outputs) while in the programming mode.

5.1.4 Error handling

Converter can detect errors during power-on diagnostics as well as when in normal measurement mode. Errors are divided into two main categories viz. fatal errors and non-fatal errors. Fatal errors cause measurement to stop since they are serious in nature. Non-fatal errors do not affect functionality of the converter.

If one or more errors are present, display (in the measurement mode) starts blinking. If programmed so, error information is shown on display, interleaved between the display of two parameters.

5.2 Operating elements



CAUTION To avoid damage to electronics, be certain that the area around the meter is dry before removing the electronics compartment cover.

The operating elements are accessible after removing the cover of the electronics section using the special wrench.

CAUTION Do not damage screw thread, never allow dirt to accumulate, and make sure it is well greased at all times.

① Display, 1st line
② Display, 2nd line
③ Display, 3rd line
Cursor symbols described below

- q_v Volumetric flow rate
- q_m Mass flow rate
- Σ Totalizer value
- T Measured / Set temperature value
- P Measured / Set pressure value
- $\bar{u}$ Velocity of medium

④ Keys for programming the Signal Converter, refer to Sect. 5.4 for the functions of keys.

⑤ Magnetic Sensors to program the converter by means of a hand-held bar magnet without having to open the housing, refer to Sect. 6.3. Function of sensors is same as keys ④. Hold the bar magnet by the cap. Apply other end of the magnet (north pole) to the glass pane above the magnetic sensors. Sensor or key response is acknowledged by symbols appearing in 1st line of display.

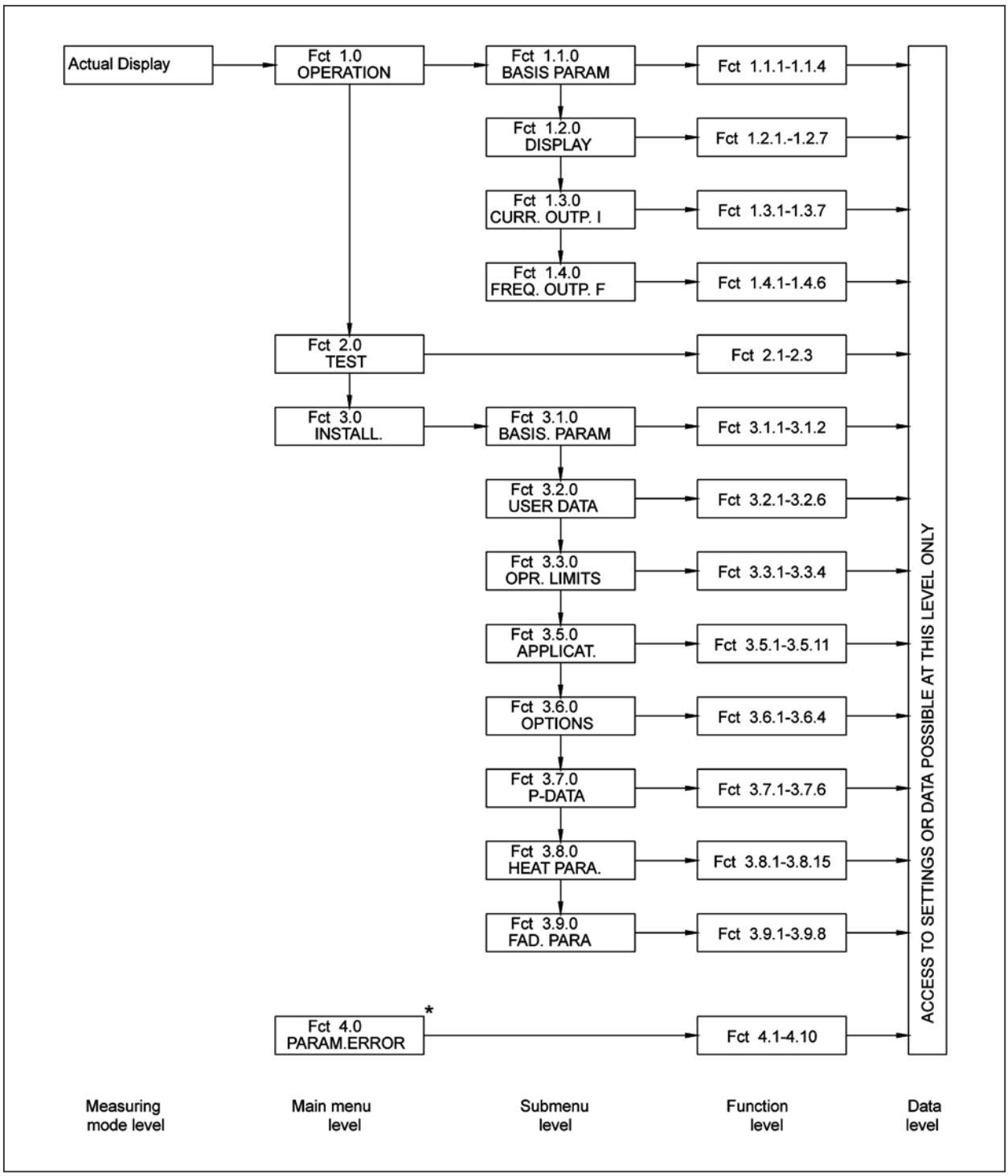
6 ⑥ xxx on the display is used to describe the type of the meter. It can be :

1. AGA - Natural Gas Meter (AGA)
2. FAD - Free Air Delivery
3. HM - Heat Meter
4. NHM - Net Heat Meter
5. STD - Standard

5.3 Program organization & programming chart

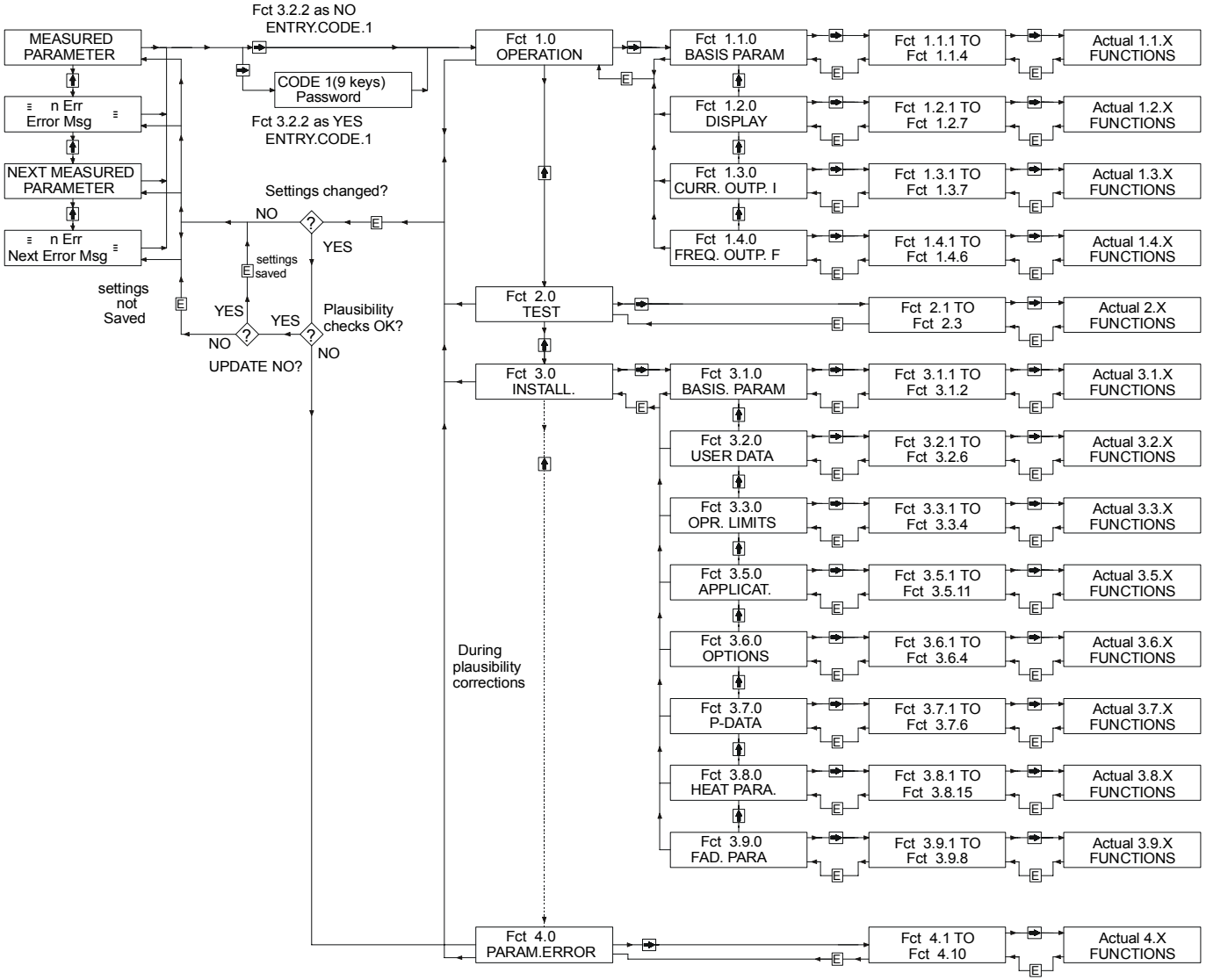
5.3.1 Menu Levels

The program for the signal converter consists of 5 levels. The 1st line of display will identify the menu level during programming.



* Function 4.0 is not accessible in usual manner and is explicitly generated due to errors detected by one or more plausibility checks, refer Sect 5.6

5.3.2 Programming chart



5.3.3 Description of keys

❶ Measuring mode level	❷ Main menu level	❸ Submenu level	❹ Function level	❺ Data level
↑ display measured parameters /error messages	↑ Go to main menu → Enter main menu displayed	↑ Go to submenu → Enter submenu displayed	↑ Go to Function	Units/Options
E Enter programming mode	**E** Return to measuring mode level	**E** Return to main menu level	→ Enter/execute function displayed. Then continue as under ❺ data level	↑ Go to next propos →
			E Return to submenu level or main menu level	**E** Temporarily save proposal then with further data any, or return function level

Important	
1.	All changes made in programming mode are stored temporarily and do not affect operation of the signal converter until operator leaves menu mode and responds with ***UPDATE YES.*** Exceptions: all 2.X test functions.
2.	Main menu level 4.0 ***PARAM.ERROR*** is automatically created if the plausibility checks on the new configuration detects invalid values entered. (See section 5.6 for details)
3.	VFM 5090(I) continues to function even when in programming mode.

5.4 Programming and function of keys

Function of keys in measurement mode :

After power - on, the signal converter enters the normal measuring mode. Display shows the actual measured value of the parameter, units and arrow markers to identify parameter. A steady (non - blinking) display indicates that there are no errors in measuring mode. Use the ↑ key to get the next parameter on display. If display is in cyclic mode (***Fct. 1.2.7 CYCLE DISP*** as ***YES***) the next parameter is displayed after every 6 seconds and ↑ has no function.

Use the → key to go to the programming mode. If ***Fct. 3.2.2 ENTRY.CODE.1*** is ***YES*** then converter will ask for the code 1 password. Password is the sequence of 9 keys as given under ***Fct. 3.2.3 CODE 1.*** A wrong password generates a set of unfamiliar characters on display. Press **E** key to go back to normal display.

Using the **E** key results in prompt for Code 2 password when converter is in measuring mode. Code 2 password is predefined and reserved for KHRONE MARSHALL service person. Operator should not use **E** key at normal display. If used by accident then give any arbitrary key sequence to Code 2 prompt until display gets back to normal.

Using keys in measuring mode

KEY	**FUNCTION**	
→ → Followed by 9 keys	With } without	coding, dependent on programming of ***Fct. 3.2.2*** Go to programming mode.
↑		Display next parameter measured or next error message (***Fct. 1.2.6 as YES*** for error messages) If in non cyclic mode (***Fct. 1.2.7*** as ***NO***) In cyclic mode the key has no function.
E followed by ↑ →		Resets LINE INTR error.

Function of keys in programming mode :

Programming and other functions are grouped in a menu tree structure. To navigate in the menu tree use keys as follows :

- → To go into the branch i.e. from main menu level to submenu level or submenu level to function level. If you were already at function level then that function will be executed.
- ↑ Selects other options/branches at the same level.
- **E** Takes you one level back. If you were already at main menu level then this key takes you back to measurement mode.

Programming functions involve one or more of the following types of data.

1. Selecting an option from option list - initially present option is displayed in second line of display and display blinks to indicate that there are other choices. Use the ↑ key to scroll through all options one by one. Using **E** will cause that option to be selected and also completes selection process.
2. Entering a numeric value-Entering numeric data is very flexible in VFM 5090(I). You can enter +ve or -ve number in floating point with /without exponent notation.
   Formats : *ddd.ddddd* floating point e.g.
   1.2345678, -12.34567
   dd. dddEdd exponent e.g.
   1.00000E6, -1.2345E-3
   Method of entry : Initially the present value is displayed (in floating point format as far as possible) in the first line of display. A flashing digit will change by using ↑ key. → selects next digit position in sequence and **E** terminates entry of the number.

Notes

a) When you use ➔ to move cursor and all digits start flashing then it means that you are at the decimal point position. At this time use of ↑ moves decimal point across the number.
b) Usually digits cycle through 0-9 values. At certain relevant position they cycle through 0, 1, 2, . . . 9, -/E for -ve number or exponent notation.
c) When you enter a value beyond its limit then you get message dddd.dddd (***MIN.VALUE***) or dddd.dddd (***MAX.VALUE***). Press **E** after you have noted limit and then correct value to be in valid limits.
d) If you don't want to change value press **E** at the beginning itself!

3. Entering string (alphanumeric value) - This type of data input is required by a few functions. Present string is displayed in the 2nd line and as usual 1st column blinks. Use :

↑ to scroll through characters ***0 - 9, A - Z, a - z*** and some other punctuation characters.
➔ Change flashing (cursor) position
E Terminate data entry.

Note :

Since scroll list (using ↑ key) is far too long, an **autorepeat function** to keys is enabled. This allows you to press and hold down ↑ key to quickly reach the target character.

Using keys in programming mode

Key	Main menu level	Submenu level Function level	Data level	
			Option/Units	Numerical values/strings
↑	Go to main menu	Go to submenu or function	Select next proposal	Change flashing digit or character
➔	Enter displayed main menu	Enter displayed submenu or (execute) function		Shift flashing digit or character position
E	Quit Programming mode and go back to measurement mode	Return to main menu or submenu	Select displayed proposal and return to function level if no further data entry is required by the function	Enter the displayed numerical value or alphanumerical string. Then returns to function level if no further data input is required by that function.

VFM 5090(I) continues to perform measurement functions even when you are in the programming mode as per the configuration stored in non-volatile memory. Newly entered data will be saved in non-volatile memory and accepted by measuring program only after termination of programming mode as described below :

Pressing the **E** key at main menu level quits the programming mode. Software then checks whether one has altered existing settings (refered to as configuration). If no changes are detected, then converter goes back to measurement mode. If configuration has been changed, converter displays options ***UPDATE NO or UPDATE YES*** prompting you, if you really want to change existing configuration. When you say yes to update, then plausibility of the new configuration is checked. If there are no errors in plausibility checks, then only the new configuration is saved in nonvolatile memory and converter reverts to measurement mode as per the newly programmed configuration. (If any errors are detected in the plausibility checks then a new main menu level ***Fct 4.0 PARAM.ERROR*** is automatically created for you to correct for plausibility errors. The converter goes to programming mode at ***Fct 4.0*** (See Sect. 5.6 for details of plausibility checks).

5.5 Error messages

5.5.1 Error messages in measurement mode

Error message (display 2nd line)	Type	Description	Corrective action required
INTL.ERR.nn	*	Internal error in converter operation	Switch off the power and try again. If the problems persists contact KHRONE MARSHALL service.
NO SIGNAL	N	No signal from the vortex sensor	No flow through the primary or Vortex sensor problem
CHECK INST	N	Vortex sensor signal quality is bad	Check that 1. Flow rate > q min if OK. 2. Check for excessive pipe vibration & proper installation.
LOW SIGNAL	N	Vortex signal amplitude too low.	Check that 1. Flow rate > q min if OK contact KHRONE MARSHALL Service.
HIGH SIGNAL	N	Vortex sensor signal amplitude too high	This occurs very rarely. Check 1. Flow rate < q max if OK contact KHRONE MARSHALL Service.
LOW.FREQ.	N	Vortex frequency too low	Check 1. Flow rate > q min else call KHRONE MARSHALL Service.
HIGH.FREQ.	N	Vortex frequency too high	check 1. Flow rate < q max else call KHRONE MARSHALL Service.
LOW.FLOW	N	Flow rate lower than minimum flow rate q min.	Converter will continue to display actual flow rate. However, accuracy of measurement may suffer. If flow rate reduces further, then other errors such as CHECK INSTALL,LOW SIGNAL will be generated
HIGH.FLOW	N	Actual flow rate higher than q max.	Corrective action depends on application process. If flow rate exceeds too much further it may damage entire instrument physically !
LOW.TEMP. OPR	N	Operating temp. lower than limit.	Corrective action depends on the process.
HIGH.TEMP.OPR	N	Operating temp. higher than limit	Corrective action depends on the process.
LOW.PRES. OPR	N	Operating pressure lower than limit.	Take corrective action depending on the process.
HIGH.PRES. OPR	N	Operating pressure higher than limit.	Corrective action is process dependent.
LOW.TEMP. PHY.	N	Operating temp. lower than physical limit.	Take corrective action depending on the process.
HIGH.TEMP.PHY	F	Operating temp. higher than physical limit.	Will cause damage to primary as well as signal converter !
LOW.PRES.PHY.	N	Operating pressure lower than physical limit.	Take corrective action depending on process.
HI.PRES.PHY	F	Operating pressure higher than physical limit.	Will cause damage to primary and signal converter!
T.SENS.SHORT	N	Temp. sensor / wires short circuit.	Indicates fault in temperature/pressure sensor. Contact KHRONE MARSHALL Service. You may use signal converter with temperature or pressure compensation offline in the mean time till you get the service. P&T values entered through menu are used.
T.SENS.OPEN	N	Temp. sensor open circuit.	
P.SENS.OPEN	N	Pressure sensor open circuited	
INV. CONFIG	F	Configuration data in non-volatile memory is not valid.	Check entire configuration again. If error persists-call for service

LINE.INTR	N	Mains power to the instrument was interrupted.	This error is generated only when totalizer is on to indicate that internal totalizer could not totalize flow during period of the power failure. Acknowledge & reset the error by keying in **E** ↑ →

* This text is displayed for a wide variety of errors and most of them are Fatal in nature. The nature of error is beyond the scope of user (failure of IC or other hardware inside converter electronics etc.) We therefore suggest the user to switch OFF power and then try again. If error message continues, call KHRONE MARSHALL service.
nn = internal error number.

- Type N indicates non fatal errors whereas F indicates fatal errors.
- Measurement stops if any Fatal error is encountered. This means flow rate q = 0, current output to minimum value 0/4 mA or to error value 2/22 mA (as per programming of current output), frequency output = 0Hz.
- When errors are displayed during the measuring mode, "n Err" (n = number of errors) will appear in the 1st line. n gives the number of momentarily occuring errors that are displayed alternately with the actual measured value.
- Error messages disappear when their cause disappears.

5.5.2 Error messages in programming mode

Error in programming mode can only occur while entering any numerical value. When you enter numerical value outside possible limits you get message " *nnnn.nnnn* " in 1st line and ***MIN. VALUE*** or ***MAX. VALUE*** in the 2nd line ("***MIN. VALUE*** " if entered value is less than lower limit and "***MAX. VALUE***" if higher limit is crossed). Note the message indicating permissible limit; then press the **E** key to continue.

5.5.3 Other Error messages

VFM 5090(I) signal converter does lot of mathematical computations to calculate various physical parameters and other quantities. Math functions of the instrument software will generate errors for cases such as divide by zero, square root of a -ve number etc. Such errors are never expected to occur in VFM 5090(I). If (due to corruption of memory data or in the unlikely event of a software 'bug') any math error occurs, instrument cannot function since there is no simple recovery and it annunciates errors such as - ***HALTED - RUN.TIME.ERR*** then ***DEVIDE.BY O*** or other math error message. All measurement functions are stopped, display continuously annunciates the same message. In such a case switch OFF the mains supply and then switch ON again. If the same error occurs again contact KHRONE MARSHALL Service.

5.6 Plausibility checks

These checks are carried out when operator leaves programming mode and desires to save the new configuration in non-volatile memory. These checks detect whether the configuration as a whole is plausible or not. If any error(s) are detected in plausibility checks, a new main menu level ***Fct. 4.0 PARAM.ERROR*** is automatically created. The functions under ***PARAM.ERROR*** enable you to correct parameters which caused plausibility checks to fail. To understand the concept, consider the following example :

Fct 3.1.1 NOMINAL.DIA is ***DN 50*** & ***Fct. 3.1.2 K-FACTOR*** is 6250. Then operator changes ***Fct. 3.1.2 NOMINAL.DIA*** as ***DN 80*** and attempts to save the configuration. Now the limits for K factor are 1740 to 2730 for DN 80 which are dependent on nominal diameter of primary. Since the K factor lies outside valid limits, plausibility check will fail. Operator should then change the K factor under ***Fct. 4.1 K-FACTOR.***. Thus when the operator changes a menu function without changing other functions whose validity depended on the changed function, the error gets trapped by the plausibility checks. Plausibility checks are designed to resolve all such interdependencies, to ensure that the configuration as a whole is plausible to work with.

5.7 Options available with VFM5090(I)

5.7.1 METER TYPE

1. Heat Meter

VFM-5090(I), supports thermal power and energy calculations for Steam and Water. Thermal power is calculated on line from the mass flow and specific enthalpy, at the operating P&T and thermal energy is calculated by time integrating (totalizing) thermal power. An **energy totalizer** is provided to accumulate the thermal energy.

The thermal power can be displayed in one of the following units -

KJ/hr, MJ/hr, GJ/hr, BTU/hr, KCal/hr, KW and MW.

Corresponding units for energy display are - KJ, MJ, GJ, BTU, KCal, KWh and MWh.

2. FAD Meter

An air compressor sucks in air from the atmosphere and delivers it compressed to the required pressure. Since atmospheric air contains water vapour, what the compressor actually sucks in is a mixture of air and water vapour. Under these conditions the Free Air Delivery specification of the compressor is not directly and easily known. Almost all manufacturers specify FAD at standard suction conditions only. What the user gets to use as eventual plant air or process air needs to be found out and hence metered with ease and a reasonable accuracy of at least ±1%.

VFM 5090(I) FAD-METER can measure FAD on-line, compensated for humidity and RPM apart from its use as STD FLOWMETER.The software built into the meter evaluates the FAD automatically on line. The menu driven user friendly software prompts the user for information like ambient temperature, pressure and relative humidity, design & actual RPM, and discharge pressure. The steam tables and compressibility data are programmed into the memory as a standard feature. There is a temperature sensor which measures on line discharge temperature. The meter is also available with an optional pressure sensor which measures the discharge pressure on-line eliminating the need to feed in the value manually.

3. AGA Natural Gas Meter

The special version software is made with added capability for density computation according to American Gas Association (AGA) standards.

AGA Natural Gas Meter - This software is made with the purpose of using VFM5090(I) Meter as a Natural Gas meter which accurately calculates the density value of the gas mixture at given temperature and pressure so that the mass flow and normalized mass flow calculations will be very much accurate. Please note that this is a special version and supports only natural gas and gas mixture applications.

Heat Meter - The same software can be used to calculate the thermal power and energy for natural gas applications. Heat value of the gas mixture is also available. Thermal power at the operating P&T is calculated on line using the composition of natural gas. Thermal energy is calculated by time integrating (totalizing) thermal power. An **energy totalizer** is provided to accumulate the thermal energy.

Heat value, compressibility factor and thermal power at the operating P & T is calculated on line using the composition of natural gas.

Heat vale of the mixture can be displayed in one of the following units -

KJ/m3, MJ/m3, GJ/m3, BTU/ft3, BTU/in3, KCal/m3

The thermal power can be displayed in one of the following units -

KJ/hr, MJ/hr, GJ/hr, BTU/hr, KCal/hr, KW and MW.

Corresponding units for energy display are - KJ, MJ, GJ, BTU, KCal, KWh and MWh.

The gas components supported are

- ***Methane***
- ***Ethane***
- ***Hydrogen Sulfide***
- ***Oxygen***
- ***i-Pentane***
- ***n-Heptane***
- ***n-Decane***
- ***Nitrogen***
- ***Propane***
- ***Hydrogen***
- ***i-Butane***
- ***n-Pentane***
- ***n-Octane***
- ***Helium***
- ***Carbon Dioxide***
- ***Water***
- ***Carbon Monoxide***
- ***n-Butane***
- ***n-Hexane***
- ***n-Nonane***
- ***Argon***

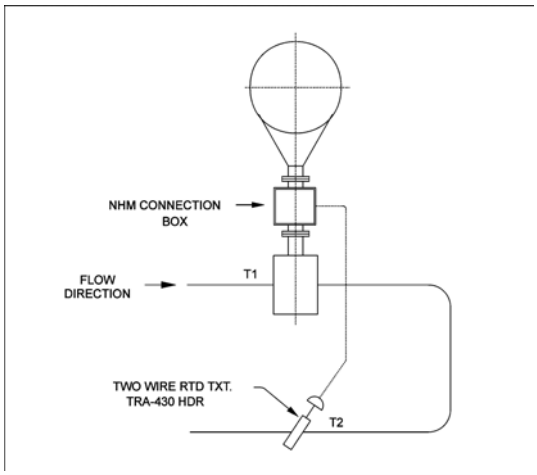
4. Net Heat Meter

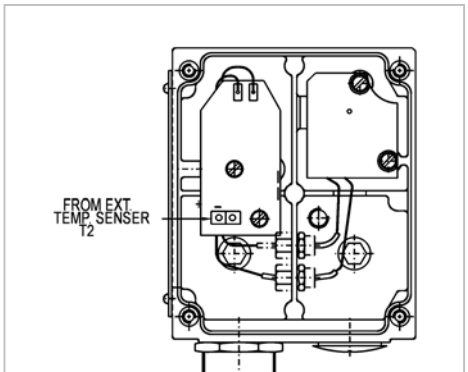
VFM-5090(I) supports net thermal power and net energy calculations for saturated steam and water. Thermal power is calculated on line from mass flow and specific enthalpy both at the inlet of the process and at the outlet. The difference between these two values is the net thermal power. The net thermal energy is calculated by time integrating (totalizing) the net thermal power. The mass flow is measured by the VFM along with the temperature at that point. The temperature at the exit of the process is also measured and transmitted (4 to 20 mA) to the VFM through an additional junction box. The mass flow rate at the inlet and outlet of the process is assumed to be the same.

Net or external thermal power can be displayed in any one of the following units.
KJ/hr, MJ/hr, GJ/hr, BTU/hr, KCAL/hr, KW, MW.

Net thermal energy units may be displayed in one of the following units.
KJ, MJ, GJ, BTU, KCAL, KWH, MWH.

For external temperature sensing, 2 wire RTD transmitter can be used. This should have current output 4 to 20 mA.& Accuracy better than +/- 0.25% of full scale .





5.7.2 OUTPUT TYPE

1. RS-232 OUTPUT

The RS-232 output option provides a means for communication of measured values to remote system. At present, this communication is in one direction only [from VFM 5090(I) to remote system]. Measured values as well as Error Messages which appear on the instrument display in the normal measurement mode are output on RS-232 line. When the RS-232 output option is present, the usual frequency output function cannot be used.

