KROHNE

4/2001

Vortex flowmeter

Installation and Operating Instructions VFM 1091(I)

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Part A system installation and start-up

1. Description

KRONHE MARSHALL vortex flowmeters operate on the Karman vortex street principle to measure volumetric flow rate of gases /steam and liquids. VFM 1091 computes normalized volumetric and mass flow rates from operating & normalized density values supplied through operator interface.

Items included with shipment for Compact flowmeter

- Compact Vortex flowmeter and operating instructions
- Installation and Operating Instructions
- Mounting bolts, washers, nuts
- Programming chart indicating factory configuration setting
- Optional upstream and downstream pipes
- Gaskets between primary head & pipeline

Items included with shipment for field mounted Flowmeter

- Field mounted sensor VFS 1091 F
- Pipe/Wall mounted separated signal converter VFC 091F
- Connecting Cable (10m) between VFS 1091 F & VFC 091F
- Installation and Operating Instructions
- Mounting bolts, washers, nuts
- Programming chart indicating factory setting.

Provided by customer

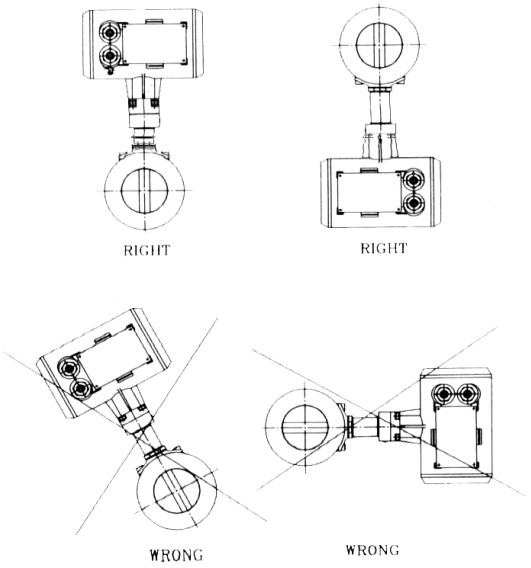
- All cables for electrical connections.

2. Installation in the pipeline

2.1 General

1. Flow direction and meter position -

- Flow must always be in the direction of the 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 diameters of primary head and pipeline

DN Meter size of primary head in millimeters or Inches
Φ Inside diameter of primary head in millimeters Max.
ΔΦ allowable difference between inside diameters of primary head and pipeline

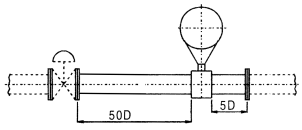
SIZE DN (mm)	ϕ mm (inch)	Δϕ mm (inch)	SIZE DN (inch)	ϕ mm (inch)	Δϕ mm (inch)
10S	8.9 (0.35)	0.4 (0.016)	3/8"S	8.9 (0.35)	0.4 (0.016)
10	12.6 (0.50)	0.4 (0.016)	3/8"	12.6 (0.50)	0.4 (0.016)
15	14.9 (0.59)	0.4 (0.016)	1/2"	14.9 (0.59)	0.4 (0.016)
20	20.9 (0.82)	0.4 (0.016)	3/4"	20.9 (0.82)	0.4 (0.016)
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 upstream and down-stream pipes are smooth and without deposits or scaling of welding beads.

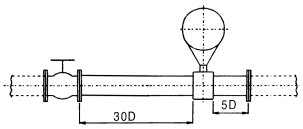
3. Straight, unimpeded inlet and outlet runs

D = Meter size (Nominal Dia. DN)

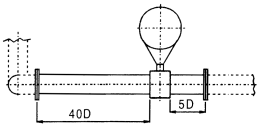
CONTROL VALVE



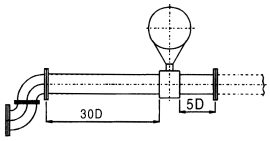
BALL/GATE VALVE
(FULLY OPEN)



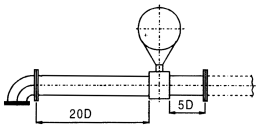
2 X 90^0 BENDS
3-DIMENSIONAL
(SAME FOR 3 X 90^0 BENDS)



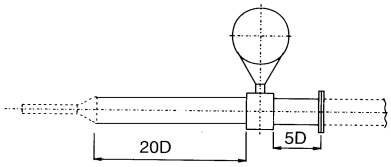
2 X 90^0 BENDS



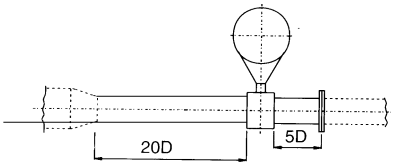
90^0 BENDS
OR "T" PIEC



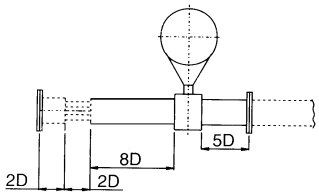
EXPANDER



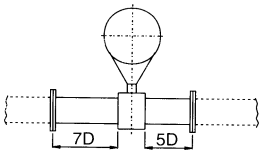
REDUCER



FLOW STRAIGHTENER



SPACIAL FLOW STRAIGHTENER

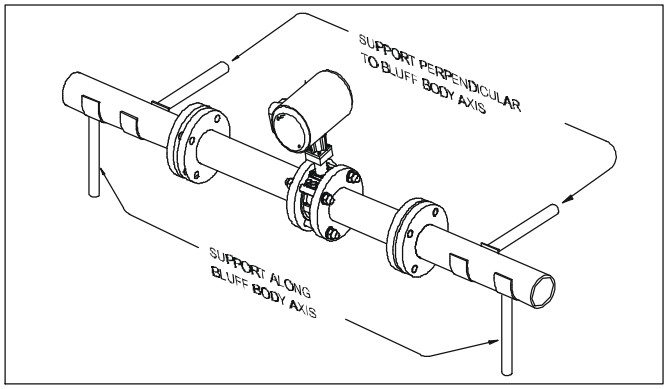


With flow straightener the inlet pipe length may be halved e.g. for a control valve the inlet length is 25D instead of 50D. The minimum inlet pipe length including flow straightener must always be 12 D.
The small sizes (below 1" or DN 25) come with upstream & downstream pipelines & flange connections to suit customer's flanges.

4. 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 & bluffbody axis.

Flexible pipes or bellows may be used before the upstream and after the downstream in case the vibrations are too high. Pipe vibration limit is 0.2 g peak to peak up to 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.

Do not lag (Thermally insulate) the meter body.

6. Orientation

- Turn the Display board through ±90 or 180 to obtain horizontal positioning of the display.