1.1 RS-232 OUTPUT

- **The RS-232 output is galvanically isolated** from all inputs and output circuits but **not** from current output. Therefore, only one grounded receiver may be connected to either RS-232 output or current output. Note that connecting RS-232 to IBM PC/compatibles will ground the RS-232 output.
- **Operating data for RS-232 output** is not programmable as in case of current or frequency output. VFM 5090(I) always uses the following operating data : 1 Start bit, 8 Data bits, No Parity, 1 Stop bit at a baud rate of 1200 bits/sec.
- **Connection diagram** for RS-232 output is given below. Please note that the RS-232 output uses the same terminals as used by the Frequency output. Consequently, when the RS-232 option is present, frequency output function can not be used.

5 **+**	**6** **-**	**4** **RXD**	**4.1** **TXD**	**4.2** **GND**

1.2 CHARACTER FORMAT

Measured values or Error messages which appear on instrument display in normal measuring mode are coded as series of 8-bit characters or “bytes”. These are transmitted serially, using a conventional UART (Universal Asynchronous Receiver/Transmitter) function to serialize each byte. As in RS-232 or other asynchronous communication, a start bit and stop bit are added to each byte. This allow the receiving UART to identify the start of each character.

A single 8-bit byte is sent as the following sequence of 1’s and 0’s.

	0	DO	D1	D2	D3	D4	D5	D6	D7	1

Start bit <----------8 Data Bits ----------> Stop bit

Baud Rate is 1200 bits/sec. All characters are encoded in ASCII character format.

1.3 DATA FORMAT

Format for transmitting Measured values or Error messages is as follows :

Measured Value	<SP> <SP>	*unit*	<CR>	<LF>

#nn Err#	<SP> <SP>	*error mesg.*	<CR>	<LF>

where,

Measured Value	Numeric value of measured parameter as displayed in numeric field.
<SP>	ASCII space character.
unit	Unit of the measured value.
<CR> <LF>	ASCII carriage return and line-feed sequence.
#nn Err#	*nn* is the number of errors detected by the instrument.
error mesg.	Error message as appears in the alphanumeric line of display.

examples -

1234.56 <SP> <SP> m3/hr <CR> <LF>
1 Err# <SP> <SP> LOW FLOW <CR> <LF>

Note that the actual number of characters in each format is not fixed and depends on the contents of *Measured Value, unit* and *error mesg.* fields. The user system may use the 2 space characters and CR, LF characters as delimiters for fields.

2. RS-485 OUTPUT

The RS-485 output option provides a means for communication of measured values to remote system such as steam flow indicator. At present, this communication is in one direction only [from VFM5090(I) to remote system]. Measured Values as well as Error Messages which appear on the instrument display in the normal measurement mode are output on RS-485 line. When the RS-485 output option is present; the usual frequency output function cannot be used.

2.1 RS-485 OUTPUT

- **The RS-485 output is galvanically isolated** from all inputs and output circuits but **not** from current output. Therefore, only one grounded receiver may be connected to either RS-485 output or current output.
- **Operating data for RS-485 output** is not programmable as in case of current or frequency output. VFM 5090(I) always uses the following operating data : 1 Start bit, 8 Data bits, Odd Parity, 1 Stop bit at a baud rate of 1200 bits/sec.
- **Connection diagram** for RS-485 output is given below. Please note that the RS-485 output uses the same terminals as used by the Frequency output. Consequently, when the RS-485 option is present, frequency output function can not be used.

5 +	6 -	**4** **TX+**	**4.1** **TX-**	**4.2** **GND**

2.2 CHARACTER FORMAT

Measured values or Error messages which appear on instrument display in normal measuring mode are coded as series of 8-bit characters or “bytes”. These are transmitted serially, using a conventional UART (Universal Asynchronous Receiver/Transmitter) function to serialize each byte. As in RS-485 or other asynchronous communication, a start bit and stop bit are added to each byte. This allow the receiving UART to identify the start of each character.

A single 8-bit byte is sent as the following sequence of 1’s and 0’s.

	0	DO	D1	D2	D3	D4	D5	D6	D7	P	1
										Odd	

Start bit <---------- 8 Data Bits ---------- > Parity Stop bit

Baud Rate is 1200 bits/sec.

All characters are encoded in ASCII character format.

2.3 FORMAT

Format for transmitting Measured values or Error messages is as follows :

<u>If there are no Fatal Errors detected by 5090(I) :</u>

:QV<*QVval*><sp><sp><*QVunits*><sp><sp>
:QN<*QNval*><sp><sp><*QNunits*><sp><sp>
:QM<*QMval*><sp><sp><*QMunits*><sp><sp>
:TV<*TVval*><sp><sp><*TVunits*><sp><sp>
:TN<*TNval*><sp><sp><*TNunits*><sp><sp>
:TM<*TMval*><sp><sp><*TMunits*><sp><sp>
:PR<*PRval*><sp><sp><*PRunits*><sp><sp>
:TR<*TRval*><sp><sp><*TRunits*><sp><sp>
:VE<*VEval*><sp><sp><*VEunits*><sp><sp>
:FR<*FRval*><sp><sp><*FRunits*><sp><sp>
:TP<*TPval*><sp><sp><*TPunits*><sp><sp>
:TE<*TEval*><sp><sp><*TEunits*><sp><sp>
:QF<*QFval*><sp><sp><*QFunits*><sp><sp>
:XT<*XTval*><sp><sp><*XTunits*><sp><sp>
:XP<*XPval*><sp><sp><*XPunits*><sp><sp>
:NP<*NPval*><sp><sp><*NPunits*><sp><sp>
:NE<*NEval*><sp><sp><*NEunits*><sp><sp>
:H<ID>E# nn Err#<sp><sp>
:m<*mesg* m><cr><lf>

<u>If there are Fatal Errors detected by 5090(I) then measurement is not made and transmitted :</u>

:FEFATAL.ERROR<cr><lf>
:H<ID>E# nn Err#<sp><sp>
:<mesg m><cr><lf>

where,

QVval	Numeric value of measured volumetric flowrate.
QVunit	Unit of the volumetric flowrate value.
QNval	Numeric value of measured normalised flowrate.
QNunit	Unit of the normalised flowrate value.
QMval	Numeric value of measured mass flowrate.
QMunit	Unit of the mass flowrate value.
TVval	Numeric value of computed totalised volumetric flow.
TVunit	Unit of the totalised volumetric flow value
TNval	Numeric value of computed totalised normalised flow.
TNunit	Unit of the totalised normalised flow value
TMval	Numeric value of computed totalised mass flow.
TMunit	Unit of the totalised mass flow value
PRval	Numeric value of the operating pressure.
PRunit	Unit of the operating pressure
TRval	Numeric value of operating temperature.
TRunit	Unit of the operating Temperature.
VEval	Numeric value of flow velocity.
VEunit	Unit of the flow velocity.
FRval	Numeric value of measured vortex frequency
FRunit	Unit of measured vortex frequency
TPval	Numeric value of computed thermal power
TPunit	Unit of thermal power
TEval	Numeric value of computed thermal energy
TEunit	Unit of thermal energy
QFval	Numeric value of computed FAD
QFunit	Unit of FAD
XT val	Numeric value of measured external temperature

XT units	Unit of external temperature
XP val	Numeric value of computed external thermal power.
XP units	Unit of external thermal power.
NP val	Numeric value of computed net thermal power.
NP units	Unit of net thermal power.
NE val	Numeric value of computed net thermal energy.
NE units	Unit of net thermal energy.
<ID>	**Optional** meter identifier. Value between 00 to 99
#*nn* Err#	*nn* is the number of errors detected by the instrument.
error mesg.	Error message as appears in the alphanumeric line of display.
<sp>	ASCII space character.
<cr> <lf>	ASCII carriage return and line-feed sequence.

Note : Either QV, QN or QM is transmitted at a time. Similarly for TV, TN and TM.
For all transmitted parameters, the user selected unit is used.
After all parameters <cr><lf> is send instead of <sp><sp>

Example -

:QM1234.56 <sp> <sp>kg/hr <sp> <sp>
:TM1000.00<sp><sp>kg<sp><sp>
:PR1.00<sp><sp>atm<sp><sp>
:TR100.0<sp><sp>Deg.C<CR><lf>
:HE# 1 Err# <sp> <sp> LOW FLOW <cr> <lf>

Note that the actual number of characters in each format is not fixed and depends on the contents of *Measured Value, unit* and *error mesg.* fields. The user system may use the 2 space characters and CR, LF characters as delimiters for fields.

2.4 RS-485 OUTPUT (FOR AGA NATURAL GAS METER)

RS485 option given for AGA supported software is same except for some transmitted values.These values are as follows :

:CF<*CFval*><sp><sp><*CFunits*><sp><sp>
:TH<*THval*><sp><sp><*THunits*><sp><sp>
:HE# nn Err#<sp><sp>
:m<*mesg* m><cr><lf>

If there are Fatal Errors detected by 5090(I) then measurement is not made and transmitted :

:FEFATAL.ERROR***<cr><lf>***
:HE# nn Err#<sp><sp>
:<mesg m><cr><lf>
where

CFval	Numeric value of computed compressibility factor
CFunit	Unit of computed compressibility factor
THval	Numeric value of computed thermal heat value
THunit	Unit of the computed thermal heat value
#*nn* Err#	*nn* is the number of errors detected by the instrument.
error mesg.	Error message as appears in the alphanumeric line of display.
<sp>	ASCII space character.
<cr> <lf>	ASCII carriage return and line-feed sequence.

Note : Either QV, QN or QM is transmitted at a time. Similarly for TV, TN and TM.
For all transmitted parameters, the user selected unit is used.
Only those parameters selcted in the display cycle are transmitted.
After all parameters, <cr><lf> is sent instead of <sp><sp>

Example -

:QM1234.56 <sp> <sp>kg/hr <sp> <sp>
:TM1000.00<sp><sp>kg<sp><sp>
:PR1.00<sp><sp>atm<sp><sp>
:TR100.0<sp><sp>Deg.C<CR><lf>
:HE# 1 Err# <sp> <sp> LOW FLOW <cr> <lf>

Note that the actual number of characters in each format is not fixed and depends on the contents of *Measured Value, unit* and *error mesg.* fields. The user system may use the 2 space characters and CR, LF characters as delimiters for fields.
Note : In this software QFval computed FAD value is not applicable.

6. Description of program functions

6.1 Numerical order description

6.1.1 Program function description

Program functions are given in numeric order as follows

- Function number and title
- DESCRIPTION of the function
- LIMITS - Applicable limits for numerical input.
- APPEARS - Conditions when the function appears. When any function does not appear it is because it is not required

Fct. 1.0 OPERATION

This is the first main menu level. Submenus and their functions grouped under ***Fct. 1.0*** (1.x.x functions) control the operation of the instrument in the following areas.

- Range of flow measurement
- Display settings of measured values, units, errors
- Current and frequency output programming.

APPEARS - always

Fct. 1.1.0 BASIS.PARAM

The submenu groups the functions that do

- Setting of basic flow measurement type (volumetric/normalized-volumetric/mass flow measurement).
- flow range (minimum & maximum flow) to measure.
- time constant for flow rate.

APPEARS - Always.

Fct. 1.1.1 MEAS. INST. **measuring instrument type**

Set instrument to measure volumetric or normalized volumetric or mass flow rate as per the options -

● ***VOLUME*** ● ***NORM.VOLUME*** ●***MASS***

Usually, this function is used once initially. If you need to change the basic measurement type later on, you should check/reprogram all flow rate and totalizer related functions such as - ***MAX.FLOW, MIN.FLOW, FLOW UNITS, TOTAL.UNITS, 0/4mA FLOW, 20mA FLOW, RANGE F, TOT. VALUE***

LIMITS - Not applicable
APPEARS - Always

Fct. 1.1.2 MAX.FLOW **maximum flow rate**

Enter the maximum flow rate desired. Max. flow should be within the measuring range for the given primary data (3.1.x functions) and application data (3.5.x functions).

The frequency output range value directly corresponds to max. flow. If flow rate exceeds max. flow an error condition (***HIGH FLOW***) is generated which may affect current output depending on programming of ***Fct. 1.3.2 RANGE I.***

The following units are available to choose from depending on programing of ***Fct. 1.1.1 MEAS.INST.***

for volumetric flow -

● ***m3/hr***	● ***m3/min***	● ***m3/sec***
● ***Litre/hr***	● ***Litre/min***	● ***Litre/sec***
● ***ft3/hr***	● ***ft 3/min***	● ***ft3/sec***
● ***cft/hr***	● ***cft/min***	● ***cft/sec***
● ***cuft/hr***	● ***cuft/min***	● ***cuft/sec***
● ***US Gal/hr***	● ***US Gal/min***	● ***US Gal/sec***
● ***UK Gal/hr***	● ***UK Gal/min***	● ***UK Gal/sec***

for normalized volumetric flow -

● ***Norm.m3/hr***	● ***Norm.m3/ min***	● ***Norm.m3/ sec***
● ***Norm.L/hr***	● ***Norm.L/min***	● ***Norm.L/sec***
● ***Sft3/hr***	● ***Sft3/min***	● ***Sft3/sec***
● ***Scft/hr***	● ***Scft/min***	● ***Scft/sec***

for mass flow -

● ***Kg/hr***	● ***kg/min***	● ***kg/sec***
● ***T/hr***	● ***T/min***	● ***T/sec***
● ***Lb/hr***	● ***Lb/min***	● ***Lb/sec***

LIMITS. - 1 to 10,000,000,000 Practically no limit when entering max. flow. Real check on this parameter is done during plausibility test. For reference see ***Fct. 4.5 MAX. FLOW***.

APPEARS - Always

Fct. 1.1.3 MIN. FLOW **minimum flow rate** Enter the minimum flow rate in the same units as for max.flow above. Min. flow should be within the measuring range for the given primary data (3.1.X functions) and application data (3.5.X functions). If flow is below min. flow then an error condition (***LOW FLOW***) will be generated. Note that this value cannot be zero for vortex flowmeters.

LIMITS - > 0 to (0.5* max flow). Higher limit is the 50% of the value entered in ***Fct. 1.1.2 MAX. FLOW.*** Real check on this parameter is done during plausibility test. For reference see ***Fct. 4.6 MIN.FLOW.***

APPEARS – Always

Fct. 1.1.4 TIMECONST. time constant for flow rate

Enter a low-pass filter time constant in seconds to be applied to flow rate. A value of zero indicates that low-pass filter is not to be applied. With this function it is possible to compromise between a steady indication (on display/current output) and response time (to flow changes).

LIMITS - 0 to 20 seconds.

APPEARS - Always.

Fct. 1.2.0 DISPLAY

This submenu groups the display functions which

- Allow selection of units for all measured parameters.
- Select what parameters to include in display cycle.
- Select display mode (cyclic/non-cyclic) and error messages to appear or not to appear in display cycle.

APPEARS - Alwayss

Fct. 1.2.1 FLOW UNITS for display

Select a unit in which flow rate is to be displayed from the following list of the available units, depending on programming of ***Fct.1.1.1MEAS. INST.***

for volumetric flow -

- ***m3/hr*** ***m3/min*** ***m3/sec***
- ***Litre/hr*** ***Litre/min*** ***Litre/sec***
- ***ft3/hr*** ***ft 3/min*** ***ft3/sec***
- ***cft/hr*** ***cft/min*** ***cft/sec***
- ***cuft/hr*** ***cuft/min*** ***cuft/sec***
- ***US Gal/hr*** ***US Gal/min*** ***US Gal/sec***
- ***UK Gal/hr*** ***UK Gal/min*** ***UK Gal/sec***
- ***% MAX. FLOW***

for normalized volumetric flow -

- ***Norm.m3/hr*** ***Norm.m3/ min*** ***Norm.m3/ sec***
- ***Norm.L/hr*** ***Norm.L/min*** ***Norm.L/sec***
- ***Sft3/hr*** ***Sft3/min*** ***Sft3/sec***
- ***Scft/hr*** ***Scft/min*** ***Scft/sec***
- ***% MAX. FLOW***

For mass flow -

- ***Kg/hr*** ***kg/min*** ***kg/sec***
- ***T/hr*** ***T/min*** ***T/sec***
- ***Lb/hr*** ***Lb/min*** ***Lb/sec***
- ***% MAX. FLOW***

Note that the list is same as for ***Fct. 1.1.2*** except for an additional unit ***% MAX. FLOW*** (to display flow rate as a percentage of max. flow).

LIMITS - Not applicable.
APPEARS - Always.

***Fct. 1.2.2 TOTAL.UNITS* totalizer unit for display**

Totalized flow may be displayed in one of the following units.

For volumetric flow -

- ***m3*** ***Litre*** ***ft3***
- ***cft*** ***cuft*** ***US Gal***
- ***UK Gal*** ***NO DISPLAY***

For normalized volumetric flow -

- ***Norm.m3*** ***Norm.L*** ***Sft3***
- ***Scft*** ***NO DISPLAY***

For mass flow -

- ***kg*** ***T*** ***Lb***
- ***NO DISPLAY***

Use ***NO DISPLAY*** to exclude totaliser for display cycle.

LIMITS - Not applicable.

APPEARS - Always.

***Fct. 1.2.3 TEMP. UNITS* for display**

The following options exist for temperature unit

- ***Deg. C*** ***Deg. F*** ***KELVIN***
- ***NO DISPLAY***

Use ***NO DISPLAY*** to exclude temperature for display cycle.

LIMITS - Not applicable.

APPEARS - Always.

***Fct. 1.2.4 PRES. UNITS* pressure unit for display**

The following options exist for pressure. Unit with the suffix *_g* are gauge pressure units and those without the same are absolute pressure units.

- ***Pa*** ***KPa*** ***atm***
- ***Bar*** ***mBar*** ***PSI***
- ***Lbf/ft2*** ***Kg/cm2*** ***In. Hg***
- ***mm Hg*** ***mm Water*** ***pa_g***
- ***KPa_g*** ***atm_g*** ***Bar_g***
- ***mBar_g*** ***PSI_g*** ***Lbf/ft2_g***
- ***Kg/cm2_g*** ***In. Hg_g*** ***mm Hg_g***
- ***mm Water_g*** ***NO DISPLAY***

Use ***NO DISPLAY*** to exclude pressure from display cycle.

LIMITS - Not applicable.

APPEARS - If ***Fct. 3.5.1 FLUID*** is not ***LIQUID.***

***Fct. 1.2.5 VELO. UNITS* velocity unit for display**

You can choose one of the following

- ***m/Sec*** - ***ft/Sec*** - ***NO DISPLAY***

Select ***NO DISPLAY*** if you don't want this parameter to be displayed.

***Fct. 1.2.6 ERROR MSG.* display of error messages.**

If you want error messages to appear between display of parameters in normal measuring mode, choose ***YES*** otherwise select ***NO.***

LIMITS - Not applicable

APPEARS - Always.

***Fct. 1.2.7 CYCLE DISP.* cyclic/non-cyclic display.**

YES means display will cycle automatically. This means a measured parameter is shown in selected units for about 6 seconds and then the next parameter in the display cycle is shown for 6 seconds and so on. ***NO*** (non-cyclic display) means the parameter is continuously shown on the display (to see other parameters or to change setting use the ↑ key). You may see error messages in between changeover from one parameter to next if error(s) are present and ***Fct. 1.2.6 ERROR MSG.*** is ***YES.***

LIMITS - Not applicable.

APPEARS - Always.

Fct. 1.3.0 CURR.OUTP. I

This submenu groups current output related functions.

APPEARS - Always.

***Fct. 1.3.1 FUNCTION I* current output function**

Choose ***YES*** - to make current output active as per functions ***Fct. 1.3.2*** to ***Fct. 1.3.4 NO*** makes current output inactive (0 mA).

LIMITS - Not applicable.

APPEARS - Always.

***Fct. 1.3.2 RANGE I* current output range selection**

Here one selects one of the five possible range options. To set current output as 0-20mA or 4-20mA with/without error indication on current output. When a range with suffix of 22=E or 2=E is selected then it means that current output will give 22mA or 2mA error output if any error(s) are present in the instrument. Range options are listed below.

- ***0-20*** - ***4-20*** - ***0-20/22=E***
- ***4-20/22=E*** - ***4-20/2=E***

LIMITS - Not applicable.

APPEARS - If ***Fct. 1.3.1 FUNCTION I*** is ***YES.***

Fct. 1.3.3 0/4mA FLOW

Enter the flow value at which you want current output at its minimum 0mA (for 0-20 and 0-20/22=E ranges) or 4mA (for other range options).

LIMITS- 0 to (max_flow-(max_flow-min_flow)* 0.2)

Value is programmable from 0 upto below max_flow by 20% of span.

APPEARS - if ***Fct. 1.3.1 FUNCTION I*** is ***YES***

Fct. 1.3.4 20mA FLOW

Enter the flow value at which you want current output at its maximum (20mA). This function and ***Fct.1.3.3*** above define the current output with respect to flow rate. Note that both the points that you define are programmable and don't have to correspond to min. flow (***Fct. 1.1.3***) and max. flow (***Fct. 1.1.2***).

LIMITS - (iqmin + (max_flow-min_flow)*0.2) to 5* max_flow. Where iqmin is the value entered in ***Fct. 1.3.3 0/4mA FLOW*** Lower limit ensures a minimum of 20% flow span. Higher limit allows you exceed max_flow by 5 times for current output.

APPEARS : If ***Fct.1.3.1 FUNCTION I*** is ***YES.***

***Fct. 1.3.5 VARIABLE I* Current Output selection function**

Selects any one of the three options available for current output.

Options are listed below :

- ***FLOW***
- ***POWER***
- ***NET POWER***

LIMITS **:** Not applicable

APPEARS – If meter type is ***HEAT METER*** or ***NET HEAT METER.*** For meter type ***HEAT METER*** , only flow and power options are available. For meter type ***NET HEAT METER***, all three options are available.

Fct. 1.3.6 0/4 mA POWER
Enter the power value at which you want current output at its minimum 0 mA or 4 mA.

LIMITS **:** No limits

APPEARS **:** If meter type is ***HEAT METER or NET HEAT METER*** and ***Fct. 1.3.5. VARIABLE I*** is ***POWER*** or ***NET POWER.***

Fct. 1.3.7 20 mA POWER
Enter the power value at which you want current output at its minimum 20 mA.

LIMITS **:** No limits

APPEARS **:** If meter type is ***HEAT METER*** or ***NET HEAT METER*** and ***Fct. 1.3.5. VARIABLE I*** is ***POWER*** or ***NET POWER***

Fct. 1.4.0 FREQ. OUTP. F

This submenu groups frequency output related functions.

APPEARS – Always (Not when output type is RS 485 or RS 232)

Fct. 1.4.1 FUNCTION F **frequency output**

Choose ***YES*** - to make frequency output active as per functions ***Fct. 1.4.2*** to ***Fct. 1.4.4 NO*** makes frequency output inactive (0 Hz)

LIMITS - Not applicable.

APPEARS - Always. (Not when output type is RS 485 or RS 232)

Fct. 1.4.2 RANGE F **frequency output range value**

The frequency output range value is the frequency that corresponds to max. flow (***Fct. 1.1.2***). The other point is always 0 Hz for 0 flow because frequency output is designed for use with external totalizers. It is also possible to define range f in terms of pulses/unit flow.

Example -

Assume max. flow (***Fct. 1.1.2***) = 1000 Kg/hr then
range f = 10000 pulses/hr (at max. flow) and
range f = 10 pulses/Kg are identical. The latter method is better because it is easy to infer that totalizer will have a least count of 0.1 Kg (10 pulses per Kg = 1pulse per 0.1 Kg) and totalizer programming will be independent of max. flow. The various options of units for ***RANGE F*** are given below.

For volumetric flow -

- ***PULSE/hr*** ● ***PULSE/min*** ● ***PULSE/sec***
- ***PULSE/m3*** ● ***PULS/Litre*** ● ***PULS/ft3***
- ***PULS/cft*** ● ***PULS/cuft*** ● ***PULS/US.Gal***
- ***PULS/UK. Gal***

For normalized volumetric flow -

- ***PULSE/hr*** ● ***PULSE/min*** ● ***PULSE/sec***
- ***PUL/NormM3*** ● ***PULS/NormL*** ● ***PULS/Sft3***
- ***PULS/Scft***

Or mass flow -

- ***PULSE/hr*** ● ***PULSE/min*** ● ***PULSE/sec***
- ***PULS/Kg*** ● ***PULS/t*** ● ***PULS/Lb***

LIMITS - 0.0028 Hz TO 10,000 Hz. These limits are also applied when programming in pulses per unit flow units. All the necessary conversions for the same are done internally.

APPEARS - If Fct. 1.4.1 FUNCTION F is YES.

Fct. 1.4.3 PULS.WIDTH pulse width

You can limit the duration of maximum active pulse width of the frequency output for frequencies less than or equal to 10 Hz. All options that may appear are listed below. Only the possible options that are available (depending on programming of ***Fct. 1.4.2 RANGE F***) to choose are displayed during actual programming.

- ***500 mSec*** ● ***200 mSec*** ● ***100 mSec.***
- ***50 mSec*** ● ***30 mSec*** ● ***50 %***

This function helps to minimize the overheating of electro-mechanical counter coils.

LIMITS - Not applicable.

APPEARS - if ***Fct. 1.4.1 FUNCTION F*** is ***YES.***

Fct. 1.4.4 VARIABLE F **frequency output selection function**
Selects any one of the three options available for frequency output.
Options are listed below :

- ***FLOW***
- ***POWER***
- ***NET POWER***

LIMITS **:** Not applicable

APPEARS – If meter type is ***HEAT METER*** or ***NET HEAT METER.*** For meter type ***HEAT METER*** , only flow and power options are available. For meter type ***NET HEAT METER***, all three options are available.

Fct. 1.4.5 F.S. POWER
Enter full scale power value at which you want to have max. frequency programmed.

LIMITS **:** No limits

APPEARS **:** If meter type is ***HEAT METER or NET HEAT METER*** and ***Fct. 1.3.5. VARIABLE F*** is ***POWER*** or ***NET POWER.***

Fct. 1.4.6 F.S.FREQ.
Enter maximum frequency required for maximum power programmed in ***Fct. 1.4.5 F.S. POWER***

LIMITS : Maximum 10,000 Hz.

APPEARS : If meter type is ***HEAT METER*** or ***NET HEAT METER*** and ***Fct. 1.3.5. VARIABLE I*** is ***POWER*** or ***NET POWER***

Fct. 2.0 TEST.

This second main menu level groups test functions for display, current output and frequency output. There are no sub-menus under 2.0. Since these are test functions, when executed they have an immediate effect on the signal converter for the duration the test function is executed. When using all the other menu functions, the changes made are stored temporarily and have no effect on the operation of signal converter unless you quit menu and respond with ***YES*** to update changes.

APPEARS - Always

Fct. 2.1 TEST DISP. **display test**

All segments of the display are tested in the following sequence. Alphanumeric field, numeric field, arrow and key markers. You can press the **E** key at any time to terminate display test. Executing display test does not affect the normal operation of the signal converter.

LIMITS - Not applicable

APPEARS - Always.

Fct. 2.2 TEST I **current output test**

CAUTION: During this test, current output will change to test values so you should take appropriate actions depending on how you are using current output.

Place current meter in series with current loop then select one of the following values.

- ***0 mA***
- ***2 mA***
- ***4 mA***
- ***10 mA***
- ***20 mA***
- ***22 mA***

Selecting any value will cause that current to flow so that you can check on meter. Select ***CONT. YES*** to test other current value or ***CONT.NO*** to end. When the menu function finishes, normal current value depending on flow rate and programming of current output function will be restored.

LIMITS - Not applicable.

APPEARS – Always

Fct. 2.3 TEST F **frequency output test**

CAUTION: During this test frequency output will change to test values so you should take appropriate actions depending on how you are using frequency output

Connect frequency meter to frequency output. Select one of the following test values.

- ***1 Hz***
- ***10 Hz***
- ***100 Hz***
- ***1000 Hz***
- ***10000 Hz***

Selecting any value will cause that frequency to output so that you can check on meter. Select ***CONT.YES*** to test other frequency value or ***CONT.NO*** to end. When the menu function finishes, normal frequency value depending on flow rate and programming of frequency output functions will be restored.

LIMITS - Not applicable

APPEARS - Always

Fct. 3.0 INSTALL

This is a main menu level whose submenus and their functions cover all installation related functions which include

- Primary data (nominal diameter, k-factor)
- User data (language, password, totalizer setting etc.)
- Operating limits (P & T operating limits).
- Application data (medium, P & T operating etc.).
- Sensor options and pressure sensor data.

APPEARS – Always

Fct. 3.1.0 BASIS.PARAM

This submenu function allows the user to enter the vortex primary sensor data viz. nominal diameter and k-factor
APPEARS - Always.

Fct. 3.1.1 NOMINAL.DIA **nominal diameter**

Select from the options which DIN/ANSI size primary is used with the instrument. Options to choose from are -

- ***DN 10 S***
- ***DN 10***
- ***DN 15***
- ***DN 20***
- ***DN 25***
- ***DN 40***
- ***DN 50***
- ***DN 80***
- ***DN 100***
- ***DN150***
- ***DN 200***
- ***ANSI 3/8"S***
- ***ANSI 3/8"***
- ***ANSI ½"***
- ***ANSI ¾ ''***
- ***ANSI 1''***
- ***ANSI 1.5"***
- ***ANSI 2"***
- ***ANSI 3"***
- ***ANSI 4"***
- ***ANSI 6"***
- ***ANSI 8"***

LIMITS - Not applicable

APPEARS - Always

Fct. 3.1.2 K-FACTOR **k-factor of the primary**

Enter the primary constant k-factor value. This value is stamped on the instrument label in units of pulses/m3

LIMITS - Limits depend on nominal-dia

NOM.DIA	LOW LIM	HIGH LIM
DN 10S/ANSI 3/8" s	1370000	1530000
DN 10 / ANSI 3/8"	490000	543000
DN 15 / ANSI ½"	290000	330000
DN 20 / ANSI ¾"	107000	120000
DN 25 / ANSI 1"	42000	66000
DN 40 /ANSI 1.5"	12300	18700
DN 50 / ANSI 2"	6065	8800
DN 80 / ANSI 3"	1740	2730
DN 100 / ANSI 4"	775	1200
DN 150 / ANSI 6"	240	350
DN 200 / ANSI 8"	104	163

APPEARS - Always

Fct. 3.2.0 USER DATA
This is submenu level. 3.2.x functions allow selection of dialogue language, setting of password code 1, setting of built-in electronic totalizer

Fct. 3.2.1 LANGUAGE **dialogue language**
Instrument supports the following choice at present

- ***ENGLISH***
- ***GERMAN***
- ***FRENCH***

Select the language of your choice. Remember that the selection will have effect when one leaves menu and respond with ***YES*** to save changes.

LIMITS - Not applicable

APPEARS - Always

Fct. 3.2.2 ENTRY.CODE.1 **entry code 1 password**

Select ***YES*** if password should be checked to access the menu. Use password to prevent configuration changes by an unauthorized person. Answering ***NO*** means password is not required to enter menu.

LIMITS - Not applicable.

APPEARS - Always

Fct. 3.2.3 CODE 1 **code 1 password**

Enter the actual password which will be required to access menu afterwards from the point after the configuration is saved. Password consists of 9 keystrokes of 3 keys in any order. Display shows 9 empty places initially and gets filled with '*' as you go on entering keystrokes. After 9 keystrokes are over you are again requested to enter the same sequence for verification purpose. If verification is found correct then the function returns to menu level but if something went wrong, function displays ***WRONG*** for a couple of seconds (original password, if any, remains unchanged) and then returns to menu

LIMITS - Not applicable

APPEARS - If ***Fct. 3.2.2 ENTRY CODE 1*** is ***YES***.

Fct. 3.2.4 LOCATION **installation location**

Enter an alphanumeric string upto 10 characters to describe location of installation. This input has no bearing on the performance of the instrument in any way, it merely serves as a means of identification.

LIMITS - Not applicable

APPEARS - Always.

Fct. 3.2.5 TOT.VALUE **totalizer value**

This function can be used to reset the totalizer (to zero) or to set the totalizer to any starting value. Two options are presented.

- ***RESET***
- ***SET.***

To reset totalizer - Select ***RESET*** then select ***RESET YES*** as a double confirmation.

To set totalizer - Select ***SET*** then enter the value

LIMITS - Setting limits 0 to 1,000,000

APPEARS - Always.

Fct. 3.2.6 TOT. ON/OFF totalizer on/off

Select option ***TOT. ON*** to start/restart totalizer and select option ***TOT. OFF*** to stop totalizer. Stopping totalizer means flow will not be accumulated till the time totalizer is turned on again.

LIMITS - Not applicable.

APPEARS - Always

Fct. 3.3.0 OPR.LIMITS

This submenu level has functions which allow user to set process temperature and pressure limits. These values should be within the physical limits of the instrument itself. (Physical limits are programmed by KHRONE MARSHALL and user has no access to them. They depend on primary pressure rating and standard or high temperature version). Programming these values are important because it is possible to ascertain whether any limit is being exceeded by the process.
To check pressure limits pressure sensor should be present in the primary. Temperature sensor is always present in the primary.

APPEARS - Always.

Fct. 3.3.1 TEMP. LOW temperature low limit

Enter value for operating temperature lower limit. The value can be entered in the following units -

- ***Deg. C***
- ***Deg. F***
- ***KELVIN***

LIMITS - Temp_low_phy to temp_high_phy are the physical limits which are preprogrammed by KHRONE MARSHALL. Typically, the ranges are :- 20 to 180 Deg. C and -20 to 240 Deg. C for standard and high temp. version respectively.

APPEARS - Always.

Fct. 3.3.2 TEMP. HIGH temperature high limit

Enter value for operating temperature higher limit. The value is entered in the same units as in ***Fct. 3.3.1*** above.

LIMITS - temp_low_opr to temp_high_phy. temp_low_opr is temperature value entered in ***Fct. 3.3.1 TEMP.LOW.***

APPEARS - Always.

Fct. 3.3.3 PRES. LOW pressure low limit

Enter value for operating pressure lower limit. The value can be entered in the following units. Unit with the *_g* suffix are gauge pressure units and those without the same absolute pressure units.

- ***Pa***
- ***KPa***
- ***atm***
- ***Bar***
- ***mBar***
- ***PSI***
- ***Lbf/ft2***
- ***Kg/cm2***
- ***In. Hg***
- ***mm Hg***
- ***mm Water***
- ***Pa_g***
- ***KPa_g***
- ***atm_g***
- ***Bar_g***
- ***mBar_g***
- ***PSI_g***
- ***Lbf/ft2_g***
- ***Kg/cm2-g***
- ***In. Hg_g***
- ***mm Hg_g***
- ***mm Water_g***

LIMITS - Pres_low_phy to pres_high_phy above are the physical limits which are preprogrammed by KHRONE MARSHALL, depending on the pressure rating of primary.

APPEARS - Always.

Fct. 3.3.4 PRES. HIGH pressure high limit

Enter value for operating pressure higher limit. The value is entered in the same units as in ***Fct. 3.3.3*** above.

LIMITS - Pres_low_opr to pres_high_phy pres_low_opr is pressure value entered in ***Fct. 3.3.3 PRES.LOW.***

APPEARS - Always.

Fct. 3.5.0 APPLICAT.

This submenu groups functions which allow to view/enter the application data. These functions gives the following information to the instrument.
- process medium
- operating temperature and pressure conditions.
- density of medium at operating conditions. Required only if software within instrument do not support the medium (***Fct. 3.5.2*** is selected as -***NONE***-).
- normal or reference P & T values required for normalized flow measurements only (depending on ***Fct. 1.1.1***). Usual values are temp.norm=0 or 20^0 C and pres.norm=1 atm.
- density at normal conditions. Required only for normalized volumetric flow and if software within instrument does not support the medium (***Fct. 3.5.2*** is selected as -***NONE***-).

APPEARS - Always.

***Fct. 3.5.1 FLUID* fluid type**

Select whether process medium is Steam, Gas (including air), Mixture of gases, Moist gas or Liquid.

- ***STEAM*** - ***GAS*** - ***GAX MIX***
- ***WET GAS*** - ***LIQUID***

LIMITS - Not applicable

APPEARS - Always.

***Fct. 3.5.2 MEDIUM* process medium**

Select the medium from the options given below. If the medium used is not included in the option list select ***-NONE-***. For all the mediums except ***-NONE-*** instrument software calculates density of the medium from P & T conditions which is required for meter sizing, mass flow and normalized flow computations. However, for unsupported medium user has to supply density at operating P & T and density at normal P & T (latter for normalized flow only)

Options for fluid STEAM -

- ***SAT STEAM*** - ***SUP STEAM***

(Saturated and superheated steam)

Options for fluid **Gas**

- ***AIR*** - ***AMMONIA*** - ***ARGON***
- ***I-BUTANE*** - ***N-BUTANE*** - ***CO***
- ***CO2*** - ***ETHANE*** - ***ETHYLENE***
- ***HEXANE*** - ***HYDROGEN*** - ***H2S***
- ***METHANE*** - ***NEON*** - ***NITROGEN***
- ***OXYGEN*** - ***I-PENTANE*** - ***N-PENTANE***
- ***PROPANE*** - ***XENON*** - ***-NONE-***

(***CO*** is carbon monoxide, ***CO2*** is carbon dioxide, ***-NONE-*** is none of the above)

Option for fluid WET GAS

- ***AIR*** - ***AMMONIA*** - ***ARGON***
- ***I-BUTANE*** - ***N-BUTANE*** - ***CO***
- ***CO2*** - ***ETHANE*** - ***ETHYLENE***
- ***HEXANE*** - ***HYDROGEN*** - ***H2S***
- ***METHANE*** - ***NEON*** - ***NITROGEN***
- ***OXYGEN*** - ***I-PENTANE*** - ***N-PENTANE***
- ***PROPANE*** - ***XENON***

Option for fluid LIQUID

- ***WATER*** - ***-NONE-***

LIMITS - Not applicable

APPEARS - Fluid is other than ***GAS MIX.***

***Fct. 3.5.3 SAT. P/T* use saturation P or T**

For saturated steam only one of the operating temperature or pressure is needed for density calculation. Select whether you are going to specify saturation temp. or pressure from the following options -

- ***SAT TEMP*** - ***SAT.PRES.***

Actual value of temp. or pressure is to be entered under ***Fct. 3.5.6 TEMP.OPR*** or ***Fct. 3.5.7 PRES.OPR.***

LIMITS - Not Applicable

APPEARS - if fluid is ***STEAM*** and medium is ***SAT STEAM***

***Fct. 3.5.4 % GAS MIX* percentage of gases**

Select the components of gas mixture. Enter the mole fraction percentage of gases present in the mixture of gases. The list of gases available is given below. For the components not present in the mixture, keep the percentages as zero. The sum of percentages of gas components should be equal to 100 ± 0.1.

List of gases for fluid GAS MIX -

- ***AMMONIA*** - ***ARGON*** - ***I-BUTANE***
- ***N-BUTANE*** - ***CO*** - ***CO2***
- ***ETHANE*** - ***ETHYIENE*** - ***HEXANE***
- ***HYDROGEN*** - ***H2S*** - ***METHANE***
- ***NEON*** - ***NITROGEN*** - ***OXYGEN***
- ***I-PENTANE*** - ***N-PENTANE*** - ***PROPANE***
- ***XENON***

LIMITS - 0 to 100 % for each gas.

APPEARS - if fluid is ***GAS MIX***

***Fct. 3.5.5. % REL HUM* Relative humidity**

Enter relative humidity of moist gas in the range of zero to hundred.

LIMITS - 0 to 100 %

APPEARS - if fluid is WET GAS

***Fct. 3.5.6 TEMP. OPR* operating temperature**

Enter the mean (average) operating temperature of the medium. This parameter is very important since it is involved in the following -
Flow range check - During plausibility check, flow range of measurement is computed to see that ***Fct. 1.1.2 MAX FLOW*** and ***Fct. 1.1.3 MIN. FLOW*** are plausible. This calculation is function of nom.

diameter, fluid, medium and density. Where density depends on temp. operating for all mediums except ***-NONE-***

Flow computations - When temp. sensor is not present, value given here is used in flow computations for all mediums except -***NONE***- Temperature value can be entered in one of the units same as in ***Fct. 3.3.1.***

LIMITS - Temp_low_opr to temp_high_opr

Limits for operating temp. are the operating temp. range as given in -

Fct 3.3.1 TEMP. LOW and ***Fct. 3.3.2 TEMP. HIGH.***

APPEARS - Does not appear if medium is saturated steam and ***Fct. 3.5.3 SAT. P/T*** is set to ***SAT. PRES.***

Fct. 3.5.7 PRES. OPR **operating pressure**

Enter the mean (average) operating pressure of the medium. This parameter is very important since it is involved in the following -

Flow range check - During plausibility check, flow range of measurement is computed to see that ***Fct. 1.1.2 MAX. FLOW*** and ***Fct. 1.1.3 MIN. FLOW*** are plausible. This calculation is function of nom. diameter, k-factor, fluid, medium and density. Where density depends on operating pressure for all mediums except ***-NONE***-.

Flow computations - When pressure sensor is not present, value given here is used in flow computations for mass or normalized flow computations for mass or normalized flow and for all mediums except -***NONE***-. Pressure value can be entered in one of the units same as in ***Fct. 3.3.3.***

LIMITS - Pres_low_opr to pres_high_opr

Limits for operating pressure are the operating pressure range given in ***Fct. 3.3.3 PRES. LOW*** and ***Fct. 3.3.4 PRES. HIGH.***

APPEARS - Does not appear if -

1. Medium is saturated steam & ***Fct. 3.5.3 SAT. P/T*** is set to ***SAT. TEMP*** or
2. ***Fluid*** is ***Liquid***.

Fct. 3.5.8 DENS. OPR. **density at operating P&T**

Enter the density of medium at operating pressure and temp. conditions. The value can be entered in one of the following units -

- ***Kg/m3***
- ***Kg/Litre***
- ***Lb/ft3***
- ***Lb/cft***

LIMITS - 0.6 to 100Kg/m^3

APPEARS - If fluid is ***GAS*** and medium is ***NONE -***

Fct. 3.5.9 TEMP. NORM **normal temperature**

Enter value for normal/base/reference temperature.

This value is usually 0^0 or 20^0 C. Unit options for this value are the same as in ***FCT. 3.3.1***.

LIMITS - 0 to 50 Deg. C.

APPEARS - if ***Fct. 1.1.1 MEAS. INST*** is ***NORM. VOLUME.***

Fct. 3.5.10 PRES. NORM normal pressure

Enter value for normal/base/reference pressure. This value is usually 1 atm. Unit options for this value are the same as in ***Fct. 3.3.3.***

LIMITS - 0.1 to 10 bar

APPEARS - if ***Fct. 1.1.1 MEAS. INST*** is ***NORM.VOLUME*** and fluid is not ***LIQUID.***

Fct. 3.5.11 DENS.NORM. **density at normal P&T**

Enter the density of medium at normal pressure and temp. conditions. The value can be entered in one of the following units -

- ***Kg/m3***
- ***Kg/Litre***
- ***Lb/ft3***
- ***Lb/cft***

LIMITS - 0.6 to 100 Kg/m^3

APPEARS - if ***Fct. 1.1.1 MEAS.INST*** is ***NORM.VOLUME*** and fluid is ***GAS*** and medium is ***-NONE-***

Fct. 3.6.0 OPTIONS
Functions under this submenu allow one to inform instrument whether pressure sensor and temperature sensor are installed.

APPEARS - Always.

Fct. 3.6.1 T-SENSOR **temperature sensor**

Select ***YES*** if temperature sensor option is present else select ***NO.***

LIMITS - Not applicable.

APPEARS - Always

***Fct. 3.6.2 P-SENSOR* pressure sensor**

Select ***YES*** if pressure sensor option is present else select ***NO.***

LIMITS **-** Not applicable.

APPEARS - If fluid is not ***LIQUID.***

***Fct. 3.6.3 RS485 ID* RS485 identifier**

Use this menu to select whether identifier of the meter should be used in RS485 transmission. If ***YES*** is selected, then identifier number for the meter can be entered using ***Fct. 3.6.4 METER ID*** menu.

LIMITS - Not applicable

APPEARS - If output type of the meter is selected as RS 485.

***Fct. 3.6.4 METER ID* Meter identifier**

Use this menu to set the RS485 identifier number for the meter. This number is used in RS485 transmission and is transmitted with every data frame if ***Fct. 3.6.3 RS485 ID*** is selected as ***YES.***

LIMITS - 0 to 99

APPEARS - If output type of the meter is selected as ***RS 485*** and ***Fct. 3.6.3 RS485 ID*** is selected as ***YES.***

Fct. 3.7.0 P-DATA

This submenu groups functions which input the pressure sensor calibration data. Pressure sensor calibration data (mV output vs. pressure) is obtained at two temperatures. So, it is possible to compensate pressure sensor for temperature variations.

APPEARS - If ***FLUID*** is not ***LIQUID*** and ***Fct. 3.6.2 P-SENSOR*** is ***YES.***

***Fct. 3.7.1 T1* calibration temperature 1**

Enter the calibration temperature 1. Units possible to use are same as in ***Fct. 3.3.1.***

LIMITS - 20 to 100 Deg. C.

APPEARS - if Fct. 3.6.2 ***P-SENSOR*** is ***YES*** and ***FLUID*** is not ***LIQUID***.

***Fct. 3.7.2 P11 V11* calibration point 1 at T1**

Enter pressure value (in one of the units same as in ***Fct. 3.3.3***) and the corresponding milli-volt value.
LIMITS - 0 to 40 Bar for P11.
0 to 25 mV for V11.

APPEARS - if ***Fct. 3.6.2 P-SENSOR*** is ***YES*** and fluid is not ***LIQUID.***

***Fct. 3.7.3 P12 V12* calibration point 2 at T1**

Enter pressure value (same unit assumed as in ***Fct. 3.7.2***) and the corresponding milli-volt value.

LIMITS - 5 to 100 Bar for P12.
40 to 125 mV for V12.

APPEARS - If ***Fct. 3.6.2 P-SENSOR*** is ***YES*** and fluid is not ***LIQUID.***

***Fct. 3.7.4 T2* calibration temperature 2**

Enter the calibration temperature 2. Unit is assumed same as selected in ***Fct.3.7.1.***

LIMITS - 101 to 200 Deg. C.

APPEARS - If ***Fct. 3.6.2 P-SENSOR*** is ***YES*** and fluid is not ***LIQUID.***

***Fct. 3.7.5 P21 V21* calibration point 1 at T2**

Enter pressure value (unit assumed to be same as selected in ***Fct. 3.7.2***) and the corresponding milli-volt value.
LIMITS - 0 to 40 Bar for P21.
0 to 25 mV for V21.

APPEARS - If ***Fct. 3.6.2 P-SENSOR*** is ***YES*** and fluid is not ***LIQUID.***

***Fct. 3.7.6 P22 V22* Calibration point 2 at T2**

Enter pressure value (same unit assumed as in ***Fct.3.7.2)*** and the corresponding milli-volt value.
LIMITS - 5 to 100 Bar for P22
40 to 125 mV for V22

APPEARS - if ***Fct. 3.6.2 P-SENSOR*** is ***YES*** and fluid is not ***LIQUID.***

Fct. 3.8.0 HEAT PARA.

This submenu groups functions which allow to view/enter the heat meter power/energy calculation related data. These functions give the following information to the instrument
- Units for power
- Units for energy
- Energy totalizer Reset/Set
- Energy totalizer ON/OFF
- Dryness factor for Saturated steam applications.

APPEARS - If ***Fct. 1.1.1 MEAS. INST*** is ***MASS*** and ***Fct. 3.5.1 FLUID*** is ***STEAM*** or ***LIQUID.***

***Fct. 3.8.1 POWER. UNITS* thermal power units**

Thermal power may be displayed in one of the following units.

- ***KJ/hr*** ***MJ/hr*** ***GJ/hr***
- ***BTU/hr*** ***KCal/hr***
- ***KW*** ***MW*** ***NO DISPLAY***

LIMITS - Not Applicable

APPEARS - Always.

Fct. 3.8.2 ENER UNITS **thermal energy units**

Thermal energy may be displayed in one of the following units. These units are used for energy totalizer.

- ***KJ*** ***MJ*** ***GJ***
- ***BTU*** ***KCal***
- ***KWH*** ***MWH*** ***NO DISPLAY***

LIMITS - Not Applicable

APPEARS - Always

Fct. 3.8.3 E. TOT.VAL **energy totalizer value**

This function can be used to reset the energy totalizer (to zero) or to set the totalizer to any starting value.

Two options are presented –

- ***RESET*** ***SET***

LIMITS - 0 to 1,000,000

APPEARS - Always

Fct. 3.8.4 ETOT.ON/OFF **energy totalizer on/off**

Select option ***TOT.ON*** to start/restart energy totalizer and select option ***TOT.OFF*** to stop energy totalizer. Stopping energy totalizer means energy value will not be accumulated till the time the energy totalizer is turned on again.

LIMITS - Not Applicable.

APPEARS - Always.

Fct. 3.8.5 DRY.FACT **dryness factor**

Enter dryness factor for Saturated Steam.

LIMITS - 0.85 to 1.0

APPEARS - If ***Fct. 3.5.1 FLUID*** is ***STEAM*** and ***Fct. 3.5.2 MEDIUM*** is ***SAT.STEAM***

Fct. 3.8.6 NT.PWR UNITS **Net thermal power units.** Thermal power can be displayed in any one of the following units.

- ***KJ/hr*** ***BTU/hr*** ***GJ/hr***
- ***MW*** ***MJ/h*** ***KCAL/hr*** ***KW***
- ***NO DISPLAY***

LIMITS **:** Not applicable

APPEARS **:** If meter is ***NET HEAT METER***

Fct. 3.8.7 NT.PWR UNITS **Net thermal energy units.**
Thermal energy can be displayed in any one of the following units.

- ***KJ*** ***MJ*** ***GJ***
- ***BTU*** ***KcaL*** ***KWH***
- ***MWH*** ***NO DISPLAY***

LIMITS : Not applicable
APPEARS : If meter type is ***NET HEAT METER.***

Fct. 3.8.8 NT.EN.TOT.VAL **Net energy totalizer value.**
This function can be used to reset the totalizer to zero or to set it to any starting value. Two options are presented.

- ***RESET***
- ***SET***

To reset the totalizer – select ***RESET*** then select ***RESET YES*** as a double confirmation.
To set totalizer – select *SET* then enter the value.

LIMITS - Setting limits 0 to 10,00,000

APPEARS : If meter is ***NET HEAT METER***

Fct. 3.8.9 NE.TOT.ON/OFF **Net energy totalizer on/off**
Select option ***TOT.ON/OF*** to start/restart the totalizer and select ***TOT,OFF*** to stop thre totalizer means net power will not be accumulated till the time totalizer is turned on again.

LIMITS - Not Applicable.

APPEARS : If meter is ***NET HEAT METER***

Note : If the NET HEAT METER option is selected, only two of the three totalizers i.e. flow totalizer energy totalizer ,net energy totalizer can be selected at a time and not all the three.

Fct.3.8.10 EXT.TEMP.UNIT.**External temperature display unit.**
This selects unit to display temperature of the external temperature sensor. The options available are

- ***Deg. C***
- ***Deg. F***
- ***KELVIN***
- ***NO DISPLAY***

Fct. 3.8.11 EXT. TEMP. F. S. **External tempertaure full scale value.**
This function is used to enter the full scale value of the external tempertaure sensor.

LIMITS **:Upto 300 Deg. C**

APPEARS **: If meter type is *NET HEAT METER*.**

Fct. 3.8.12 EXT. POWER UNITS
This function is used to select the units to display thermal power at external temperature sensor location. The options avaliable are

- ***KJ/hr***
- ***MJ/hr***
- ***GJ/hr***
- ***BTU/hr***
- ***KW***
- ***MW***
- ***NO DISPLAY***

Fct. 3.8.13 EX. DRY.FACT. **External dryness factor.**
Enter dryness factor for saturated steam.

LIMITS **:** from 0 to 1

APPEARS **:** If meter type is ***NET HEAT METER*** **and Fct.3.5.1 *FLUID* is *STEAM.***

Fct. 3.8.14 SEL. PROCESS **Select process.**
This function is used to select the process. Options available are

- ***HEAT T1>T2***
- ***CHILL T2 > T1***
- ***DON'T CARE***

LIMITS **:Not applicable.**

APPEARS **:**If meter type is ***NET HEAT METER.***

Fct. 3.8.15 NULL TEMP.
This function is used to null the difference between temperature sensors T1 & T2 in the plant when plant is not running. This eliminates the error in the calculation due to offset in same temperature reading if measured by two different temperature sensors.

LIMITS - max 3 deg. C
APPEARS – If meter type is ***NET HEAT METER.***

Fct 3.9.0 FAD PARA

This submenu level has functions which allow user to program all operating data for FAD application.

APPEARS - If meter type is FAD meter.

Fct. 3.9.1 FAD UNITS **units for FAD**

Select unit for display of parameter FAD Volume flow. (FAD flow is vol. flow as calculated by meter at the suction side of compressor.).

- ***FAD.m3/hr***
- ***FAD.m3/min***
- ***FAD.m3/sec***
- ***FAD.L./hr.***
- ***FAD.L./min***
- ***FAD.L./sec***
- ***FAD.ft3/hr***
- ***FAD.ft3/min***
- ***FAD.ft3/sec***
- ***FAD.cft/hr***
- ***FAD.cft/min***
- ***FAD.cft/sec***
- ***NO DISPLAY***

LIMITS - Not Applicable

APPEARS - Always

NOTE: If the unit selected is NO DISPLAY then all other *Fct.3.9.x* functions are not shown and FAD calculations are not performed by VFM 5090(I)

Fct. 3.9.2 TEMP.SUCT **suction temperature**

Enter the suction temperature in any of the following units -

- ***Deg. C***
- ***Deg. F***
- ***KELVIN***

LIMITS - 20^0C to 70^0C

APPEARS - Please refer to the NOTE.

Fct. 3.9.3 PRES. ATM. **atmospheric pressure**

Enter atmospheric pressure. Possible units for this parameter are -

- ***Pa***
- ***KPa***
- ***atm***
- ***Bar***
- ***mBar***
- ***PSI.***
- ***Lbf/ft2***
- ***Kg/cm2***
- ***In.Hg.***
- ***mm Hg***
- ***mm Water***
- ***Pa_g***
- ***KPa_g***
- ***atm_g***
- ***Bar_g***
- ***mBar_g***
- ***PSI_g***
- ***Lbf/ft2_g***
- ***Kg/cm2_g***
- ***In. Hg_g***
- ***mm Hg_g***
- ***mm Water_g***

LIMITS - 0.5 to 2.0 atm

APPEARS - Please refer to the NOTE.

Fct. 3.9.4 PRES. FDROP Filter Pressure drop

Enter value of pressure drop across the filter at the inlet of the compressor. (If there is no such filter installed then keep this value as zero).

Units for this parameter entry are

- ***Pa***
- ***KPa***
- ***atm.***
- ***Bar***
- ***mBar***
- ***PSI.***
- ***Lbf / ft2***
- ***Kg/cm2***
- ***In. Hg.***
- ***mm Hg***
- ***mm Water***
- ***Pa_g***
- ***KPa_g***
- ***atm_g***
- ***Bar_g***
- ***mBar_g***
- ***PSI_g***
- ***Lbf / ft2_g***
- ***Kg / cm2_g***
- ***In. Hg_g***
- ***mm Hg_g***
- ***mm Water_g***

LIMITS - 0 to 2.0 atm.

APPEARS - Please refer to the NOTE.

Fct. 3.9.5 RH SUCT. Relative humidity at suction

Enter the relative humidity at the suction side (i.e. ambient air). Units are % RH.

LIMITS - 0 to 100

APPEARS - Please refer to the NOTE.

Fct. 3.9.6 RPM ACTUAL actual rpm

Enter the measured speed of the compressor motor in RPM.

LIMITS - 0 to 10000

APPEARS - Please refer to the NOTE

Fct. 3.9.7 RPM RATED rated rpm

Enter the rated speed of the compressor motor in RPM.

LIMITS - 0 to 10000

APPEARS - Please refer to the NOTE.

Fct. 3.9.8 RH OP relative humidity operating

Enter the relative humidity at the meter side (i.e Compressor outlet side). Typically this value is 100%. Units are % RH.

LIMITS - 0 to 100
APPEARS - Please refer to the NOTE.

Fct. 4.0 PARAM.ERROR

Parameter Error menu level appears if parameter check fails in the plausibility tests. There are no submenus under this level. When this menu is displayed use the ➔ key to see the functions which need be corrected. When you correct the parameter, that function instantly disappears from the 4.x. list and when all such function parameters are corrected, menu automatically returns to 4.0 level.

APPEARS - if plausibility test detects errors when attempting to save the configuration in non-volatile memory.

Fct. 4.1 K-FACTOR k-factor of the primary

Enter the primary constant k-factor value. This value is stamped on the instrument label and in units of pulses/m3.

LIMITS - Limits are same as those given in ***Fct. 3.1.2***

APPEARS - if k-factor is outside its limits (due to change in the nominal diameter.)

Fct. 4.2 TEMP. OPR operating temperature

Enter the mean (average) operating temperature of the medium. This parameter is very important since it is involved in the following -

Flow range check - During plausibility check, flow range of measurement is computed to see that ***Fct. 1.1.2 MAX.FLOW*** and ***Fct. 1.1.3 MIN. FLOW*** are plausible. This calculation is function of nom. diameter, k-factor, fluid, medium and density. Where density depends on temp. operating for all mediums except ***-NONE-.***

Flow computations - When temp. sensor is not present, value given here is used in flow computations for mass or normalized flow and for all mediums except ***-NONE-*** Temperature value can be entered in one of the units same as in ***Fct. 3.3.2.***

LIMITS - Limits are same as those given in ***Fct. 3.5.6***

APPEARS - if operating temp. is outside its limit. This may happen if operating temp. range is changed without changing operating temp. such that the operating temp. is outside its limits.

Fct. 4.3 PRES.OPR operating pressure

Enter the mean (average) operating pressure of the medium. This parameter is very important since it is involved in following -

Flow range check - During plausibility check, flow range of measurement is computed to see that ***Fct. 1.1.2 MAX. FLOW*** and ***Fct. 1.1.3 MIN. FLOW*** are plausible. This calculation is function of nom. diameter, k-factor, fluid, medium and density. Where density depends on operating pressure for all mediums except ***-NONE-***

Flow computations - When pressure sensor is not present, value given here is used in flow computations for mass or normalized flow for all mediums except ***-NONE-***

Pressure value can be entered in one of the units same as in ***Fct. 3.3.3.***

LIMITS - Limits are same as those given in the ***Fct.3.5.7.***

APPEARS - if operating pressure is outside its limits. This may happen if operating pressure range is changed without changing the operating pressure such that the operating pressure is outside its valid limits.

Fct. 4.4 % GAS MIX Percentage of gases

Select the components of gas mixture. Enter the mole fraction percentage of gases present in the mixture of gases. The list of gases available is given below. For the components not present in the mixture, keep the percentage as zero. The sum of percentages of gas components should be equal to 100 ± 0.1

List of gases for fluid GAS MIX -

- ***AMMONIA***
- ***ARGON***
- ***I-BUTANE***
- ***N-BUTANE***
- ***CO***
- ***CO2***
- ***ETHANE***
- ***ETHYLENE***
- ***HEXANE***
- ***HYDROGEN***
- ***H2S***
- ***METHANE***
- ***NEON***
- ***NITROGEN***
- ***OXYGEN***
- ***I-PENTANE***
- ***N-PENTANE***
- ***PROPANE***
- ***XENON***

LIMITS - 0 to 100 % for each gas

APPEARS - if fluid is ***GAS MIX.***

Fct. 4.5 MAX. FLOW maximum flow rate

Enter the maximum flow rate desired. Max. flow should be within measuring range for the given primary data (3.1.x functions) and application data (3.5.x functions). The frequency output range value directly corresponds to max. flow. If flow rate exceeds max. flow an error condition (***HIGH FLOW***) is generated which may affect current output depending on programming of ***Fct. 1.3.2 RANGE I.*** The following units are available to choose from depending on programming of ***Fct. 1.1.1 MEAS. INST.***

For volumetric flow -

- ***m3/hr***
- ***m3/min***
- ***m3/sec***
- ***Litre/hr***
- ***Lirtre/min***
- ***Litre/sec***
- ***ft3/hr***
- ***ft3/min***
- ***ft3/sec***
- ***cft/hr***
- ***cft/min***
- ***cft/sec***
- ***cuft/hr***
- ***cuft/min***
- ***cuft/sec***
- ***US Gal/hr***
- ***US Gal/min***
- ***US Gal/sec***
- ***UK Gal/hr***
- ***UK Gal/min***
- ***UK Gal/sec***

For normalized volumetric flow -

- ***Norm.m3/hr***
- ***Norm.m3/min***
- ***Norm.m3/sec***
- ***Norm.L./hr***
- ***Norm.L./min***
- ***Norm.L./sec***
- ***Sft3/hr***
- ***Sft3/min***
- ***Sft3/sec.***
- ***Scft/hr***
- ***Scft/min***
- ***Scft/sec***

or mass flow –

- ***Kg/hr***
- ***Kg/min***
- ***Kg/sec***
- ***T/hr***
- ***T/min***
- ***T/sec***
- ***Lb/hr***
- ***Lb/min***
- ***Lb/sec***

LIMITS - Limit is calculated from the sizing calculation from the application data and primary data. Sizing involves :

- Calculation of density at operating conditions. (User supplied value is used for unsupported medium ***-NONE).***
- calculation of minimum velocity, Vmin, from the graph of velocity vs. density. See diag. III in section Technical data.
- Maximum flow velocity,
  Vmax = 135.7306 /$\sqrt{\rho_{op}}$
  for sizes DN25 to 200(1" to 8")
  = 83.87146 / $\sqrt{\rho_{op}}$
  for sizes DN10S to 20(3/8"S to 3/4")

In both cases Vmax is clamped at 75m/s. For densities at and above 50kg/m3, Vmin is fixed at 0.94192 m/s for all sizes.

- Volumetric flow limits are qv_min = Vmin*area & qv_max = Vmax*area.
- Normalized volumetric flow rate limits are qvn_min = qv_min *opr_density/norm_density and
  qvn_max = qv_max*opr_density/norm_density.
- Mass flow rate limits are
  qm_min = qv_min*opr density and
  qm_max = qv_max*opr_density.

APPEARS - if max. flow ***Fct. 1.1.2 MAX.FLOW*** is outside the measuring range of the instrument. Metering range is computed by sizing the application as explained in the limits above.

Fct. 4.6 MIN. FLOW **minimum flow rate**

Enter the minimum flow rate in the same units as for ***MAX. FLOW*** above. ***MIN. FLOW*** should be within the measuring range for the given primary data
(3.1.x functions) and application data (3.5.x functions). If flow rate measured is below min. flow then an error condition (***LOW FLOW***) will be generated. Note that this value cannot be zero for vortex flowmeters.

LIMITS - Limit is calculated from the sizing calculations from the application data and primary data. For details of sizing see above paragraph.

APPEARS - if min. flow entered in ***Fct. 1.1.3 MIN. FLOW*** is outside the measuring range of instrument. Metering range is computed by sizing the application.

Fct. 4.7 0/4mA FLOW
Enter the flow value at which you want current output at its minimum 0mA (for 0-20 and 0-20/22 =E ranges) or 4mA (for other range options).

LIMITS - Limits are the same as those mentioned in ***Fct. 1.3.4. 0/4mA FLOW.***

APPEARS - If value entered in ***Fct. 1.3.3 0/4mA FLOW*** lies outside its limits (due to change in flow range).

Fct. 4.8 20mA FLOW
enter the flow value at which you want current output at its maximum (20mA). This function and ***Fct. 1.3.3.*** above define the current output with respect to flow rate. Note that both the points that you define are programmable and independent of min. Flow (***Fct. 1.1.3***) and max. flow (***Fct. 1.1.2.***)

LIMITS - Same as in ***Fct. 1.3.4 20 mA FLOW.***

APPEARS - if value entered in ***Fct. 1.3.4 20mA FLOW*** lies outside its limits (due to change in flow range).

Fct. 4.9 RANGE F **frequency output range value**

The frequency output range value is the frequency that corresponds to max. flow (***Fct. 1.1.2***). The other point is always 0 Hz for 0 flow because frequency output is designed for use with external totalizers. It is also possible to define range f in terms of pulses/unit flow .
Example -

Assume max. flow (***Fct. 1.1.2***) = 1000 Kg/hr then range f = 10000 pulses/hr (at max. flow) and
range f = 10 pulses/Kg are identical. The latter method is better because it is easy to infer that totalizer will have a least count of 0.1 Kg (10 pulses per Kg = 1 pulse per 0.1 Kg) and totalizer programming will be independent of max. flow. The various options of units for range f are given below.

for volumetric flow -

- ***PULSE/hr*** ***PULSE/min*** ***PULSE/sec***
- ***PULSE/m3*** ***PULS/Litre*** ***PULS/ft3***
- ***PULS/cft*** ***PULS/cuft*** ***PULS/US.Gal***
- ***PULS/UK.Gal***

for normalized volumetric flow -

- ***PULSE/hr*** ***PULSE/min*** ***PULSE/sec***
- ***PUL/Norm. m3*** ***PULS/Norm.l*** ***PULS/sft3***
- ***PULS/Scft***

or mass flow -

- ***PULSE/hr*** ***PULSE/min*** ***PULSE/sec***
- ***PULS/Kg*** ***PULS/t*** ***PULS/Lb***

LIMITS - 0.0028Hz to 10,000 Hz (Same limits as in ***Fct. 1.4.2 RANGE F.***)

APPEARS - if value entered in ***Fct. 1.4.2 RANGE F*** lies outside its limits (due to change in flow range without subsequently changing ***Fct. 1.4.2*** and invalidating its limit).

Fct. 4.10 PULS. WIDTH **pulse width**

You can limit the duration of maximum active pulse width of the frequency output for frequencies less than or equal to 10 Hz. All options that may appear are listed below. Only the possible options that are available (depending on programming of ***Fct. 1.4.2 RANGE F)*** to choose are displayed during actual programming

- ***500 mSec.*** ***200 mSec*** ***100 mSec***
- ***50 mSec.*** ***30 mSec*** ***50%***

This helps minimize the overheating of totalizer coils.

LIMITS - Not applicable

APPEARS - if value entered in ***Fct. 1.4.2 RANGE F*** is changed such that the existing pulse-width option is now not valid.

6.1.2. Program function description for AGA supported software

Fct. 3.8.5 H_VAL.UNITS **Heating value units**

May be displayed in one of the following units.

- ***KJ / m3*** ***MJ / m3*** ***GJ / m3***

- ***BTU / ft 3*** - ***BTU / in3*** - ***KCal / m3***

LIMITS - Not applicable

APPEARS – Always

***Fct. 3.8.6 Z FACTOR* compressibility factor units**
Compressibility factor display can be enabled by selecting the unit as Z-FACTOR from the menu list.

- ***Z FACTOR*** - ***NO DISPLAY***

LIMITS - Not Applicable

APPEARS - Always

6.2 Functional order description

6.2.1 Physical units

FLOW RATE UNITS

Refer to functions.
***Fct. 1.1.2 MAX. FLOW* maximum flow rate**
***Fct. 1.1.3 MIN. FLOW* minimum flow rate**
***Fct. 1.2.1 FLOW UNITS* for display**
Fct. 1.3.3 0/4mA FLOW
Fct. 1.3.4 20mA FLOW
***Fct. 4.5 MAX FLOW* maximum flow rate**
***Fct. 4.6 MIN.FLOW* minimum flow rate**
Fct. 4.7 0/4 mA FLOW
Fct. 4.8 20/mA FLOW
Functions ***MIN. FLOW, mA 0/4 FLOW & 20mA FLOW*** use the same unit as selected in ***MAX. FLOW.***

Units for flow rate -

For volumetric flow -

- ***m3/hr*** - ***m3/min*** - ***m3/sec***
- ***Litre/ hr*** - ***Litre/ min*** - ***Litre/sec***
- ***ft3/ hr*** - ***ft3/ min*** - ***ft3/sec***
- ***cft/hr*** - ***cft/ min*** - ***cft/sec***
- ***cuft/ hr*** - ***cuft/ min*** - ***cuft/sec***
- ***US Gal/ hr*** - ***US Gal/ min*** - ***US Gal/sec***
- ***UK Gal/ hr*** - ***UK Gal/ min*** - ***UK Gal/sec***
- ***% MAX FLOW*** (only for *Fct. 1.2.1 FLOW UNITS*)

for FAD-METER following units are also available

Fct. 3.9.1 FAD UNITS select unit display of parameter FAD Volume flow.

- ***FAD.m3/hr*** - ***FAD.m3/min*** - ***FAD.m3/sec***
- ***FAD.L../hr*** - ***FAD.L/min*** - ***FAD.L./sec***
- ***FAD.ft3/hr*** - ***FAD.ft3/min*** - ***FAD.ft3/sec***
- ***FAD.cft/hr*** - ***FAD.cft/min*** - ***FAD.cft/sec***

For normalized volumetric flow -

- ***Norm.m3/ hr*** - ***Norm.m3/ min*** - ***Norm.m3/ sec***
- ***Norm.Litre/ hr*** - ***Norm.Litre/ min*** - ***Norm.Litre/sec***
- ***Sft3/ hr*** - ***Sft3/ min*** - ***Sft3/ sec***
- ***Scft/ hr*** - ***Scft/ min*** - ***Scft/ sec***
- ***% MAX FLOW*** (only for ***Fct. 1.2.1 FLOW UNITS***)

For mass flow -

- ***Kg/hr*** - ***Kg/min*** - ***Kg/sec***
- ***T/hr*** - ***T/min*** - ***T/sec***
- ***Lb/hr*** - ***Lb/min*** - ***Lb/sec***
- ***% MAX FLOW***
  (only for ***Fct. 1.2.1 FLOW UNITS***)

TOTALIZER UNITS
Refer to functions -
***Fct. 1.2.2 TOTAL.UNITS* totalizer unit for display**
***Fct. 3.2.5 TOT. VALUE* totalizer value**
Function TOT. VALUE uses the same unit as selected in ***TOTAL.UNITS.***
Units for totalizer -

- ***m3*** - ***Litre*** - ***ft3***
- ***cft*** - ***cuft*** - ***US Gal***
- ***UK Gal***

If meter is HEAT-METER, Refer to functions -
***Fct. 3.8.3 E.TOT.VAL* energy totalizer value**

- ***KJ*** - ***MJ*** - ***GJ***
- ***BTU*** - ***KCal***
- ***KWH*** - ***MWH***

If meter type is NET HEAL METER, refer Fct. 3.8.7 for net thermal energy units.

TEMPERATURE UNITS
Refer to functions -
***Fct . 1.2.3 TEMP. UNIT* for display**
***Fct. 3.3.1 TEMP. LOW* temperature low limit**
***Fct. 3.3.2 TEMP. HIGH* temperature high limit**
***Fct. 3.5.6 TEMP. OPR* operating temperature**
***Fct. 3.5.9 TEMP. NORM* normal temperature**
***Fct. 3.8.10 EXT. TEMP. UNIT* external temp. display unit.**
***Fct. 3.7.1 T1* calibration temperature 1**
***Fct. 3.7.4 T2* calibration temperature 2**
***Fct. 4.2 TEMP. OPR* operating temperature**
Unit for ***TEMP. HIGH*** is same as for ***TEMP.LOW***
Unit for ***T2*** is same as for ***T1***

Units for temperature -

- ***Deg. C*** - ***Deg. F*** - ***KEL VIN***

PRESSURE UNITS

Refer to functions -

Fct. 3.3.3. PRES. LOW **pressure low limit**
Fct. 3.3.4 PRES. HIGH **pressure high limit**
Fct. 3.5.7 PRES. OPR **operating pressure**
Fct. 3.5.10 PRES. NORM **normal pressure**
Fct. 3.7.2 P11 V11 **calibration point 1 at T1**
Fct. 3.7.3 P12 V12 **calibration point 2 at T1**
Fct. 3.7.5 P21 V21 **calibration point 1 at T2**
Fct. 3.7.6 P22 V22 **calibration point 2 at T2**

Unit for ***PRES. HIGH*** is same as for ***PRES.LOW.***
Pressure unit for functions ***P12 V12, P21, V21*** and ***P22 V22*** is same as for ***P11 V11***

Units for pressure -Units with the _g suffix are gauge pressure units and those without the same are absolute pressure units.

- ***Pa***
- ***KPa***
- ***atm***
- ***Bar***
- ***mBar***
- ***PSI***
- ***Lbf/ft2***
- ***Kg/cm2***
- ***In. Hg***
- ***mm Hg***
- ***mm Water***
- ***Pa_g***
- ***KPa_g***
- ***atm_g***
- ***Bar_g***
- ***mBar_g***
- ***PSI_g***
- ***Lbf/ft2_g***
- ***Kg/cm2_g***
- ***In. Hg_g***
- ***mmHg_g***
- ***mm Water_g***

VELOCITY UNITS

Refer to function -

Fct. 1.2.5 VELO. UNITS **velocity unit for display**

Units for velocity -

- ***m/sec***
- ***ft/sec***

FREQUENCY OUTPUT UNITS

Refer to function -

Fct. 1.4.2 RANGE F **frequency output range value**
Fct. 4.9 RANGE F **frequency output range value**

Units for ***RANGE F -***

For volumetric flow -

- ***PULSE/hr***
- ***PULSE/min***
- ***PULSE/sec***
- ***PULSE/m3***
- ***PULS/Litre***
- ***PULS/ft3***
- ***PULS/cft***
- ***PULS/cuft***
- ***PULS/US.Gal***
- ***PULS/UK. Gal***

For normalized volumetric flow -

- ***PULSE/hr***
- ***PULSE/min***
- ***PULSE/sec***
- ***PUL./Norm.m3***
- ***PULS/Norm.L***
- ***PULS/Sft3***
- ***PULS/Scft***

For mass flow -

- ***PULSE/hr***
- ***PULSE/min***
- ***PULSE/sec***
- ***PULSE/Kg***
- ***PULS/t***
- ***PULS/Lb***

DENSITY UNITS

Refer to function -

Fct. 3.5.8 DENS. OPR.. **density at operating P&T**
Fct. 3.5.11 DENS. NORM. **density at normal P&T**

Units for density -

- ***Kg/m3***
- ***Kg/Litre***
- ***Lb/ft3***
- ***Lb/cft***

THERMAL POWER UNITS :

If meter is HEAT-METER refer to function -

Fct. 3.8.1 POWER.UNITS **thermal power units**

- ***KJ/hr***
- ***MJ/hr***
- ***GJ/hr***
- ***BTU/hr***
- ***KCal/hr***
- ***KW***
- ***MW***

If meter is NET HEAL METER, refer ***Fct. 3.8.6.*** for net thermal power units & ***Fun. 3.8.12*** for external power unit.

H-VALUE UNITS

If the meter has AGA supported software refer to the function-

Fct.3.8.5 H.VAL.UNITS **heating value units**

- ***KJ/m3***
- ***MJ/m3***
- ***GJ/m3***
- ***BTU/ft3***
- ***BTU/in3***
- ***Kcal/m3***

6.2.2 Numerical format

- **Display of numerical values**

Real (i.e. fractional) values are displayed in the first line of the display consisting of 8 digits. Number is displayed in floating point format as far as possible, otherwise an exponent notation is used. See examples below.
Floating format : 1234.5678, 100.00
Exponent format : 1234E-10, 12345E12
In most practical applications, it is very rare that parameters need be displayed in exponent format. The precision (i.e. number of digits after the decimal point) is automatically decided depending on the unit in which the parameter is being displayed.
For example pressure of 1.23456 Bar will be displayed in bar as "1.23" (2 digits after decimal point) & in mBar as "1234.6" (1 digit after decimal point. Also, note the rounding - off of the last digit).

- **Input of numerical values**

Entering a numeric value is very flexible. Enter a +ve or -ve number in floating point format or exponent format as required or convenient.
Example : 1.2345678, -1234.567, 0.0001234
123456E1, -12345E4, 1234E-4
Programming : refer to section 5.4.

6.2.3 Display

Organisation - Display consists of the following 3 fields.

Field 1 : Numeric (8 digit, 7 segment) used primarily for showing numeric values.
Field 2 : alphanumeric (10 characters, 14 segments) used for showing units, messages etc.
Field 3 : Consists of [a] 6▼ markers at the bottom of display which are used to identify the parameter being displayed and [b] key-field at the top left of the display which is used to acknowledge the keys.

Programming - Measurement mode settings are as follow :

- To allow selection of units for all measured parameters
  Refer to Sect. 6.1 ***Fct. 1.2.1 to 1.2.6***
- Select what parameters to include in display cycle.
  Refer to Sect. 6.1 ***Fct. 1.2.2 to 1.2.6***
- Select display mode (cyclic / non-cyclic) and error messages to / not to appear in display cycle.
  Refer to Sect. 6.1 ***Fct. 1.2.6 to 1.2.7***

Measurement mode - Display shows measured parameter(s) in its selected unit. The ▼ markers identify the parameter being displayed. Parameter is displayed continuously in non-cyclic mode. [Refer sect. 6.1 ***Fct. 1.2.7***]. To select other parameter(s) of the display cycle, if any, use the ↑ key. In cyclic mode, all the parameters selected in the display cycle are displayed in sequence one after another every 6 seconds.

Programming mode - Numeric line indicates menu/functions level such as ***Fct. 1.0*** [current menu level digit "1" blinks] and alphanumeric line indicates menu/function title such as ***OPERATION.***

Error indications - Blinking display in measurements mode indicates that error(s) are present. Error messages are displayed interleaved between changing from one display parameter to other, if ***Fct. 1.2.6 ERROR.MSG*** is ***YES.*** For description of error messages refer Sect. 5.5.

Testing of display - Use ***Fct. 2.1 TEST DISP*** for display test. All segments of the display are tested in the following sequence. Alphanumeric field, numeric field, arrow and keymarkers. You can press the **E** key at any time to terminate display test. Executing display test does not affect the normal operation of the signal converter.

6.2.4 Flow range and meter size

Flow rate (min. flow to max. flow) which the flowmeter will be able to measure depends on the primary data (3.1.x functions) and application data (3.5.x functions). thus, the flow range specified under the ***Fct. 1.1.2 MAX. FLOW*** and ***Fct. 1.1.3 MIN. FLOW*** must be within the measuring range.

Flow range for any given application is determined by sizing of the meter for that application.
Refer Sect. 6.1 ***Fct. 4.5*** for details on how the application is sized.
The frequency output range value, if programmed in PULSE/time units, directly corresponds to max flow. If flow rate exceeds max flow an error condition ***HIGH FLOW*** is generated which may affect current output depending on programming of ***Fct. 1.3.2 RANGE I***. When the flow rate falls below the min. flow an error condition ***LOW FLOW*** is generated. Vortex sensor signal is weak at this condition and if flow rate reduces further, vortex signal related errors such as ***CHECK INST., LOW SIGNAL*** will occur.

6.2.5 Primary information

Primary data gives VFM 5090(I) the basic information about the vortex primary sensor. Use ***Fct. 3.1.1 NOMINAL.DIA*** for specification of the nominal DN/ANSI size and ***Fct. 3.1.2 K-FACTOR*** for the calibration factor of the primary.
Depending on whether the primary has temperature & pressure sensors, settings need be done in ***Fct. 3.6.1 T-SENSOR*** and in ***Fct. 3.6.2 P-SENSOR.*** These sensors enable VFM 5090(I) to provide online **T** and/or **P** compensation.

6.2.6 Application information

This is the data of process medium, its operating conditions and physical properties. It consists of :

- process medium ***Fct. 3.5.1 FLUID*** & ***Fct. 3.5.2 MEDIUM***
- operating temperature and pressure conditions. Refer ***Fct. 3.5.6 TEMP. OPR*** and ***Fct. 3.5.7 PRES. OPR.***
- density of medium at operating conditions. Required only if software within instrument does not support the medium (***Fct. 3.5.2*** is selected as -***NONE***-)
  Refer ***Fct. 3.5.8 DENS.OPR.***
- normal or reference P & T values required for normalized flow measurements only (depending on ***Fct. 1.1.1***).
  Usual values are temp.norm = 0 or 20 Deg. C and pres.norm = 1 atm. Refer ***Fct. 3.5.9 TEMP.NORM*** and ***Fct. 3.5.10 PRES.NORM.***
- density at normal conditions. Required only for normalize volumetric flow and if software within instrument does not support the medium (***Fct. 3.5.2*** is selected as -***NONE***-)
  Refer ***Fct. 3.5.11 DENS.NORM.***
- Refer also to ***Fct. 3.5.3 SAT.P/T*** which is applicable to saturated steam only.

Not all of the above data need be given for any given application. Only relevant functions appear during actual programming.

6.2.7 Internal Electronic Totalizer

- The internal electronic totalizer counts volume, normalized- volume or mass. Totalizer value is saved in the non-volatile memory upon power failure. Totalizer can be displayed in the unit desired as per the programming of ***Fct. 1.2.2 TOTAL.UNITS.*** Totalizers counting is interrupted for the duration of power failure. Counting may optionally be stopped and thereafter restarted by the use of ***Fct. 3.2.6 TOT. ON/OFF.***
- Resetting [to 0] or Setting of the totalizer is possible by using ***Fct. 3.2.5 TOT. VALUE.***
  If the meter is HEAT METER energy totalizer is provided to store thermal energy.
  Refer functions ***3.8.3 E.TOT.Val*** and ***Fct. 3.8.4 E.TOT.ON/OFF.***

  If the meter is ***NET HEAT METER,*** one more energy totalizer is provided to store net thermal energy. Refer functions ***3.8.8 NT. EN. TOT. VAL*** and ***3.8.9 NE . TOT. ON/OFF.*** But in this case, only two totalizer out of three (flow, power & net power) can be enabled at a time and not three.

6.2.8 Current (analog) output I

Current output gives an analog representation of the flow rate, power and net power also. Programming of current output is provided by 1.3.X functions.

Fct. 1.3.1 FUNCTION I current output function

Choose ***YES*** to make current output active as per functions ***Fct. 1.3.2*** to ***Fct. 1.3.4. NO*** makes current output inactive (0 mA). When current output function is not required choose the option ***NO.***

Fct. 1.3.2 RANGE I current output range selection

Current output can have a 0-20 mA or 4-20 mA range with or without error indication. Flow rates corresponding to $I_{0\%}$ [= 0 mA for 0-20 mA ranges and = 4 mA for 4-20 mA ranges] and $I_{100\%}$ [= 20 mA for both ranges] are programmable. Refer to figure I-1 for behaviour of current output.

Fct. 1.3.3 0/4mA FLOW and *Fct. 1.3.4 20 mA FLOW*

Allows to define relationship of current output with respect to the flow rate.
Refer to figure I-1 and Sect. 6.

Fct. 1.3.5. VARIABLE I Current output selection function

You can have current output proporational to any of flow, power and net power. This facility is available if the meter is Heat meter or Net Heat meter only.
Since validity of the minimum and maximum values of net heat meter is not checked, please ensure that the value for 20 mA is greater than that for 4/0 mA by a factor of 2.

Fct. 1.3.6 0/4 mA POWER and Fct. 1.3.7 20 mA POWER

This defines the relationship between current output and power for Heat meter and Net Heat meter. Refer to figure I-1 and sect. 6.

TESTING OF CURRENT OUTPUT I

Fct. 2.2. TEST I can be used to check current output. The following test values are provided ***0/2/4/10/20/22 mA*** to be monitored on a current meter. During the test, current output changes to the test value(s). The normal current value is restored automatically [as per programming of current output] when the testing is over.

CHARACTERISTICS OF CURRENT OUTPUT I

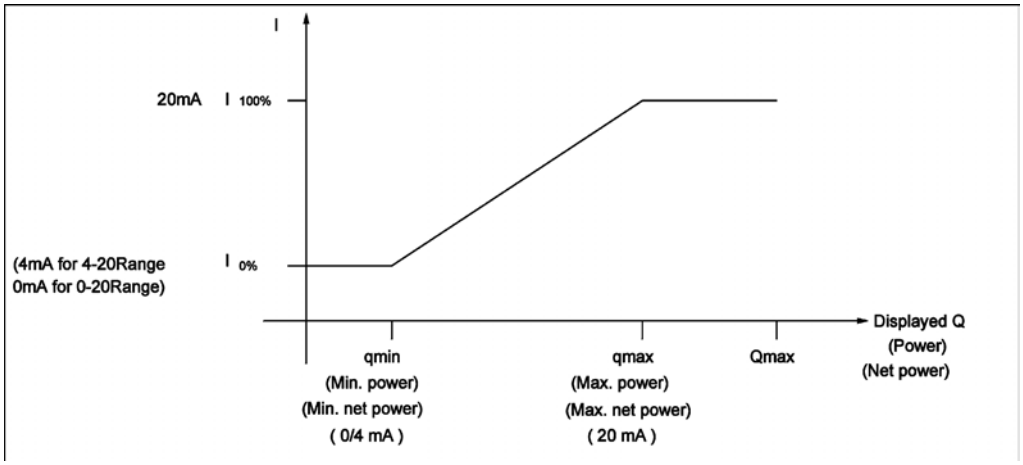


Diagram I-1

6.2.9 Frequency (pulse) output F

Frequency output value is directly proportional to the flow rate, power and net power. Programming of frequency output value is provided by 1.4 functions.

***Fct. 1.4.1 FUNCTION F* frequency output**

Choose ***YES*** -to make frequency output active as per functions ***Fct. 1.4.2*** to ***Fct. 1.4.3.*** ***NO*** makes frequency output inactive (0 Hz). When frequency output function is not required choose the option ***NO.***

***Fct. 1.4.2 RANGE F* frequency output range value**

Frequency output is 0 Hz for 0 flow rate and the value programmed in ***RANGE F*** for qmax flow rate. [qmax is the maximum flow programmed in ***Fct. 1.1.2 MAX. FLOW***] ***RANGE F*** can be programmed in pulse/time units or in the form of pulse/unit flow units. See example below :

Example of pulses/unit flow

Full scale setting, qmax	:	1000 Litre/sec (set via ***Fct. 1.1.2)***
RANGE F	:	1 PULSE/Litre (set via ***Fct. 1.4.2***)
at 1000 litres per second	:	1000 pulses per second = 1 pulse per litre.
Changeover of		
Full scale setting, qmax	:	2000 Litre/sec (set via ***Fct. 1.1.2***)
RANGE F	:	unchanged, 1 PULS/Litre (set via ***Fct. 1.4.2***)
at 2000 litres per second	:	2000 pulses per second = 1 pulse per litre as before.

Example of pulses/time

Full scale setting, qmax	:	1000 Litre/sec (set via ***Fct.1.1.2***)
RANGE F	:	1000 PULSE/sec (set via ***Fct.1.4.2***)
Pulse value is then	:	1 pulse per litre
Changeover of		
Full scale setting, qmax	:	2000 Litre/sec (ser via ***Fct.1.1.2***)
RANGE F	:	unchanged 1000 PULSE/sec (set via ***Fct. 1.4.2***)
Pulse value is now	:	1 pulse per 2 litres

For limits on programming of ***RANGE F*** refer to Sect. 6.

Frequency output automatically works in the pulse mode when the following conditions are satisfied

1) fmax evaluates to $\leq$ 0.5 Hz
2) Internal electronic totalizer is ON.
3) fmax is programmed in pulses/unit flow units.

In pulse mode of operation, the pulse output is generated by tracking the totalized flow and thus provides true reflection of internal totalizer value.

***Fct. 1.4.3 PULS. WIDTH* pulse width**

Enables to limit the active duration of frequency output, to reduce the overheating of external electromechanical totalizer coil. Available only when ***RANGE F*** evaluates to $\leq$ 10 Hz. Possible widths to select are -
30 / 50 / 100 / 200 / 500 mSecs. For details refer to Sect. 6.

***Fct. 1.4.4 VARIABLE F* frequency output selection function.**

Frequency output proportional to any of flow, power and net power is available. This facility is available only if meter type is Heat meter or Net Heat meter.

Fct. 1.4.5. F.S. POWER and Fct. 1.4.6 F.S. FREQ

This defines the relationship between frequency output and power for Heat meter and Net Heat meter. Refer diagrame F-1 and sect. 6.

TESTING OF FREQUENCY OUTPUT F

Fct. 2.2 TEST F can be used to check frequency output. The following test values are provided.
1 / 10 / 100 / 1000 / 10000 Hz to be monitored on a frequency meter. During the test frequency output changes to the test values(s). The normal frequency value is restored automatically [as per programming of frequency output] when the testing is over.

CHARACTERISTICS OF FREQUENCY OUTPUT F

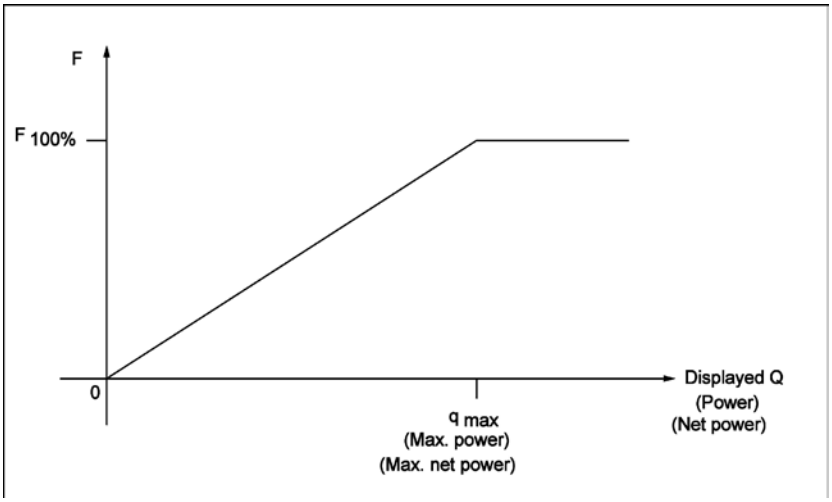


Diagram F1

6.2.10 Languages of display text

Fct. 3.2.1 LANGUAGE offers choice of the display text language. The following options are available

- ***ENGLISH***
- ***GERMAN***
- ***FRENCH***

6.2.11 Coding desired for entry into programming mode

Fct. 3.2.2 ENTRY.CODE.1 set to ***YES*** for coding. The entry code is to be given under ***Fct. 3.2.3 CODE 1.***

The entry code consists to 9 key strokes of the 3 keys in any combination.

6.2.12 Behavior of outputs during programming

Programming of the VFM 5090(I) is "on-line" meaning that the instrument keeps working even when it is in the programming mode. This means VFM 5090(I) will keep measuring flow rate, pressure & temperature; totalizing flow and control outputs (current & frequency) as per the programmed configuration. Thus there is no change to the behaviour of outputs during programming.

EXCEPTION: Test functions ***Fct. 2.2 TEST I*** and ***TEST F*** will affect the current and frequency outputs respectively only for the duration of testing.

Part C Function Checks and Trouble Shooting hints

7. Functional checks

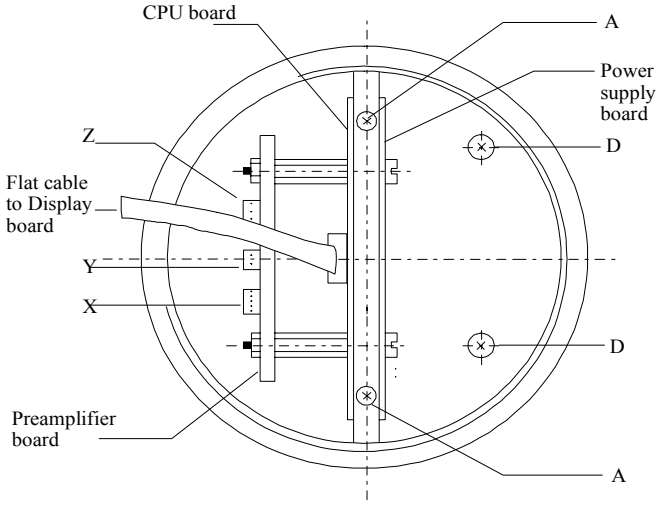
This section describes some functional checks which can be performed without using any special equipment. It **must** be noted that these checks are very preliminary and do **not** check the total functionality of the primary head or the signal converter.

7.1 Primary head functional checks

7.1.1 Vortex sensor

To perform preliminary testing of the vortex piezo sensor, the signal cable of the piezo sensor should be disconnected from the signal converter electronics. To do this : **always switch-OFF power source before commencing work!**

1. Use the special wrench to remove the cover from the electronic compartment. Ensure that screw threads of electronic compartment cover are well greased at all times!



2. Remove screws **A** and fold display board to side.
3. Remove the piezo cable from the preamplifier board at location **Z** by its connector (and not by pulling cable itself!)
4. Do the following tests.

Capacitance between centre pin and each outer pin.

ANSI DN	3/8" S to 1" 10S to 25	1.5", 2" 40, 50	3" & above 80 & above
C(nF)	0.8 to 1.5	2.0 to 3.4	2.7 to 4.5

Resistance between centre pin and each outer pin > 200 M ohm. Also resistance between each sensor wire pin and earth should be > 200 M ohm.

5. Re-assemble converter in the reverse order

7.1.2 Temperature Sensor

PT-1000 temperature sensor can be checked by measuring its resistance.

Always switch-OFF power source before commencing work!

Follow the steps 1, 2 same as in the above Section. 7.1.1

3. Remove the temperature sensor cable at location **Y** of the preamplifier board. Pull cable by its end connector and **not** by cable itself!
4. **Resistance** between the 2 pins should be within 1K [0^0C] - 1.193k [50^0C] depending on the ambient temperature. For other temperatures resistance values as per DIN43760.
5. Re-assemble converter in the reverse order.

7.2 Signal converter functional checks.

7.2.1 Self diagnostics

On power-ON VFC 090 itself carries out diagnostic checks wherein the instrument checks its functional elements as far as possible. Diagnostic failure result in fatal errors and are indication of a hardware fault within electronics. Usually it is necessary to replace electronics in such cases.
Meanings of diagnostic error messages are given below for information purpose.

Error message	Meaning
INTL.ERR20	RAM (read/write memory) failed
INTL.ERR21	EPROM (program memory) failure
INTL.ERR22	GA (Gate Array) failure
INTL.ERR23	Interrupt function failure
INTL.ERR24	LCD (display) controller failure
INTL.ERR25	Timer channel #0 failure
INTL.ERR26	Timer channel #1 failure
INTL.ERR27	Timer channel #2 failure
INTL.ERR28	A/D converter #1 failure
INTL.ERR29	A/D converter #2 failure
INTL.ERR30	NOVRAM(nonvolatile mem.)failure
INTL.ERR31	EEPROM failure
INTL.ERR32	UART (Communication controller) failure
INTL.ERR33	KEYS (3 Keys on display board) problem

7.2.2 Display check

Display functionality can be checked by the use of ***Fct. 2.1 TEST DISP.***

This function tests all the segments of the display in the following order. Alphanumeric field, numeric field, arrow and key markers. For details refer Sect 5.4 + 6.1.

7.2.3 Current output check

Fct. 2.2 TEST I can be used to test current output function of VFC 090. With this function it is possible to generate following test values ***0/2/4/10/20/22 mA***

Current output electronics is factory calibrated and should be within +/- 0.02mA. Otherwise re-calibration of current output is necessary by KHRONE MARSHALL service person.

7.2.4 Frequency output check

Fct. 2.3 TEST F is meant for checking frequency output function. The following test frequencies may be generated ***1/10/100/1000/10000 Hz.*** Frequency output signal can be checked on an oscilloscope or a frequency meter between term 4/4.1 and term 4.1/4.2 with a load resistance of 1k to 2k ohms.

8. Trouble shooting hints

It is assumed in this section that the flowmeter has already been installed. (for installation details refer Sect. 2+3)

Following are some trouble shooting hints.
SYMPTOM : **Display is blank.**

- Supply voltage (between term 11/12) is not available.
- Mains fuse within the instrument has blown out. Fuse is accessible only after removal of electronics from the converter housing. To remove electronics follow the steps given below :

Always switch-OFF power source before commencing work!

1. Use the special wrench to remove the cover from the terminal box.
2. Disconnect all the cables from the terminals : term 5/6/4/4.1/4.2/11/12
3. Use the special wrench to remove the cover from the electronics compartment. (Refer Fig. on page 43)
4. Remove screws **A** and fold display board to side.
5. Remove plugs **X, Y, Z** to remove wires from pressure sensor, temperature sensor and vortex sensor respectively.
6. Remove screws **D** using a screwdriver for Philips- head screws [size 2, blade length 200 mm (8")] and carefully remove the complete electronics.
7. Remove the fuse from its black plastic housing located on **power supply board** for checking. Replace the fuse if necessary. Rating of fuse is dependent on line voltage.

Voltage	Fuse	
	Value	Order No.
220 / 200 / 240 VAC	125 mA	K2023937
120 VAC	200 mA	K2023938
100 / 110 VAC	250 mA	K2023939

8. Reassemble in reverse order

Important : Ensure that the screw thread of the covers on the electronic and connection compartments is well greased at all times.

- Electronics faulty

SYMPTOM : **Current output is not proper.**

- Check current output electronics (refer Sect.7.2.3)
- Check current output electronics programming of current output functions ***Fct. 1.3.x.***
- Check that current output loop is not overloaded [700 ohm max.]

SYMPTOM : **Freqency output is incorrect**

- Check the frequency output electronics (refer Sect. 7.2.4)
- Check programming of frequency output (Functions ***Fct. 1.4.x.***)
- Check that frequency output is not overloaded. For load ratings of frequency output refer Sect. 3.3.3.

SYMPTOM : **Non zero flow indicated when no actual flow in the pipe.**

- Mains interference due to improper earthing. The protective earth PE terminal should be properly grounded.
- Excessive mechanical vibration in the pipe. If so, support the pipeline near the flowmeter perpendicular to both the axis of the pipe and the axis of the bluff body.

SYMPTOM : **'CHECK INST.' error is displayed when no flow in the pipe**

Display should normally indicate 0.0 flow rate, ***LOW FLOW*** and ***LOW SIGNAL*** errors when there is no

flow in the pipe. The additional ***CHECK INSTALL*** error (flow rate = 0.0 or some steady or fluctuating value) is an indication of :

- improper / inadequate earthing
- excessive pipe vibration

SYMPTOM : **Flowrate indicated is 0.0 even with flow in the pipe.**

- Vortex sensor cable disconnected or not properly connected.
- Flow sensor faulty - some checks are given in Sect. 7.1.1

SYMPTOM : **Fatal error *INV.CONFIG* (invalid configuration)**

- Configuration data in the non-volatile memory is inadvertently corrupted. Go to the programming mode and recheck (reprogram, if necessary) all the settings. If error persists contact KHRONE MARSHALL service.

SYMPTOM : **Display contrast is progressively fading.**

- **Never expose display directly to the sunlight !** Install a sunshade if necessary.

SYMPTOM : **Flow indicated responds to changes in flow but indicated value does not correspond to actual flow rate. Also 'CHECK INST.' error may be appearing intermittantly.**

- Check programming of ***Fct. 3.1.2 K-Factor*** which should be same as on the name plate
- Meter not properly centered on the pipeline The axis of meter bore should be aligned with that of pipe.
- Gasket at the meter are protruding into pipe bore. Gaskets must not project into effective cross section of the pipe.
- Irregularities on the surface of the pipe bore. The pipe bore should be free from irregularities at the welded joints, dirt, deposits and excessive surface roughness.
- Vortex signal is falsified due to a bi-phase medium. Bi-phase media are not permitted. Use a moisture separator for wet steam applications to remove moisture droplets from the steam. Use suitable filters in gas applications to remove solid particles from the flowing gas.
- Incorrect angular position of the meter
  Refer to Sect. 2.1 (I) for allowable mounting positions.
- Insufficient upstream / downstream pipe lengths. Check that upstream / downstream pipe lengths are of correct minimum length as given in Sect. 2.1 (3).
- Check the flow direction and direction of arrow on the primary .

Part D VFM 5090(I) Ex

9. Description of the system

The compact version of Vortex Flow meter VFM 5090(I) is suitable for operation in potentially hazardous area. The Ex version is housed in a Flameproof PDC enclosure approved by PTB. The complete instrument is designed in protection categories :

EEx d[ib] IIC T2..T6 & EEx de[ib] IIC T2..T6

Signal converter housing(Electronics compartment)

Flameproof enclosure "d"
as per EN 50014, EN 50018

Signal converter housing (Terminal compartment)

Standard Increased safety "e"
As per EN 50014, EN 50019
Optional Flameproof enclosure "d"
As per EN 50014, EN 50018

Sensor circuit with integral barrier

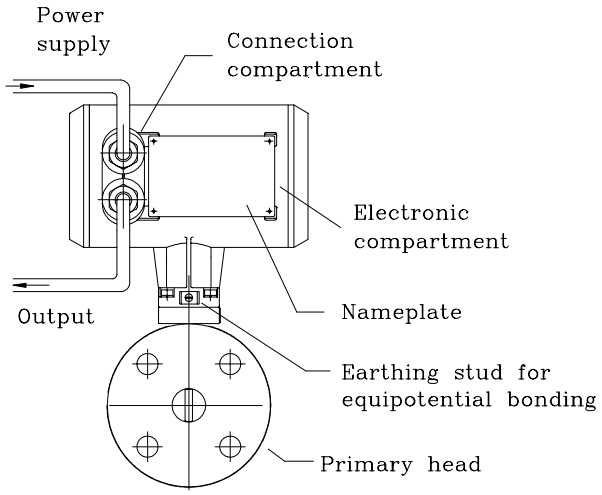
Intrinsic safety "ib"
As per EN 50014, EN 50020

9.1 VFM 5090(I) Ex Earthing connections

The compact version of VFM 5090(I) must be grounded ensuring equipotential bonding.
Connect equipotential bonding conductor PA to a separate earthing stud with screw-clamp fixed on the neck of the Flameproof enclosure.
Connection of the earth conductor in power cable should be terminated to earthing stud in Terminal compartment of the flameproof enclosure.

9.2 Electrical connection

The power cable and signal cable should be routed to the terminal compartment through separate cable glands for field connections.
The cables should have at least 9mm (0.35") outer diameter ensuring firm holding of cables and sealing in the cable glands. Refer Diagram given for field connections.



FIELD CONNECTION DIAGRAM

10. Process Pressure and Temperature

Nominal pressure is indicated on the nameplate riveted on the Instrument.
Process temperature and option of Distance piece between Primary Head and Signal Converter determine the temperature class of the product operated in hazardous area.

With Distance piece		Without Distance piece	
Temp. class	Max. medium Temp.	Temp class	Max. medium Temp.
T6	80^0C	T6	80^0C
T5	95^0C	T5	95^0C
T4	130^0C	T4	130^0C
T3	150^0C	T3	180^0C
T2	240^0C		

11. Replacement of electronics in signal converter

Important

- Switch off the mains power.
- Ensure that there is no explosion hazard.
- Ensure that all the cables are disconnected and isolated from the supply.
- Allow waiting time to lapse before opening the enclosure.

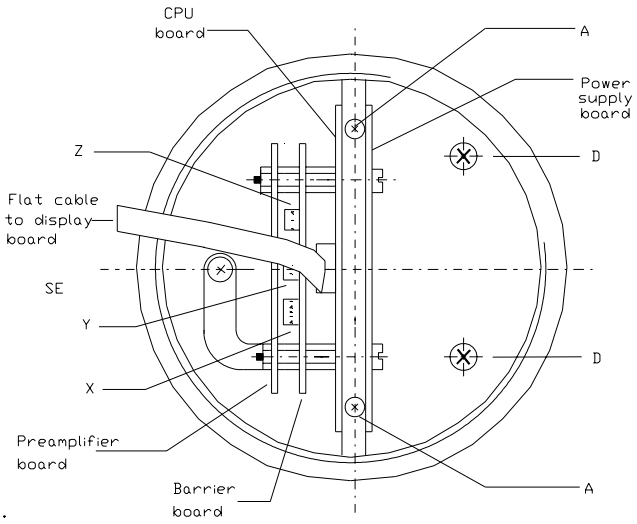
The time limit is mentioned on the nameplate for different temperature classes as:
42 minutes for temperature class T6
5 minutes for temperature class T5
0 minutes for temperature class T4..T2

Make sure that precautions as mentioned above, are taken as Important and observe the sequence as follows:

1. Use special wrench to remove window cover.
2. Remove screws A to fold Display assembly to one side.
3. Remove signal cables from latched connectors Y,Z,X (2,3,5 pin) on Barrier board assembly.
4. Unscrew the mounting screws D.
5. Pull the unit out holding the montage holder.
6. Replace the unit in reverse order, from 5 to1.

Caution

- Ensure that the earthing platelet on barrier board is firmly connected to the enclosure by screw SE.
- Ensure that the Window cover is screwed down firmly so that it cannot be opened by hand.
- Ensure that the sensor cables are properly latched to y,z,x (2,3,5 pin) connectors on barrier board.
- Ensure that the gaskets on the covers of the enclosure are properly in place.



12. Certificate No. of VFM 5090(I) Ex:

FM, CSA, PTB approvals are pending.

13. Nameplates of VFM 5090(I)Ex

The purchaser is solely responsible for the suitability in accordance with the technical regulations and applicability of our instruments

Part E Technical Data

Range Limits for gases -based on air at T = 0 deg C, p = 1.013 bar abs (14.69 psia) and density = 1.29 kg/m3 (0.081lbs/ft3)

Meter size		Inside diameter (di)				Vmin		Qmin				Vmax		Qmax			
DIN	ANSI	DIN		ANSI				DIN		ANSI				DIN		ANSI	
mm	inches	mm	inches	mm	inches	m/s	ft/s	m3/hr	cfm	m3/hr	cfm	m/s	ft/s	m3/hr	cfm	m3/hr	cfm
10S	3/8"S	8.9	0.35	8.9	0.35	14.95	49.04	3.35	2.07	3.35	2.07	73.84	242.27	16.54	9.73	16.54	9.73
10	3/8"	12.6	0.5	12.6	0.5	10.53	34.54	4.73	2.92	4.73	2.92	73.84	242.27	33.15	19.51	33.15	19.51
15	1/2"	14.9	0.59	14.9	0.59	8.78	28.82	5.51	3.40	5.51	3.40	73.84	242.27	46.35	27.28	46.35	27.28
20	3/4"	20.9	0.82	20.9	0.82	6.22	20.42	7.69	4.74	7.69	4.74	73.84	242.27	91.20	53.68	91.20	53.68
25	1"	28.5	1.12	26.7	1.05	5.91	19.37	13.56	8.37	11.90	7.35	75	246.06	172.24	101.38	151.17	88.98
40	1 1/2"	43.1	1.7	40.9	1.61	5.91	19.37	31.02	19.15	27.93	17.24	75	246.06	393.92	231.85	354.73	208.79
50	2"	54.5	2.15	52.6	2.07	5.91	19.37	49.59	30.61	46.19	28.52	75	246.06	629.86	370.72	586.71	345.33
80	3"	82.5	3.25	78	3.07	5.91	19.37	113.64	70.15	101.58	62.70	75	246.06	1443.32	849.50	1290.16	759.36
100	4"	107.1	4.22	102.4	4.03	5.91	19.37	191.51	118.22	175.07	108.07	75	246.06	2432.39	1431.65	2223.58	1308.75
150	6"	159.3	6.27	154.2	6.07	5.91	19.37	423.69	261.54	397.00	245.06	75	246.06	5381.28	3167.30	5042.23	2967.74
200	8"	206.5	8.13	202.7	7.98	5.91	19.37	711.97	439.49	686.01	423.46	75	246.06	9042.61	5322.28	8712.87	5128.20

Range Limits for liquids -based on water at 20^{o} C (68^{o} F)

Meter size		Inside diameter ϕ (di)				Vmin		Qmin				Vmax		Qmax			
DIN	ANSI	DIN		ANSI				DIN		ANSI				DIN		ANSI	
mm	inches	mm	inches	mm	inches	m/s	ft/s	m^3/hr	US GPM	m^3/hr	US GPM	m/s	ft/s	m^3/hr	US GPM	m^3/hr	cfm
10 S	3/8"S	8.9	0.35	8.9	0.35	1.12	3.67	0.25	1.1	0.25	1.1	6	19.69	1.34	5.9	1.34	5.9
10	3/8"	12.6	0.5	12.6	0.5	0.8	2.62	0.36	1.59	0.36	1.59	6	19.69	2.69	11.84	2.69	11.84
15	½"	14.9	0.59	14.9	0.59	0.67	2.2	0.42	1.85	0.42	1.85	6	19.69	3.77	16.6	3.77	16.6
20	¾"	20.9	0.82	20.9	0.82	0.5	1.64	0.62	2.73	0.62	2.73	6	19.69	7.41	32.63	7.41	32.63
25	1"	28.5	1.12	26.7	1.05	0.5	1.64	1.15	5.06	1.01	4.4	7	22.97	16.08	70.8	14.1	62.08
40	1 ½"	43.1	1.7	40.9	1.61	0.5	1.64	2.63	11.58	2.36	10.39	7	22.97	36.77	161.89	33.11	145.78
50	2"	54.5	2.15	52.6	2.07	0.5	1.64	4.2	18.49	3.91	17.22	7	22.97	58.79	258.84	54.76	241.1
80	3"	82.5	3.25	78	3.07	0.5	1.64	9.62	42.36	8.6	37.86	7	22.97	134.71	593.11	120.41	530.15
100	4"	107.1	4.22	102.4	4.03	0.5	1.64	16.22	71.41	14.82	65.29	7	22.97	227.02	999.54	207.53	913.73
150	6"	159.3	6.27	154.2	6.07	0.5	1.64	35.88	157.97	33.61	147.98	7	22.97	502.25	2211.34	470.61	2094.49
200	8"	206.5	8.13	202.7	7.98	0.5	1.64	60.28	265.4	58.09	255.76	7	22.97	843.98	3715.93	813.2	3580.41

Range Limits for saturated steam Flowrate Qm in Kg/hr for different (P) and density ρ

DN	Inside	P = 1Kg/cm2_ g		P = 3.5 Kg/cm2_ g		P =5.2 Kg/cm2_ g		P = 7 Kg/cm2_ g		P = 10.5 Kg/cm2_ g		P = 14 Kg/cm2_ g		P = 17.5 Kg/cm2_		P = 20 Kg/cm2_ g	
DIN	Dia(di)	ρ=1.12482 Kg/m3		ρ=2.39175 Kg/m3		ρ=3.22667 Kg/m3		ρ=4.10067 Kg/m3		ρ=5.78855 Kg/m3		ρ=7.47056 Kg/m3		ρ=9.15131 Kg/m3		ρ=10.3542 Kg/m3	
mm	mm	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
10S	8.9	3.94	18.89	6.59	29.05	8.18	33.74	9.76	38.04	12.61	45.19	15.32	51.34	18.01	56.82	19.80	60.44
10	12.6	5.57	37.87	9.31	58.22	11.55	67.63	13.77	76.24	17.80	90.58	21.63	102.90	25.42	113.89	27.94	121.15
15	14.9	6.50	52.96	10.86	81.42	13.47	94.57	16.07	106.61	20.77	126.67	25.23	143.90	29.66	159.27	32.60	169.41
20	20.9	9.06	104.19	15.14	160.20	18.78	186.07	22.40	209.76	28.95	249.22	35.18	283.12	41.35	313.36	45.45	333.32
25	28.5	15.99	193.75	26.73	411.96	33.16	555.77	39.55	631.23	51.10	749.97	62.10	851.99	72.99	942.98	80.23	1003.04
40	43.1	36.56	443.10	61.13	942.16	75.84	1271.05	90.44	1443.62	116.87	1715.18	142.02	1948.50	166.93	2156.58	183.50	2293.94
50	54.5	58.46	708.50	97.74	1506.48	121.26	2032.36	144.62	2308.29	186.88	2742.51	227.08	3115.59	266.91	3448.30	293.40	3667.93
80	82.5	133.97	1623.51	223.98	3452.05	277.87	4657.11	331.38	5289.39	428.22	6284.39	520.35	7139.28	611.61	7901.68	672.32	8404.97
100	107.1	225.78	2736.07	377.47	5817.66	468.28	7848.51	558.47	8914.08	721.67	10590.93	876.94	12031.66	1030.74	13316.52	1133.05	14164.70
150	159.3	499.49	6053.13	835.09	12870.66	1036.00	17363.60	1235.54	19721.01	1596.58	23430.77	1940.08	26618.18	2280.34	29460.72	2506.70	31337.18
200	206.5	839.34	10171.58	1403.27	21627.66	1740.88	29177.52	2076.18	33138.87	2682.87	39372.70	3260.09	44728.76	3831.85	49505.32	4212.22	52658.51

Flowrate Qm in Kg/hr for different pressure (P) and density ρ

DN	Inside	P = 1Kg/cm2_ g		P = 3.5 Kg/cm2_ g		P =5.2 Kg/cm2_ g		P = 7 Kg/cm2_ g		P = 10.5 Kg/cm2_ g		P = 14 Kg/cm2_ g		P =17.5 Kg/cm2_ g		P = 20 Kg/cm2_ g	
ANSI	Dia(di)	ρ=1.12482 Kg/m3		ρ=2.39175 Kg/m3		ρ=3.22667 Kg/m3		ρ=4.10067 Kg/m3		ρ=5.78855 Kg/m3		ρ=7.47056 Kg/m3		ρ=9.15131 Kg/m3		ρ=10.3542 Kg/m3	
inches	inches	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
3/8"S	0.35	3.94	18.89	6.59	29.05	8.18	33.74	9.76	38.04	12.61	45.19	15.32	51.34	18.21	56.82	19.80	60.44
3/8"	0.50	5.57	37.87	9.31	58.22	11.55	67.63	13.77	76.24	17.80	90.58	21.63	102.90	25.70	113.89	27.94	121.15
1/2"	0.59	6.50	52.96	10.86	81.42	13.47	94.57	16.07	106.61	20.77	126.67	25.23	143.90	29.99	159.27	32.60	169.41
3/4"	0.82	9.06	104.19	15.14	160.20	18.78	186.07	22.40	209.76	28.95	249.22	35.18	283.12	41.80	313.36	45.45	333.32
1"	1.05	14.03	170.04	23.46	361.57	29.10	487.79	34.71	554.01	44.85	658.23	54.50	747.77	64.06	827.63	70.42	880.34
1 1/2"	1.61	32.93	399.01	55.05	848.43	68.29	1144.61	81.45	1300.00	105.25	1544.55	127.89	1754.66	150.32	1942.04	165.24	2065.74
2"	2.07	54.46	659.95	91.05	1403.27	112.95	1893.14	134.71	2150.15	174.07	2554.62	211.52	2902.14	248.62	3212.06	273.30	3416.65
3"	3.07	119.75	1451.20	200.21	3085.74	248.38	4162.95	296.22	4728.10	382.78	5617.52	465.13	6381.69	546.71	7063.19	600.98	7513.07
4"	4.03	206.39	2501.13	345.06	5318.26	428.09	7174.84	510.53	8148.87	659.72	9681.77	801.66	10998.83	942.26	12173.39	1035.79	12948.76
6"	6.07	468.02	5671.60	782.47	12059.75	970.74	16269.75	1157.69	18478.48	1495.99	21954.51	1817.85	24941.09	2136.67	27604.54	2348.76	29362.78
8"	7.98	808.73	9800.41	1352.10	20839.00	1677.41	28113.81	2000.47	31930.45	2585.03	37936.96	3141.21	43097.71	3692.12	47700.10	4058.62	50738.30

Range Limits for saturated steam Flowrate Qm in lbs/hr for different (P) and density ρ

DN	Inside	P =15 PSIG		P =50 PSIG		P =75 PSIG		P =100 PSIG		P =150 PSIG		P =200 PSIG		P =250 PSIG		P =300 PSIG	
DIN	Dia(di)	ρ=0.072lbs/ft3		ρ=0.1498 lbs/ft3		ρ=0.2036 lbs/ft3		ρ=0.2569 lbs/ft3		ρ=0.3627 lbs/ft3		ρ=0.4682 lbs/ft3		ρ=0.5736 lbs/ft3		ρ=0.6793 lbs/ft3	
mm	mm	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
10S	8.9	8.81	42.54	14.52	63.90	18.11	74.51	21.48	83.68	27.77	99.44	33.75	112.97	39.67	125.04	44.93	136.07
10	12.6	12.43	85.27	20.49	128.07	25.56	149.33	30.32	167.73	39.19	199.30	47.64	226.43	56.00	250.62	63.42	272.73
15	14.9	14.50	119.24	23.91	179.09	29.83	208.83	35.38	234.55	45.73	278.70	55.59	316.63	65.34	350.46	74.00	381.38
20	20.9	20.22	234.61	33.33	352.36	41.58	410.87	49.33	461.48	63.75	548.35	77.49	622.98	91.09	689.54	103.15	750.38
25	28.5	35.69	436.25	58.83	907.58	73.41	1233.98	87.08	1388.73	112.55	1650.14	136.79	1874.72	160.80	2075.01	182.10	2258.09
40	43.1	81.63	997.71	134.55	2075.62	167.88	2822.11	199.15	3176.02	257.40	3773.85	312.84	4287.48	367.76	4745.54	416.47	5164.25
50	54.5	130.52	1595.30	215.14	3318.84	268.44	4512.45	318.44	5078.33	411.57	6034.25	500.23	6855.52	588.03	7587.94	665.92	8257.44
80	82.5	299.09	3655.59	492.98	7605.03	615.12	10340.16	729.69	11636.87	943.10	13827.33	1146.26	15709.25	1347.46	17387.57	1525.95	18921.70
100	107.1	504.05	6160.67	830.81	12816.57	1036.65	17426.02	1229.73	19611.34	1589.38	23302.87	1931.76	26474.42	2270.84	29302.85	2571.64	31888.29
150	159.3	1115.14	13629.53	1838.04	28354.67	2293.42	38552.35	2720.58	43387.02	3516.26	51553.97	4273.71	58570.51	5023.89	64827.98	5689.35	70547.87
200	206.5	1873.86	22902.84	3088.62	47646.73	3853.83	64782.76	4571.63	72906.86	5908.67	86630.47	7181.48	98420.95	8442.06	108935.90	9560.30	118547.51

Flowrate Qm in lbs/hr for different (P) and density ρ

DN	Inside	P =15 PSIG		P =50 PSIG		P =75 PSIG		P =100 PSIG		P =150 PSIG		P =200 PSIG		P =250 PSIG		P =300 PSIG	
ANSI	Dia(di)	ρ=0.072lbs/ft3		ρ=0.1498 lbs/ft3		ρ=0.2036 lbs/ft3		ρ=0.2569 lbs/ft3		ρ=0.3627 lbs/ft3		ρ=0.4682 lbs/ft3		ρ=0.5736 lbs/ft3		ρ=0.6793 lbs/ft3	
inches	inches	min	max	min	max	min	max	min	max	min	max	min	max	min	max	min	max
3/8"S	0.35	8.81	42.54	14.52	63.90	18.11	74.51	21.48	83.68	27.77	99.44	33.75	112.97	39.67	125.04	44.93	136.07
3/8"	0.50	12.43	85.27	20.49	128.07	25.56	149.33	30.32	167.73	39.19	199.30	47.64	226.43	56.00	250.62	63.42	272.73
1/2"	0.59	14.50	119.24	23.91	179.09	29.83	208.83	35.38	234.55	45.73	278.70	55.59	316.63	65.34	350.46	74.00	381.38
3/4"	0.82	20.22	234.61	33.33	352.36	41.58	410.87	49.33	461.48	63.75	548.35	77.49	622.98	91.09	689.54	103.15	750.38
1"	1.05	31.33	382.89	51.64	796.55	64.43	1083.03	76.43	1218.85	98.78	1448.28	120.06	1645.39	141.13	1821.18	159.83	1981.87
1 1/2"	1.61	73.51	898.45	121.16	1869.13	151.18	2541.36	179.34	2860.06	231.79	3398.42	281.72	3860.95	331.17	4273.44	375.04	4650.49
2"	2.07	121.58	1486.01	200.40	3091.47	250.05	4203.30	296.62	4730.42	383.37	5620.85	465.96	6385.85	547.75	7068.10	620.30	7691.73
3"	3.07	267.35	3267.67	440.67	6798.02	549.85	9242.91	652.26	10402.02	843.02	12360.04	1024.62	14042.25	1204.47	15542.47	1364.02	16913.81
4"	4.03	460.78	5631.83	759.49	11716.37	947.66	15930.13	1124.17	17927.85	1452.95	21302.49	1765.93	24201.78	2075.91	26787.42	2350.88	29150.92
6"	6.07	1044.88	12770.80	1722.24	26568.18	2148.92	36123.35	2549.17	40653.42	3294.72	48305.80	4004.44	54880.26	4707.36	60743.48	5330.90	66102.99
8"	7.98	1805.53	22067.68	2975.99	45909.29	3713.30	62420.44	4404.92	70248.30	5693.21	83471.46	6919.60	94832.00	8134.22	104963.53	9211.68	114224.65

Range limit Calculation for Gases

To obtain the operating density ρ_x at the operating temperature and pressure the following equation is used :

$$\rho_x = \rho_n \times \frac{Px}{Pn} \times \frac{Tn}{Tx}$$

where $\rho n, \rho x$ = density of the gas at normal and operating conditions respectively.

Pn, Px = pressure of the gas in absolute units at normal and operating conditions respectively.

Tn, Tx = temperature of the gas in Kelvin at normal and operating conditions respectively.

To obtain operating volumetric flow from normalized volumetric flow and vice-versa, following equation is used.

$$Qn = Qx \times \frac{Px}{Pn} \times \frac{Tn}{Tx}$$

Where : Qn and Qx are the normalized and operating volumetric flow rates respectively. The ratio of compressibility factors is assumed to be equal to 1.
The operating data of the process medium must be known in order to calculate the measuring range.

- Density ρx of medium at flowing conditions, in kg/m^3
- Dynamic (absolute) viscosity of medium at flowing condition, η in mPA *s (or in centipoise)
- Maximum volumetric flowrate Q_{max} in m^3/hr.
- Minimum volumetric flowrate Q_{min} in m^3/hr.
- Refer to page 64,65 & 66 for dimension of meter inside diameter.

The following limits apply to operation

- Reynolds number at min flow, Re > 20 000 for linear measurements.
- Minimum detectable flow velocity Vmin (See page 59 Diagram III)
- Maximum flow velocity Vmax = $135.7306 / \sqrt{\rho_{op}}$ ……for sizes DN25 to 200(1" to 8")
  = $83.87146 / \sqrt{\rho_{op}}$ ……...for sizes DN10S to 20(3/8"S to 3/4")

In both the cases Vmax is clamped at 75 m/s. For densities at & above 50 Kg/m3, Vmin is fixed to 0.94192 m/s for all sizes.

calculating of Reynolds number

$$Re = 353.67 * \frac{Qmin(m^3/h) * \rho x(kg/m^3)}{\phi(mm) * \eta(mPa*s)}$$

Calculating of minimum flow

$$Qmin(m^3/hr) = \frac{1}{353.67} * Vmin(m/s) * \phi^2(mm)^2$$

Calculating of maximum flow

$$Qmax\ (m^3/hr) = \frac{1}{353.67} * Vmax(m/s) * \phi^2(mm)^2$$

Range limit Calculation for Saturated Vapour

In the same way as for gases, use the above equations to establish the range limits for the volume flowrate. Refer to vapour tables for the appropriate density, and calculate the volume flowrate from the mass flowrate. Check the range limits if operating parameters change.

Flowmeter (Primary head/Sensor VFS 5090(I))

Versions and meter sizes	**Pressure ratings** see Table "Dimensions" on page 64 (Note the operating limits to DIN 2401 and ANSI B 16.5!)
Sandwich design to...	
DIN 19205	DN 25 to 150
ANSI	1" to 6"
Flange connections to ...	
DIN 2501	DN 10S to 200
ANSI B 16.5	3/8"S to 8"
Groove joint to ...(optional)	
DIN 2512	DN 25 to 150
ANSI	1" to 6"
Product and ambient temperature	see Diagram IV on page 59
Hazardous duty versions FM, CSA, PTB approvals are pending	
Accuracies	
Operating volumetric flow(Re≥20000)	
Measuring error	± 1% of measured value for DN25 to 200 & ANSI1" to 8 " ± 2% of measured value for DN10S to 20,ANSI 3/8"S to ¾"
Normalised volumetric& mass flow(Re≥20000)	
Measuring error	±1.5% of measured value for DN25 to 200 & ANSI1" to 8 " ±2.5% of measured value for DN10S to 20,ANSI 3/8"S to ¾"
Repeatability	± 0.5% of measured value
Product Temperature error	Compensated by software only

Materials			
SR.NO	**DESCRIPTION**	**MATERIAL**	**REMARKS**
1	**Housing**	Stainless Steel, A351 CF3M (316L) Stainless Steel, A351 CF8 (304)	Upto size DN100/4" From DN150/6" to DN200/8"
2	**Vortex shedding body**	Unalloyed Titanium(No.3.7035) as standard	
3	**Seals**		
	a. upto 180 deg C(356deg.F)	Viton O ring	Non steam applications
	b. upto 220deg C(428deg.F)	Kalrez 4079 O ring	Non steam applications
	c. upto 240 deg C(464deg.F)	Parofluor O ring	Steam applications
4	**Bluff body metal seal**	C ring Inconel Ni plated	Once used metal C ring should not be used again.Tightening torques for new seals are M6= 1.5 kg - m M8= 2 kg - m M10= 5.5 kg - m
5	**Gaskets**	GASKET,STYLE AF-139,NON ASBESTOS GASKET,STYLE AF-160,NON ASBESTOS GASKET,TEFLON(PTFE)	Any one as per application

Pressure loss Δp

<u>at normal conditions</u>

for air (1.013 bar/0°C/ρn = 1.29 kg/m^3) (14.69psi / 32°F /ρn = 0.0805 lbs /ft$^{3)}$	See Diagram I		
for water (20°C/ ρn = 998.2 kg/m^3) (68°F /ρn = 62.31 lbs /ft$^{3)}$	See Diagram II		
<u>at operating conditions</u>		Δp	pressure loss in Pa
for gases and liquids	$\Delta p = C * qv2 * \rho x$	C	constant (see Table)
		q_v	flow rate in m^3 /hr
for standard vapour	$\Delta p = \frac{C * q_m 2}{\rho_x}$	q_m	flow rate in kg/hr
		ρ_x	operating density in kg/ m^3

Diagram I

Pressure loss Δp for air 1.013 bar (14.69 psi) / 0°C(32°F) /ρn =1.29 kg/m^3 (0.0805 lbs/ ft^3)

Δp (psig) Δp (mbar)

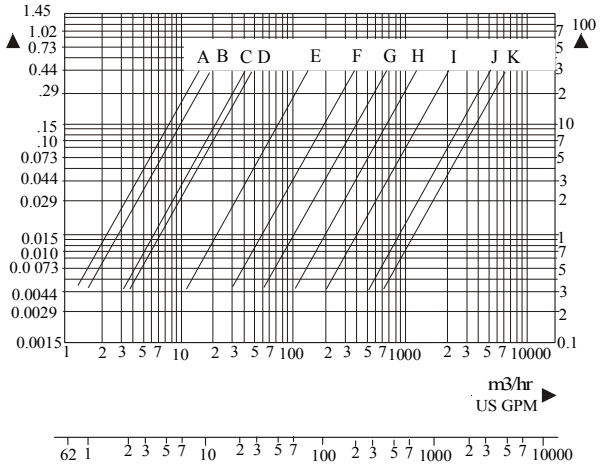
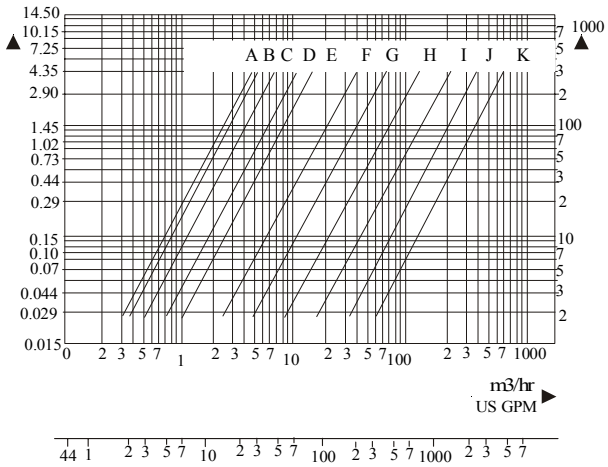


Diagram II

Pressure loss Δp for water 20°C (68°F)/ ρn=998.2 kg/m^3 (62.31 lbs/ft^3 /)

Δp (psig) Δp (mbar)

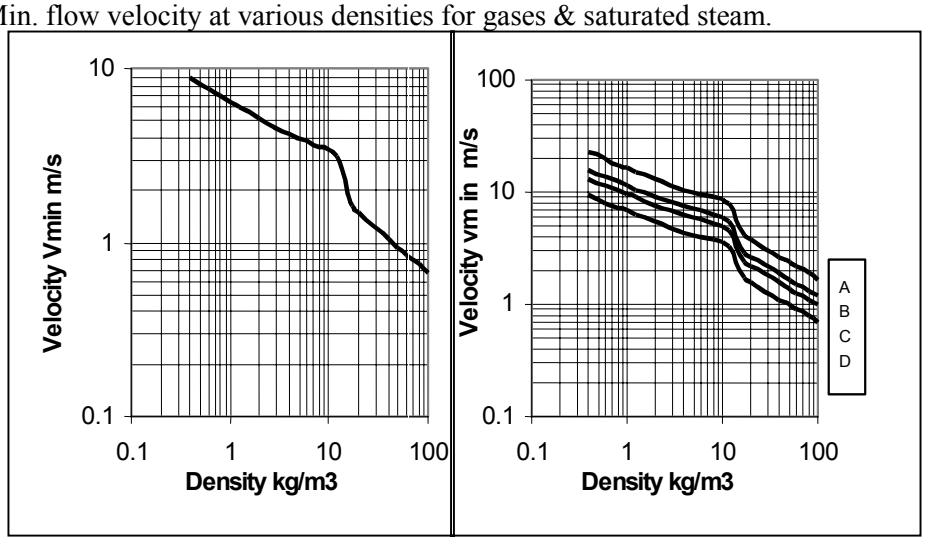


<u>Table for diagrams I +II and Constant C</u>

Curve	Meter size (DIN/ANSI)	Constant C
A	DN 10S , 3/8 ” S	13.7
B	DN 10 , 3/8 ”	3.42
C	DN 15 ,1/2 ”	1.75
D	DN 20 , 3/4 ”	0.45
E	DN 25 , 1 ”	1.50 $* 10^{-1}$
F	DN 40 , 1**1/2** ”	3.30 $* 10^{-2}$
G	DN 50 , 2 ”	7.80 $* 10^{-3}$
H	DN 80 , 3”	1.90 $* 10^{-3}$
I	DN 100 , 4”	5.30 $* 10^{-4}$
J	DN 150 , 6”	1.60 $* 10^{-4}$
K	DN 200 , 8”	5.90 $* 10^{-5}$

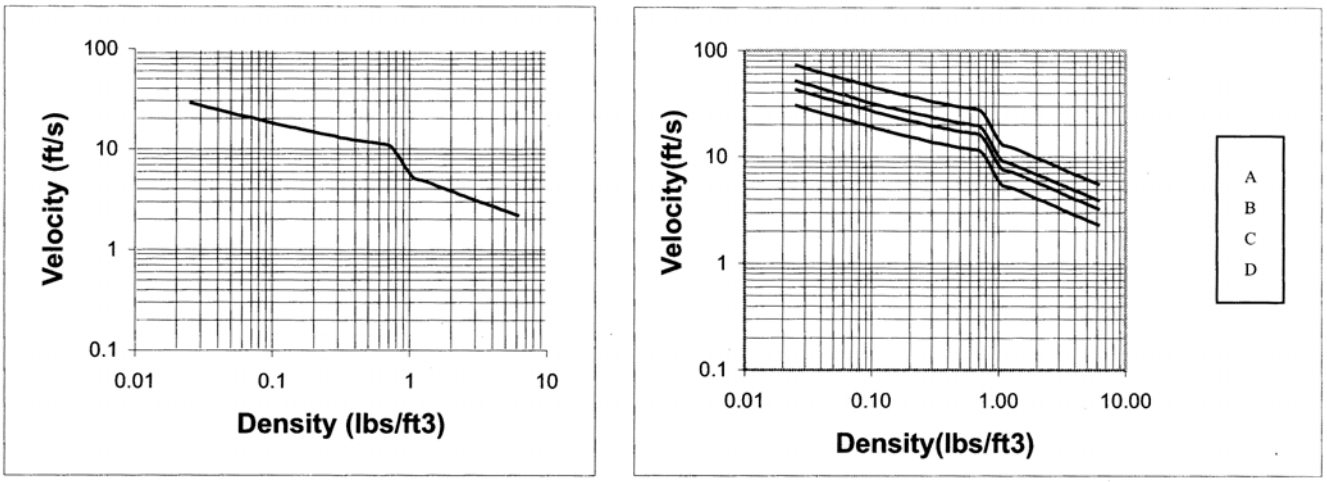
Diagram III

Min. flow velocity at various densities for gases & saturated steam.



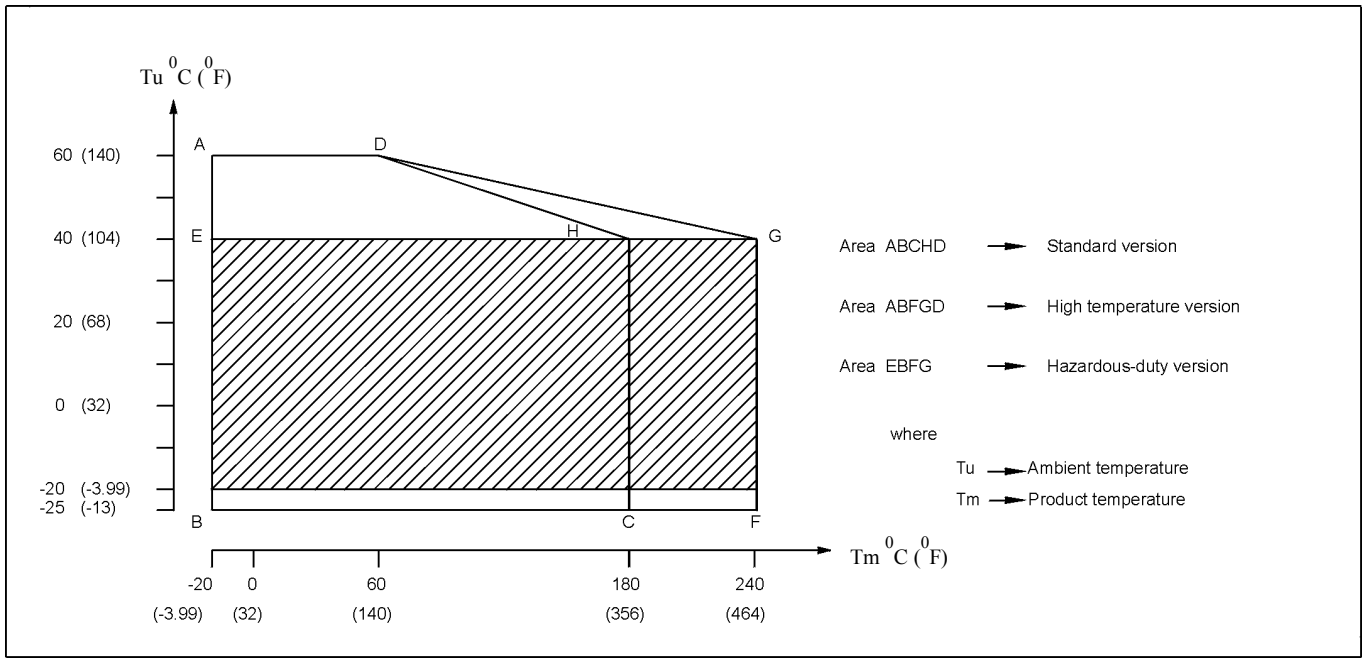
Curve	Meter Size (DIN/ANSI)
A	DN 10 S / 3/8 ” S
B	DN 10 / 3/8 ”
C	DN 15 / 1/2 ”
D	DN 20 / 3/4 ”

DN25(1") TO DN200(8") **DN10S(3/8"S) TO DN20(3/4")**



DN25(1") TO DN200(8") **DN10S(3/8"S) TO DN20(3/4")**

Diagram IV



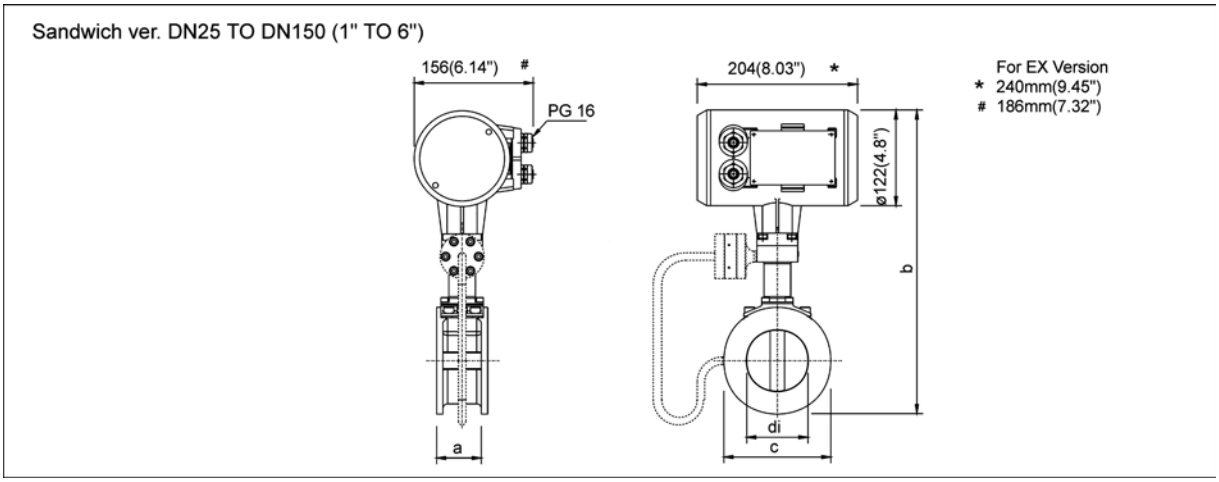
Signal Converter VFC 090

Full scale range	programmable in litres, m^3 , US/UK gallons, kg, tonnes, lbs, cub ft or standard flow rate per second, minute or hour
Power Supply	240/220/200/120/110/100 V AC + 10% - 15% } 48 to 63 Hz 230 V AC + 6% - 10%
Power Consumption	AC: 15 VA
Ambient temperature Tu	see diagram IV, page 59
Local display	3-field back-lit LCD
Display functions	actual flowrate and sum totalizer (8-digit), each programmable for continuous or sequential display of measured parameters and error messages
Display units	
Actual flowrate	Units list as per full scale range or % of full scale independently programmed
Totalizer	liters, m^3, US/UK gallon, kg, tonnes, lbs, cub. ft.
Language of plain texts	German, English, French.
Display	
1st field (top)	8 digit, 7-segment numeric display, symbols for key acknowledgement
2nd field (middle)	10-character, 14-segment text display
3rd field (bottom)	6 markers ▼ to identify actual display
Mass flow measurement	manual through keyboard or on-line with optional integrated temperature and pressure sensors
Housing, signal converter	with separate connection compartment
Material	die-cast aluminium
Protection category (EN 60529/IEC 529)	IP 65 & IP 67(better than NEMA 4 & 4X)
Current output	Operating data programmable, galvanically isolated (not from frequency output)
Current	0/4 to 20 mA corresponding to flow values independently programmable with min. span equal to 20% of full scale.
Accuracy	± 0.1% of FS
Temp. coefficient	100 ppm of fullscale range per 1^0 C.
Max. load at $I_{100\%}$ (20 mA)	700 Ω
Error annunciation	I error = 2/22 mA programmable
Frequency output	operating data programmable, galvanically isolated (not from current output)
Pulse rate for q = 100%	10 to 36000000 pulse per hour 0.167 to 600000 pulses per minute 0.0028 to 10000 pulses per second (=Hz) optionally in pulses per litre, m^3, US/UK gallon, kg, tonne, lb, cub. ft.
Active output	short-circuit-proof suitable for electromechanical (EMC) OR electronic (EC) totalizer
Amplitude	max. 24V.
Load rating	see Table "pulse width" on page 61
Passive output	open collector for connection of active electronic totalizers (EC) or switchgear
Input voltage (external supply)	5 to 24V
Load current	max. 100 mA
Ri	100 ohms.
Accuracy	Frequency output mode : +/- 0.3% of value. Pulse output mode : 0% (no additional error)

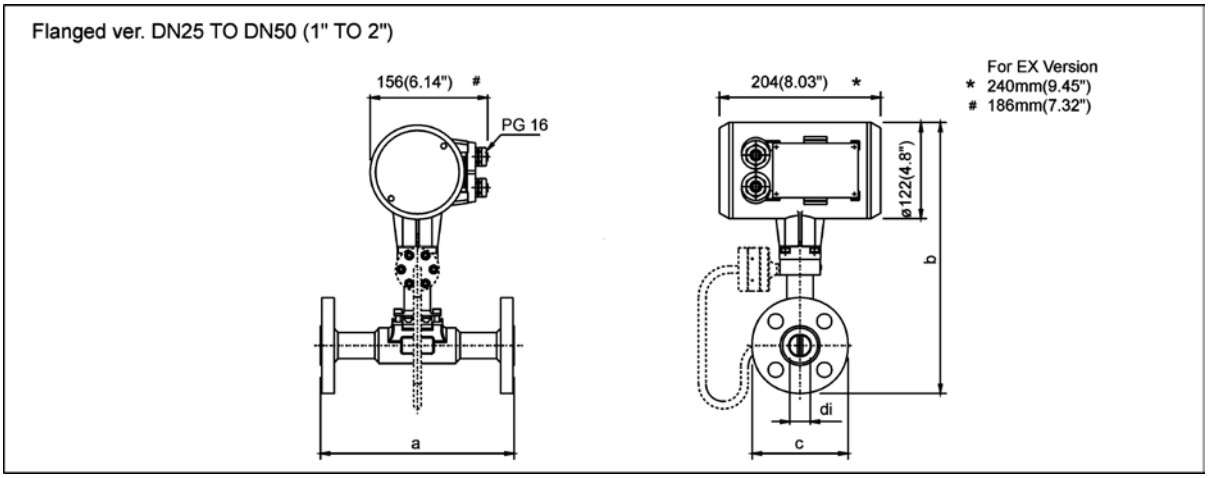
Pulse width	Frequency $f = F_{100\%}$ (at q = 100%)			Load rating of active output					
				Load current			Load		
500 ms	0.0028 Hz	< f ≤	1 Hz	≤	150	mA	≥	160	Ohm
200 ms	0.0028 Hz	< f ≤	2 Hz	≤	150	mA	≥	160	Ohm
100 ms	0.0028 Hz	< f ≤	3 Hz	≤	150	mA	≥	160	Ohm
100 ms	3 Hz	< f ≤	5 Hz	≤	60	mA	≥	400	Ohm
50 ms	0.0028 Hz	< f ≤	5 Hz	≤	150	mA	≥	160	Ohm
50 ms	5 Hz	< f ≤	10 Hz	≤	60	mA	≥	400	Ohm
30 ms	0.0028 Hz	< f ≤	6 Hz	≤	150	mA	≥	160	Ohm
30 ms	6 Hz	< f ≤	10 Hz	≤	80	mA	≥	300	Ohm
Pulse duty factor 1:1	10 Hz	< f ≤	1000 Hz	≤	25	mA	≥	1000	Ohm
160 µs	10000 Hz	< f ≤	2547 Hz	≤	25	mA	≥	1000	Ohm
50 µs	2547 Hz	< f ≤	10000 Hz	≤	25	mA	≥	1000	Ohm

DIMENSION DETAILS :-

Sandwich ver. DN25 TO DN150 (1" TO 6")

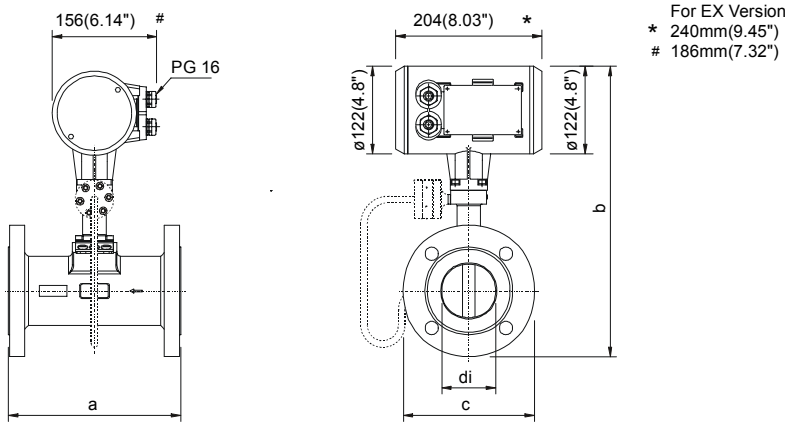


Flanged ver. DN25 TO DN50 (1" TO 2")

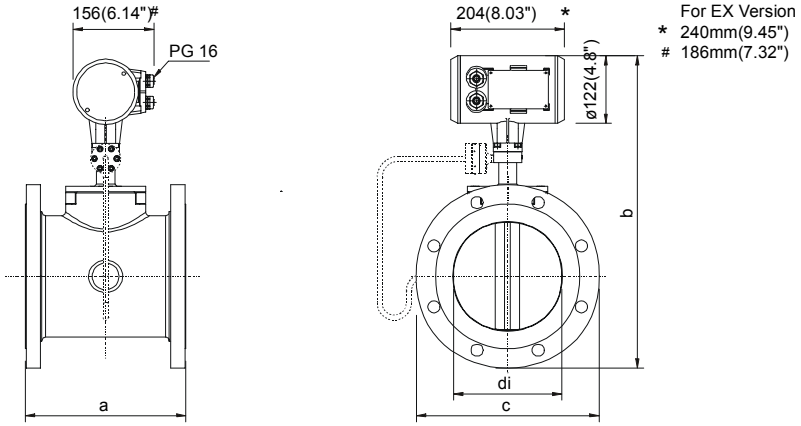


DIMENSION DETAILS :-

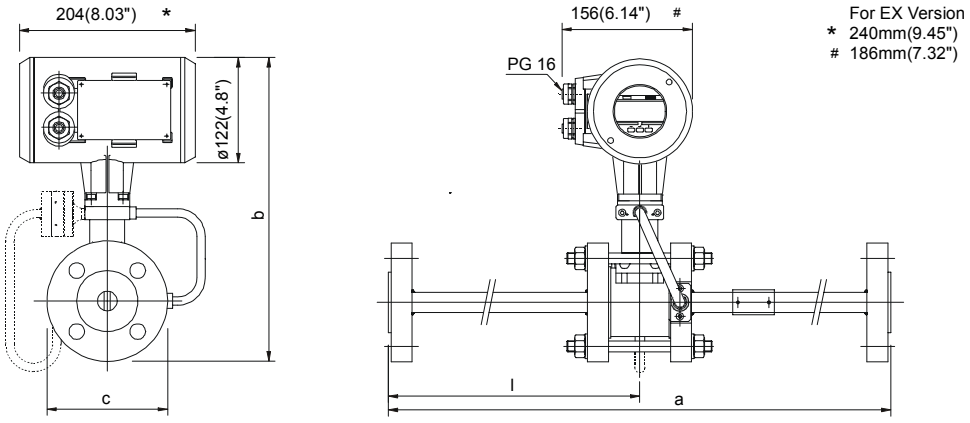
Flanged ver. DN 80 to DN150 (3" & 6")



Flanged ver. DN200 (8")



Small Size DN10s TO DN20 (3/8"s TO 3/4")



Dimensions and weights

- Flange connections to DIN 2501 and ANSI B16.5 (Schedule 40)
- Sandwich design to DIN 19205 and ANSI
- Groove joint to DIN 2512 and ANSI, dimensions on request

Dimension ‘a’ without gaskets between flowmeter and pipe flanges. Gaskets not included with flowmeter.
High temperature version with “raised” signal convertor housing: dimensions b + 100 mm
Note the operating limits to DIN 2401 and ANSI 16.5

Meter size DN:mm ANSI:inches	Pr. Rating of flanges	Sandwich version																	
		Dimensions in mm/inches														Approximate weight			
						With U/S & D/S						With pressure sensor				Without pr.sensor		With pr.sensor	
		di		a		a		b		c		b		c					
		mm	inch	mm	inch	mm	inches	mm	inch	mm	inch	mm	inch	mm	inch	kg	lbs	kg	lbs
DN25	PN40	28.5	1.12	65	2.56	365.00	14.37	318	12.52	69	2.72	365	14.38	161	6.32	5.0	11.1	5.8	12.9
DN25	PN100	28.5	1.12	65	2.56	365.00	14.37	318	12.52	69	2.72	365	14.38	161	6.32	5.0	11.1	5.8	12.9
1"	300LBS	26.7	1.05	65	2.56	365.00	14.37	319	12.56	69	2.72	366	14.40	161	6.33	5.0	11.1	5.8	12.9
DN40	PN40	43.1	1.70	65	2.56	545.00	21.46	339	13.35	89	3.50	376	14.81	178	7.01	5.5	12.1	6.3	13.8
DN40	PN100	43.1	1.70	65	2.56	545.00	21.46	339	13.35	89	3.50	376	14.81	178	7.01	5.5	12.1	6.3	13.8
1.5"	300LBS	40.9	1.61	65	2.56	545.00	21.46	340	13.39	89	3.50	377	14.86	179	7.04	5.5	12.1	6.3	13.8
DN50	PN40	54.5	2.15	65	2.56	665.00	26.18	348	13.70	100	3.94	380	14.95	188	7.41	5.7	12.6	6.5	14.4
DN50	PN64	54.5	2.15	65	2.56	665.00	26.18	348	13.70	100	3.94	380	14.95	188	7.41	5.7	12.6	6.5	14.4
DN50	PN100	54.5	2.15	65	2.56	665.00	26.18	348	13.70	100	3.94	380	14.95	188	7.41	5.7	12.6	6.5	14.4
2"	150LBS	52.6	2.07	65	2.56	665.00	26.18	349	13.74	100	3.94	381	14.99	189	7.45	5.7	12.6	6.5	14.4
2"	300LBS	52.6	2.07	65	2.56	665.00	26.18	349	13.74	100	3.94	381	14.99	189	7.45	5.7	12.6	6.5	14.4
DN80	PN40	82.5	3.25	65	2.56	1025.00	40.35	380	14.95	136	5.35	393	15.49	227	8.94	7.5	16.4	8.3	18.2
DN80	PN64	82.5	3.25	65	2.56	1025.00	40.35	380	14.95	136	5.35	393	15.49	227	8.94	7.5	16.4	8.3	18.2
DN80	PN100	82.5	3.25	65	2.56	1025.00	40.35	380	14.95	136	5.35	393	15.49	227	8.94	7.5	16.4	8.3	18.2
3"	150LBS	78	3.07	65	2.56	1025.00	40.35	387	15.23	136	5.35	401	15.77	220	8.66	7.5	16.4	8.3	18.2
3"	300LBS	78	3.07	65	2.56	1025.00	40.35	387	15.23	136	5.35	401	15.77	220	8.66	7.5	16.4	8.3	18.2
DN100	PN16	107.1	4.22	80	3.15	1280.00	50.39	406	15.98	159	6.26	408	16.07	251	9.88	8.5	18.7	9.3	20.5
DN100	PN40	107.1	4.22	80	3.15	1280.00	50.39	406	15.98	159	6.26	408	16.07	251	9.88	8.5	18.7	9.3	20.5
DN100	PN64	107.1	4.22	80	3.15	1280.00	50.39	406	15.98	159	6.26	408	16.07	251	9.88	8.5	18.7	9.3	20.5
4"	150LBS	102.4	4.03	80	3.15	1280.00	50.39	408	16.08	159	6.26	411	16.17	254	9.98	8.5	18.7	9.3	20.5
4"	300LBS	102.4	4.03	80	3.15	1280.00	50.39	408	16.08	159	6.26	411	16.17	254	9.98	8.5	18.7	9.3	20.5
DN150	PN16	159.3	6.27	145	5.71	1945.00	76.57	473	18.60	216	8.50	411	16.17	316	12.42	17.8	39.2	18.6	41.0
DN150	PN40	159.3	6.27	145	5.71	1945.00	76.57	473	18.60	216	8.50	411	16.17	316	12.42	17.8	39.2	18.6	41.0
6"	150LBS	154.2	6.07	145	5.71	1945.00	76.57	475	18.70	216	8.50	411	16.17	318	12.50	17.8	39.2	18.6	41.0
6"	300LBS	154.2	6.07	145	5.71	1945.00	76.57	475	18.70	216	8.50	411	16.17	318	12.50	17.8	39.2	18.6	41.0

For Sandwich units,

1. 1” & 1.5”, 150 lbs mating flanges are available only with 7D,5D locating pipes.
2. Face to face distance for DN 100/4” units is 80 mm , so one to one replacement with the old design in this case is not possible.

Dimensions and weights (continued) : -

Meter size DN:mm ANSI:inches	Pr.rating of flanges	Flanged version													
		Dimensions in mm/inches										Approximate weight			
								With pr.sensor				Without pr.sensor		With pr.sensor	
		di		a		b		b		c					
		mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	kg	lbs	kg	lbs
DN25	PN40	28.5	1.12	250	9.84	341	13.43	365	14.38	184	7.23	5.9	12.9	6.7	14.7
DN25	PN100	28.5	1.12	250	9.84	354	13.92	365	14.38	196	7.72	7.1	15.6	7.9	17.4
1"	150LBS	26.7	1.05	250	9.84	338	13.32	366	14.42	180	7.10	5.4	11.9	6.2	13.7
1"	300LBS	26.7	1.05	250	9.84	346	13.64	366	14.42	188	7.41	5.9	13.0	6.7	14.8
DN40	PN40	43.1	1.70	250	9.84	370	14.55	376	14.81	208	8.21	6.9	15.1	7.7	16.9
DN40	PN100	43.1	1.70	250	9.84	380	14.94	376	14.81	218	8.60	8.6	19.0	9.4	20.8
1.5"	150LBS	40.9	1.61	250	9.84	359	14.14	377	14.86	198	7.79	6.5	14.3	7.3	16.1
1.5"	300LBS	40.9	1.61	250	9.84	373	14.70	377	14.86	212	8.35	7.6	16.7	8.4	18.4
DN50	PN40	54.5	2.15	250	9.84	381	14.98	381	14.98	221	8.69	8.2	18.0	9.0	19.8
DN50	PN64	54.5	2.15	250	9.84	396	15.57	396	15.57	228	8.98	9.7	21.3	10.5	23.1
DN50	PN100	54.5	2.15	250	9.84	388	15.28	388	15.28	236	9.28	10.8	23.8	11.6	25.5
2"	150LBS	52.6	2.07	250	9.84	375	14.77	381	14.99	215	8.48	8.0	17.6	8.8	19.4
2"	300LBS	52.6	2.07	250	9.84	382	15.02	381	14.99	222	8.73	8.7	19.2	9.5	20.9
DN80	PN40	82.5	3.25	250	9.84	412	16.21	412	16.21	259	10.20	12.5	27.6	13.3	29.4
DN80	PN64	82.5	3.25	250	9.84	427	16.80	427	16.80	267	10.50	14.0	30.9	14.8	32.7
DN80	PN100	82.5	3.25	250	9.84	419	16.50	419	16.50	274	10.79	15.7	34.6	16.5	36.4
3"	150LBS	78	3.07	250	9.84	414	16.30	414	16.30	247	9.73	13.3	29.3	14.1	31.0
3"	300LBS	78	3.07	250	9.84	423	16.66	423	16.66	256	10.09	14.8	32.6	15.6	34.3
DN100	PN16	107.1	4.22	250	9.84	444	17.48	444	17.48	281	11.06	13.1	28.9	13.9	30.6
DN100	PN40	107.1	4.22	250	9.84	416	16.36	416	16.36	288	11.36	14.6	32.2	15.4	34.0
DN100	PN64	107.1	4.22	250	9.84	437	17.19	437	17.19	296	11.65	17.0	37.4	17.8	39.1
4"	150LBS	102.4	4.03	250	9.84	443	17.45	443	17.45	288	11.35	15.8	34.8	16.6	36.6
4"	300LBS	102.4	4.03	250	9.84	456	17.95	456	17.95	301	11.85	19.6	43.2	20.4	45.0
DN150	PN16	159.3	6.27	250	9.84	507	19.96	507	19.96	350	13.78	17.9	39.5	18.7	41.3
DN150	PN40	159.3	6.27	250	9.84	514	20.24	514	20.24	358	14.08	20.8	45.9	21.6	47.7
6"	150LBS	154.2	6.07	250	9.84	507	19.95	507	19.95	349	13.75	21.0	46.3	21.8	48.0
6"	300LBS	154.2	6.07	250	9.84	526	20.70	526	20.70	368	14.50	28.5	62.9	29.3	64.7
DN200	PN10	206.5	8.13	300	11.81	573	22.55	573	22.55	411	16.19	44.7	98.5	45.5	100.3
DN200	PN16	206.5	8.13	300	11.81	573	22.55	573	22.55	411	16.19	44.2	97.4	45.0	99.2
8"	150LBS	202.7	7.98	300	11.81	576	22.68	576	22.68	411	16.17	51.8	114.1	52.6	115.9
8"	300LBS	202.7	7.98	300	11.81	595	23.43	595	23.43	430	16.92	73.1	161.2	73.9	162.9

Meter size DIN:mm ANSI:inches	Pressure rating of flanges	Dimensions in mm/inches												Approximate weight			
										With pr.sensor				Without pr.sensor		With pr.sensor	
		di		a		b		c		c		l					
		mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	kg	lbs	kg	lbs
DN10S	DN10,PN40	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	11.57	25.51	12.37	27.28
	DN10,PN100	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	12.38	27.30	13.18	29.06
	DN15,PN40	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	11.73	25.86	12.53	27.63
	DN15,PN100	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	12.61	27.81	13.41	29.57
	DN20,PN40	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	12.34	27.21	13.14	28.97
	DN25,PN40	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	12.78	28.18	13.58	29.94
	DN25,PN100	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	15.47	34.11	16.27	35.88
3/8"S	1/2"NB,ANSI150	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	11.11	24.50	11.91	26.26
	1/2"NB,ANSI300	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	11.58	25.53	12.38	27.30
	3/4"NB,ANSI150	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	11.51	25.38	12.31	27.14
	3/4"NB,ANSI300	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	12.58	27.74	13.38	29.50
	1"NB,ANSI150	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	11.99	26.44	12.79	28.20
	1"NB,ANSI300	8.9	0.35	606	23.9	354	13.95	152	5.98	230	9.06	480	18.9	13.18	29.06	13.98	30.83
DN10	DN10,PN40	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	12.15	26.79	12.95	28.55
	DN10,PN100	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	12.96	28.58	13.76	30.34
	DN15,PN40	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	12.31	27.14	13.11	28.91
	DN15,PN100	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	13.18	29.06	13.98	30.83
	DN20,PN40	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	12.92	28.49	13.72	30.25
	DN25,PN40	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	13.35	29.44	14.15	31.20
	DN25,PN100	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	16.04	35.37	16.84	37.13
3/8"	1/2"NB,ANSI150	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	11.70	25.80	12.50	27.56
	1/2"NB,ANSI300	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	12.16	26.81	12.96	28.58
	3/4"NB,ANSI150	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	12.09	26.66	12.89	28.42
	3/4"NB,ANSI300	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	13.16	29.02	13.96	30.78
	1"NB,ANSI150	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	12.57	27.72	13.37	29.48
	1"NB,ANSI300	12.6	0.5	826	32.5	356	14.02	154	6.05	232	9.14	665	26.2	13.76	30.34	14.56	32.10
DN15	DN15,PN40	14.9	0.59	966	38	357	14.06	155	6.10	241	9.48	780	30.7	12.58	27.74	13.38	29.50
	DN15,PN100	14.9	0.59	966	38	357	14.06	155	6.10	241	9.48	780	30.7	13.45	29.66	14.25	31.42
	DN20,PN40	14.9	0.59	966	38	357	14.06	155	6.10	241	9.48	780	30.7	13.19	29.08	13.99	30.85
	DN25,PN40	14.9	0.59	966	38	357	14.06	155	6.10	241	9.48	780	30.7	13.62	30.03	14.42	31.80
	DN25,PN100	14.9	0.59	966	38	357	14.06	155	6.10	241	9.48	780	30.7	16.30	35.94	17.10	37.71
1/2"	1/2"NB,ANSI150	14.9	0.59	966	38	357	14.06	155	6.10	241	9.48	780	30.7	11.98	26.42	12.78	28.18
	1/2"NB,ANSI300	14.9	0.59	966	38	357	14.06	155	6.10	241	9.48	780	30.7	12.44	27.43	13.24	29.19
	3/4"NB,ANSI150	14.9	0.59	966	38	357	14.06	155	6.10	241	9.48	780	30.7	12.37	27.28	13.17	29.04
	3/4"NB,ANSI300	14.9	0.59	966	38	357	14.06	155	6.10	241	9.48	780	30.7	13.43	29.61	14.23	31.38
	1"NB,ANSI150	14.9	0.59	966	38	357	14.06	155	6.10	241	9.48	780	30.7	12.84	28.31	13.64	30.08
	1"NB,ANSI300	14.9	0.59	966	38	357	14.06	155	6.10	241	9.48	780	30.7	14.03	30.94	14.83	32.70
DN20	DN20,PN40	20.9	0.82	1326	52.2	360	14.19	158	6.21	255	10.05	780	30.7	14.03	30.94	14.83	32.70
	DN25,PN40	20.9	0.82	1326	52.2	360	14.19	158	6.21	255	10.05	780	30.7	14.47	31.91	15.27	33.67
	DN25,PN100	20.9	0.82	1326	52.2	360	14.19	158	6.21	255	10.05	780	30.7	17.13	37.77	17.93	39.54
3/4"	3/4"NB,ANSI150	20.9	0.82	1326	52.2	360	14.19	158	6.21	255	10.05	780	30.7	13.23	29.17	14.03	30.94
	3/4"NB,ANSI300	20.9	0.82	1326	52.2	360	14.19	158	6.21	255	10.05	780	30.7	14.28	31.49	15.08	33.25
	1"NB,ANSI150	20.9	0.82	1326	52.2	360	14.19	158	6.21	255	10.05	780	30.7	13.70	30.21	14.50	31.97
	1"NB,ANSI300	20.9	0.82	1326	52.2	360	14.19	158	6.21	255	10.05	780	30.7	14.88	32.81	15.68	34.57

Measuring principle

The Vortex flowmeter is used for measuring the flow velocity of fluids in pipelines. The measuring principle is based on the development of a Karman vortex shedding street in the wake of body built into the pipeline. In theory, this process enables measurements to be carried out in turbulent flows with a Reynolds number Re > 3000, but linear measurements are only possible where Re > 20,000.

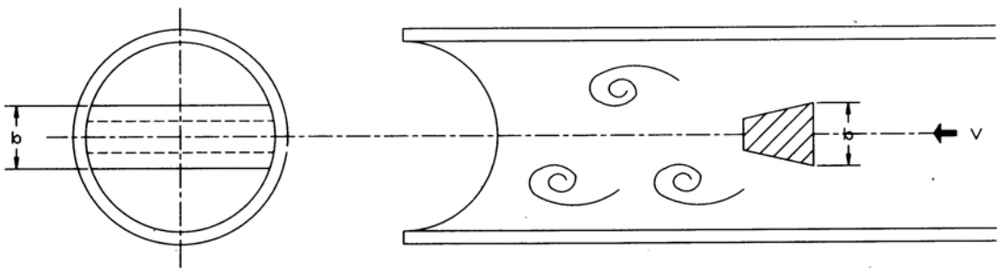
The periodic shedding of eddies occurs first from one side and then from the other side of a bluff body (Vortex-shedding body) installed perpendicular to the pipe axis. Vortex shedding generates a so-called “Karman Vortex Street” with alternating pressure conditions whose frequency f is proportional to the flow velocity v. The non-dimentional Strouhal number S (primary head constant) describes the relationship between vortex shedding frequency F. (in Hz.) width b of the body, and mean flow velocity v (in m/s.)

$$F = \frac{S * v}{b}$$

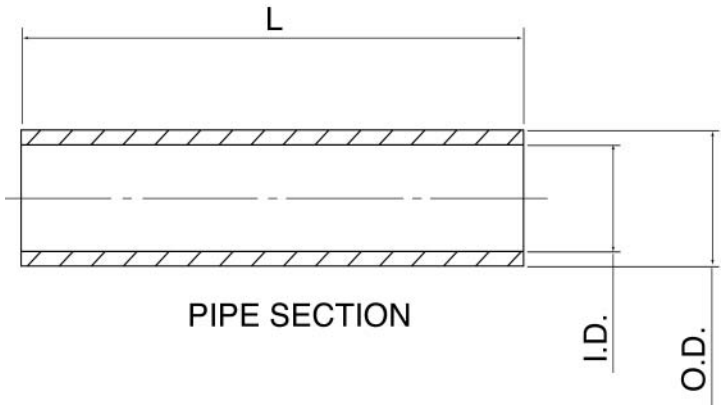
The flexural vibration of the vortex-shedding body is picked up in the primary head via sensors and analysed in the signal converter. In the case of gaseous, flowing media, the vibration frequency ranges between 10 and 7000Hz.

To permit the mass rate of flow to be calculated from the volume rate of flow, either medium pressure and temperature or medium density at the installation location of the flowmeter must be known factors.

Karman Vortex Street



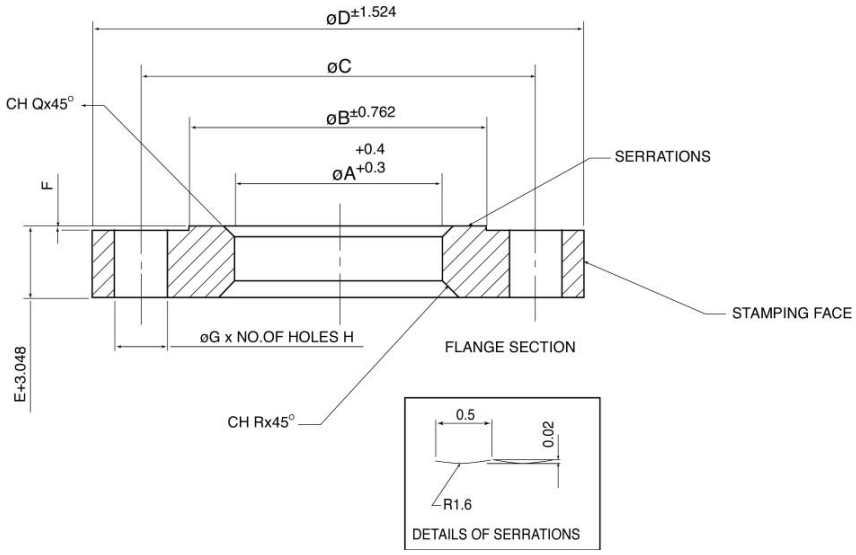
Pipe for U/S, D/S Assembly



Standard	Meter Size	O.D.	I.D.	Pipe Length in mm											
				7D	5D	10D	5D	20D	5D	30D	5D	40D	5D	50D	5D
ANSI B36.10 SH40	1”	33.4	26.7	175	125	250	125	500	125	750	125	1000	125	1250	125
	1.5”	48.3	40.9	280	200	400	200	800	200	1200	200	1600	200	2000	200
	2”	60.3	52.6	350	250	500	250	1000	250	1500	250	2000	250	2500	250
	3”	88.9	78	560	400	800	400	1600	400	2400	400	3200	400	4000	400
	4”	114.3	102.4	700	500	1000	500	2000	500	3000	500	4000	500	5000	500
	6”	168.3	154.2	1050	750	1500	750	3000	750	4500	750	6000	750	7500	750
	8”	219.7	202.7	1400	1000	2000	1000	4000	1000	6000	1000	8000	1000	10000	1000
DIN2462	DN25	33.4	28.5	175	125	250	125	500	125	750	125	1000	125	1250	125
	DN40	48.3	43.1	280	200	400	200	800	200	1200	200	1600	200	2000	200
	DN50	60.3	54.5	350	250	500	250	1000	250	1500	250	2000	250	2500	250
	DN80	88.9	82.5	560	400	800	400	1600	400	2400	400	3200	400	4000	400
	DN100	114.3	107.1	700	500	1000	500	2000	500	3000	500	4000	500	5000	500
	DN150	168.3	159.3	1050	750	1500	750	3000	750	4500	750	6000	750	7500	750
	DN200	219.7	206.5	1400	1000	2000	1000	4000	1000	6000	1000	8000	1000	10000	1000

Note :
1. Material : C.S. seamless Pipe (ASTM A106 GR-B)
2. Unless specified dimentions are in mm

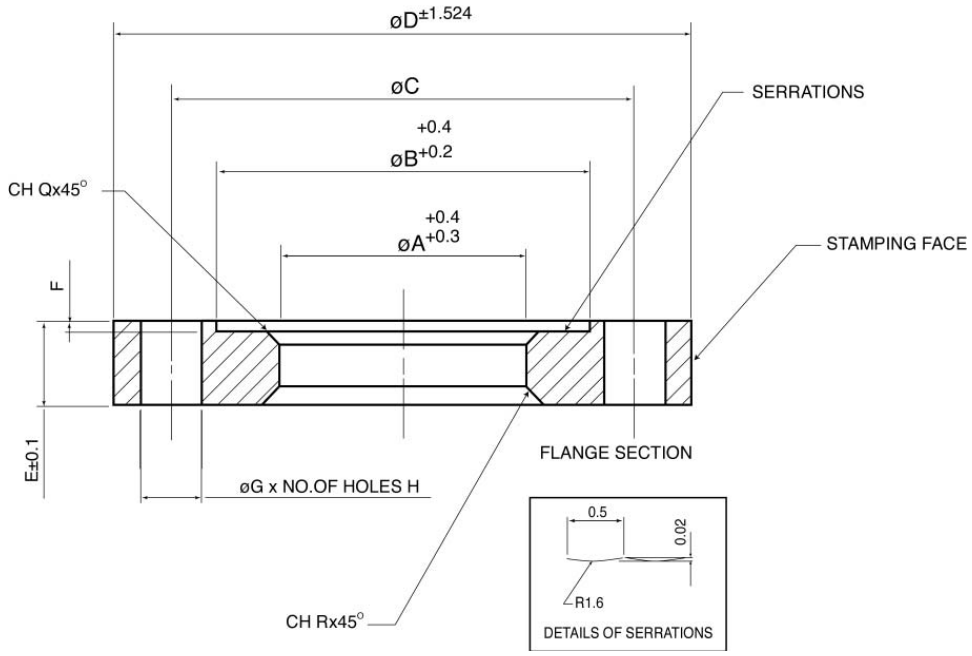
R/F Flanges for U/S, D/S Assembly ANSI SW



Size	A	B	C	D	E	F	G	H	Q	R
1" - 150	33.4	50.8	79.2	108	14.2	1.6	15.7	4	3	4.5
1" - 300	33.4	50.8	88.9	123.9	17.5	1.6	19	4	3	4.5
1.5" - 150	48.3	73.2	98.6	127	17.5	1.6	15.7	4	3	4.5
1.5" - 300	48.3	73.1	114.3	155.4	20.6	1.6	22.3	4	3	4.5
2" - 150	60.3	91.9	120.7	152.4	19.1	1.6	19.1	4	3.5	5
2" - 300	60.3	91.9	127	165.1	22.3	1.6	19	8	3.5	5
3" - 150	88.9	127	152.4	190.5	23.9	1.6	19.1	4	4.5	7
3" - 300	88.9	127	168.1	209.5	28.4	1.6	22.3	8	4.5	7
4" - 150	114.3	157.2	190.5	228.6	23.9	1.6	19.1	8	5	7.5
4" - 300	114.3	157.2	200.1	254	31.7	1.6	22.3	8	5	7.5
6" - 150	168.3	215.9	241.3	279.4	25.4	1.6	22.4	8	6	8.5
6" - 300	168.3	215.9	269.7	317.5	36.5	1.6	22.4	8	6	8.5
8" - 150	219.1	269.7	298.5	342.9	28.4	1.6	22.4	8	6	11
8" - 300	219.1	269.7	330.2	381	41.1	1.6	25.4	12	6	11

Note :
Flanges as per the B16.5
Surface finish 32 to 63 um.
Details to be stamped
* Manufacturers Name or trademark
* Flange Size
* Flange Pressure Class
* Material Designation
* Heat Code
Material : C.S., SA 516 Gr. - 60
Unless specified dimentions are in mm

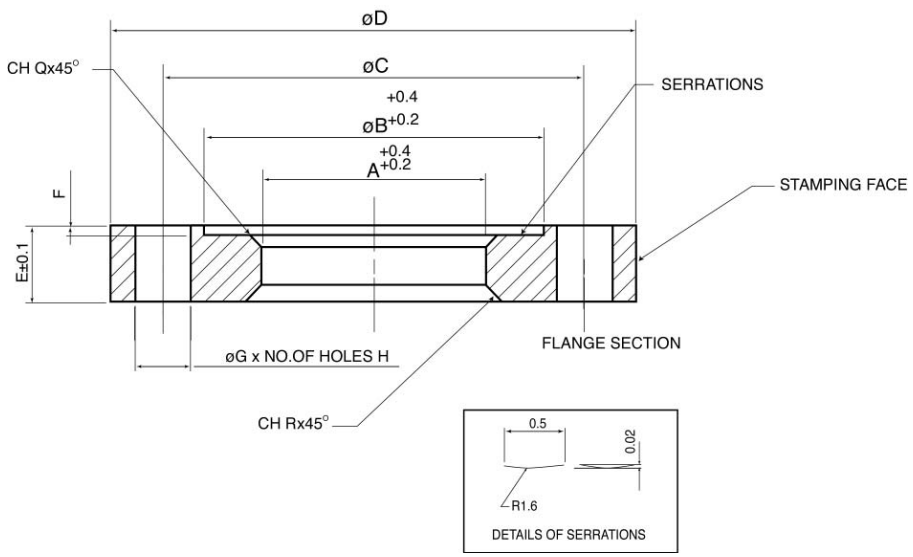
Recess Flanges for U/S, D/S Assembly ANSI, SW



Size	A	B	C	D	E	F	G	H	Q	R
1" - 300	33.4	69	88.9	123.9	22	4	19	4	3	4.5
1.5" - 300	48.3	89	114.3	155.4	25	4	22.3	4	3	4.5
2" - 150	60.3	100	120.7	152.4	23	4	19.1	4	3.5	5
2" - 300	60.3	100	127	165.1	27	4	19	8	3.5	5
3" - 150	88.9	136	152.4	190.5	28	4	19.1	4	4.5	7
3" - 300	88.9	136	168.1	209.5	33	4	22.3	8	4.5	7
4" - 150	114.3	159	190.5	228.6	28	4	19.1	8	5	7.5
4" - 300	114.3	159	200.1	254	36	4	22.3	8	5	7.5
6" - 150	168.3	216	241.3	279.4	30	4	22.4	8	6	8.5
6" - 300	168.3	216	269.7	317.5	41	4	22.4	12	6	8.5

Note :
Flanges Mating Dimentions as per ANSI B16.5
Surface finish 32 to 63 um.
Details to be stamped
* Manufacturers Name or trademark
* Flange Size
* Flange Pressure Class
* Material Designation
* Heat Code
How to Stamp
* Flange Recess Facing away operator
Material : C.S. SA 516 GR - 60
Unless specified dimentions are in mm

R/F Flanges for U/S, D/S Assembly DIN

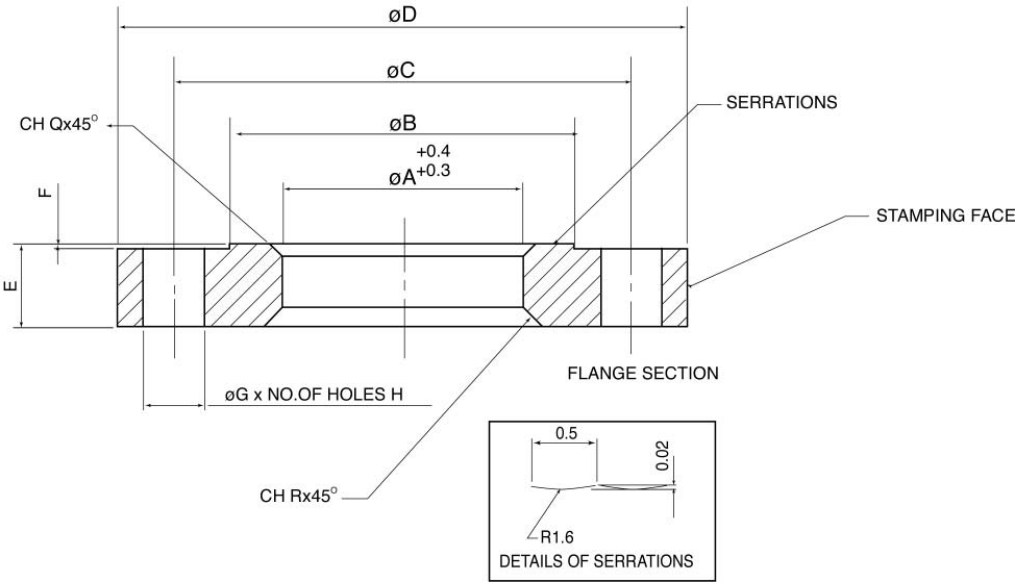


Tolerance Details			
Size	B	D	E
DN25/PN40	-1	±1	+0.8
DN25/PN100			+0.1
DN40/PN40	-2		+0.8
DN40/PN100			+0.1
DN50/PN40			+0.8
DN50/PN64			+1
DN50/PN100			
DN80/PN40			
DN80/PN64		±1.5	
DN80/PN100			
DN100/PN16			
DN100/PN40			
DN100/PN64			
DN150/PN16			
DN150/PN40			
DN200/PN10		±2	
DN200/PN16			

Size	A	B	C	D	E	F	G	H	Q	R
DN25/PN40	33.4	68	85	115	18	2	14	4	3	4.5
DN25/PN100	33.4	68	100	140	24	2	18	4	3	4.5
DN40/PN40	48.3	88	110	150	18	3	18	4	3	4.5
DN40/PN100	48.3	88	125	170	26	3	22	4	3	4.5
DN50/PN40	60.3	102	125	165	20	3	18	4	3.5	5
DN50/PN64	60.3	102	135	180	26	3	22	4	3.5	5
DN50/PN100	60.3	102	145	195	28	3	26	4	3.5	5
DN80/PN40	88.9	138	160	200	24	3	18	8	4.5	7
DN80/PN64	88.9	138	170	215	28	3	22	8	4.5	7
DN80/PN100	88.9	138	180	230	32	3	26	8	4.5	7
DN100/PN16	114.3	158	180	220	20	3	18	8	5	7.5
DN100/PN40	114.3	162	190	235	24	3	22	8	5	7.5
DN100/PN64	114.3	162	200	250	30	3	26	8	5	7.5
DN150/PN16	168.3	212	240	285	22	3	22	8	6	8.5
DN150/PN40	168.3	218	250	300	28	3	26	8	6	8.5
DN200/PN10	219.1	268	295	340	24	3	22	8	6	11
DN200/PN16	219.1	268	295	340	24	3	22	12	6	11

Note :
Flanges as per DIN 2501, Surface finish 32 to 63 um., Details to be stamped
* Manufacturers Name or trademark
* Flange Size
* Flange Pressure Class
* Material Designation
* Heat Code
How to Stamp
* Flanges Facing operator
Material : C.S. SA 516 GR - 60
Unless specified dimentions are in mm

Recess Flanges for U/S, D/S Assembly DIN, SW

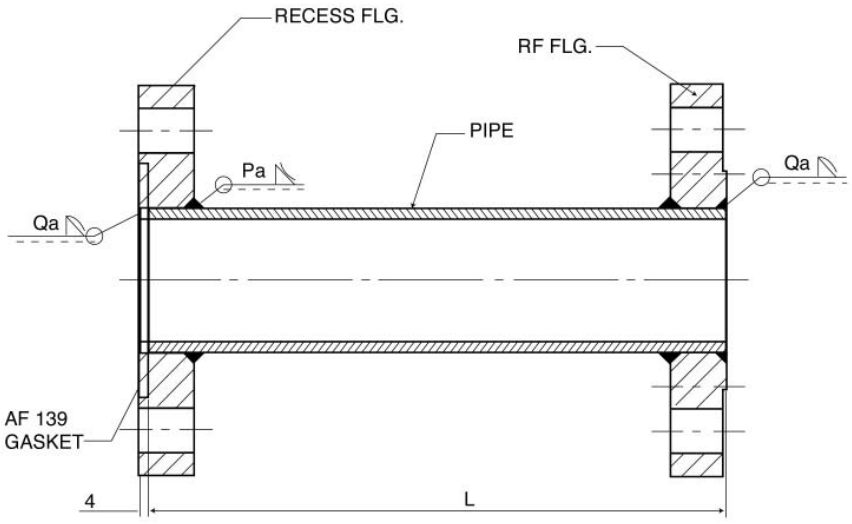


Tolerance Details	
Size	**D**
DN25/PN40	± 1
DN25/PN100	
DN40/PN40	
DN40/PN100	
DN50/PN40	
DN50/PN64	
DN50/PN100	
DN80/PN40	
DN80/PN64	± 1.5
DN80/PN100	
DN100/PN16	
DN100/PN40	
DN100/PN64	
DN150/PN16	
DN150/PN40	
DN200/PN10 DN200/PN16	± 2

Size	A	B	C	D	E	F	G	H	Q	R
DN25/PN40	33.4	69	85	115	22	4	14	4	3	4.5
DN25/PN100	33.4	69	100	140	28	4	18	4	3	4.5
DN40/PN40	48.3	89	110	150	22	4	18	4	3	4.5
DN40/PN100	48.3	89	125	170	30	4	22	4	3	4.5
DN50/PN40	60.3	100	125	165	24	4	18	4	3.5	5
DN50/PN64	60.3	100	135	180	30	4	22	4	3.5	5
DN50/PN100	88.9	100	145	195	32	4	26	4	3.5	5
DN80/PN40	88.9	136	160	200	28	4	18	8	4.5	7
DN80/PN64	88.9	136	170	215	32	4	22	8	4.5	7
DN80/PN100	114.3	136	180	230	36	4	26	8	4.5	7
DN100/PN16	114.3	159	180	220	24	4	18	8	5	7.5
DN100/PN40	114.3	159	190	235	28	4	22	8	5	7.5
DN100/PN64	168.3	159	200	250	34	4	26	8	5	7.5
DN150/PN16	168.3	216	240	285	26	4	22	8	6	8.5
DN150/PN40	168.3	216	250	300	32	4	26	8	6	8.5

Note :
Flange Mating Dimentions as per DIN 2501, Surface finish 32 to 63 um., Details to be stamped
* Manufacturers Name or trademark
* Flange Size
* Flange Pressure Class
* Material Designation
* Heat Code
How to Stamp
* Flanges Recess Facing away operator
Material : C.S. SA 516 GR - 60
Unless specified dimentions are in mm

Up Stream & Down Stream Assembly for SW



U/S, D/S ASSLY. SECTION

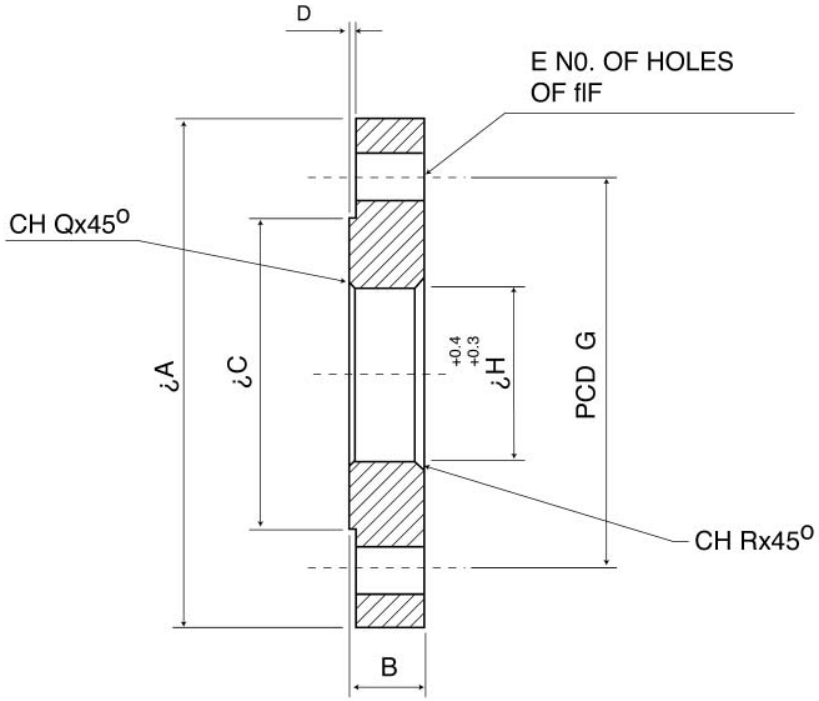
Meter Size	Pa	Qa	Pipe Length in mm											
			7D	5D	10D	5D	20D	5D	30D	5D	40D	5D	50D	5D
1" /300	3	4	175	125	250	125	500	125	750	125	1000	125	1250	125
1.5" /300	3	4	280	200	400	200	800	200	1200	200	1600	200	2000	200
2" /150	3.5	4.5	350	250	500	250	1000	250	1500	250	2000	250	2500	250
2" /300	3.5	4.5	350	250	500	250	1000	250	1500	250	2000	250	2500	250
3" /150	5	6	560	400	800	400	1600	400	2400	400	3200	400	4000	400
3" /300	5	6	560	400	800	400	1600	400	2400	400	3200	400	4000	400
4" /150	5	7	700	500	1000	500	2000	500	3000	500	4000	500	5000	500
4" /300	5	7	700	500	1000	500	2000	500	3000	500	4000	500	5000	500
6" /150	6	8	1050	750	1500	750	3000	750	4500	750	6000	750	7500	750
6" /300	6	8	1050	750	1500	750	3000	750	4500	750	6000	750	7500	750
DN25/PN40	3	4	175	125	250	125	500	125	750	125	1000	125	1250	125
DN25/PN100	3	4	175	125	250	125	500	125	750	125	1000	125	1250	125
DN40/PN40	3	4	280	200	400	200	800	200	1200	200	1600	200	2000	200
DN40/PN100	3	4	280	200	400	200	800	200	1200	200	1600	200	2000	200
DN50/PN40	3.5	4.5	350	250	500	250	1000	250	1500	250	2000	250	2500	250
DN50/PN64	3.5	4.5	350	250	500	250	1000	250	1500	250	2000	250	2500	250
DN50/PN100	3.5	4.5	350	250	500	250	1000	250	1500	250	2000	250	2500	250
DN80/PN40	5	6	560	400	800	400	1600	400	2400	400	3200	400	4000	400
DN80/PN64	5	6	560	400	800	400	1600	400	2400	400	3200	400	4000	400
DN80/PN100	5	6	560	400	800	400	1600	400	2400	400	3200	400	4000	400
DN100/PN16	5	7	700	500	1000	500	2000	500	3000	500	4000	500	5000	500
DN100/PN40	5	7	700	500	1000	500	2000	500	3000	500	4000	500	5000	500
DN100/PN64	5	7	700	500	1000	500	2000	500	3000	500	4000	500	5000	500
DN150/PN16	6	8	1050	750	1500	750	3000	750	4500	750	6000	750	7500	750
DN150/PN40	6	8	1050	750	1500	750	3000	750	4500	750	6000	750	7500	750

Note :
* One set of U/S Assly. and one set of D/S Assly is to be supplied
* To be painted with heat resistant paint.
* Flanges to welded off center.
* Welding std.- Ad-Merkblatt B8

Material : C.S.

Unless specified dimentions are in mm

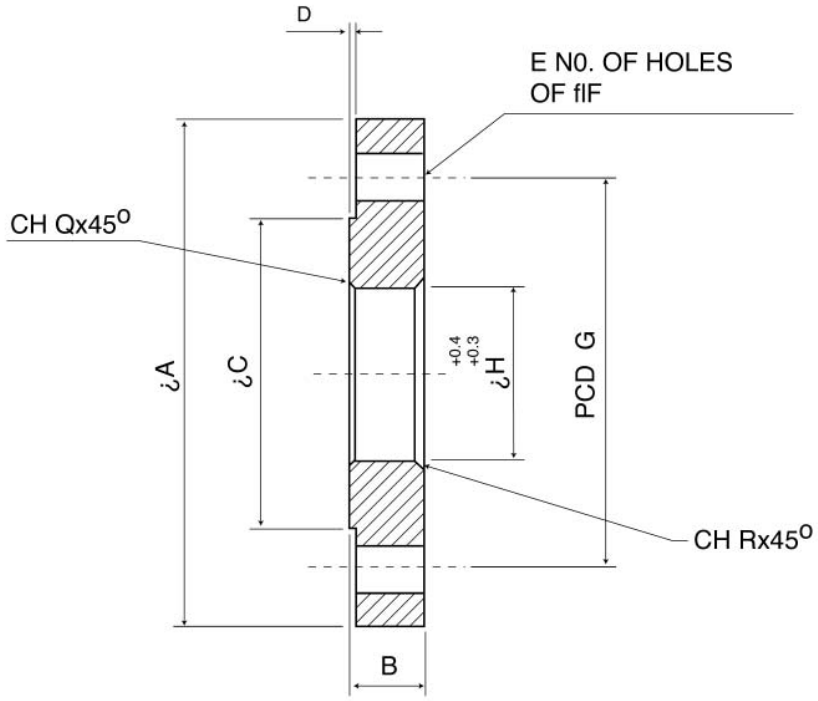
End Connection JIS Flanges for U/S, D/S pipes for SW VFM



Size	JIS FLG.	øA	B	øC	D	No. of Holes E	øF	PCD G	Bore øH	Q	R
1" SW	25A 10K	125	14	67	1	4	19	90	33.7	3	4.5
1.5" SW	40A 10K	140	16	81	2	4	19	105	48.3	3	4.5
2" SW	50A 10K	155	16	96	2	4	19	120	60.3	3	4.5
3" SW	80A 10K	185	18	126	2	8	19	150	88.9	3	4.5
4" SW	100A 10K	210	18	151	2	8	19	175	114.3	3	4.5
6" SW	150A 10K	280	22	212	2	8	23	240	168.3	3.5	5

Note :
Flanges as per JIS B2210
Surface finish 32 to 63 um.
Details to be stamped
* Manufacturers Name or trademark
* Flange Size
* Flange Pressure Class
* Material Designation
* Heat Code
How to Stamp
* Flange RF Facing operator
Material : C.S. SA 516 GR. 60
Unless specified dimentions are in mm

U/S, D/S pipe Assly. with JIS 10K & ANSI Flanges



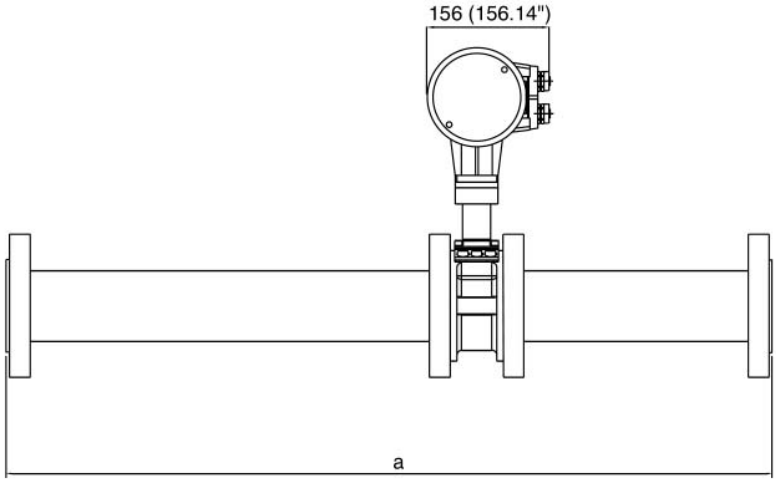
Size	JIS FLG.	øA	B	øC	D	No. of Holes E	øF	PCD G	Bore øH	Q	R
1" SW	25A 10K	125	14	67	1	4	19	90	33.7	3	4.5
1.5" SW	40A 10K	140	16	81	2	4	19	105	48.3	3	4.5
2" SW	50A 10K	155	16	96	2	4	19	120	60.3	3	4.5
3" SW	80A 10K	185	18	126	2	8	19	150	88.9	3	4.5
4" SW	100A 10K	210	18	151	2	8	19	175	114.3	3	4.5
6" SW	150A 10K	280	22	212	2	8	23	240	168.3	3.5	5

Note :
* One set of U/S Assly. and one set of D/S Assly is to be supplied
* To be painted with heat resistant paint.
* Flanges to welded off center.
* Welding std.- Ad-Merkblatt B8

Material : C.S.

Unless specified dimentions are in mm

SW Vortex Flowmeter with U/S & D/S



Meter Size ANSI/DIN	Total Length with U/S and D/S									
	with 7D U/S & 5D D/S		with 20D U/S & 5D D/S		with 30D U/S & 5D D/S		with 40D U/S & 5D D/S		with 50D U/S & 5D D/S	
	Inch	mm	Inch	mm	Inch	mm	Inch	mm	Inch	mm
1"/DN25	14.61	371	27.40	696	37.24	946	47.09	1196	56.93	1446
1.5"/DN40	21.69	551	42.17	1071	57.91	1471	73.66	1871	89.41	2271
2"/DN50	26.42	671	52.01	1321	71.69	1821	91.38	2321	111.06	2821
3"/DN80	40.59	1031	81.54	2071	113.03	2871	144.53	3671	176.02	4471
4"/DN100	50.63	1286	101.81	2586	141.18	3586	180.55	4586	219.92	5586
6"/DN150	76.81	1951	153.58	3901	212.64	5401	271.69	6901	330.75	8401

Note :

- 150 LBS AND 300 LBS PIPE METER MATING FLANGES WITH 7D&5D LOCATING PIPES
- 1" AND 1.5" METER MATING FLANGES WILL 300LBS ONLY BUT PIPE MATING FLANGES CAN BE 150LBS/300LBS

- Face to face distance for DN 100/4" units is 80 mm , so one to one replacement with the old design in this case is not possible.

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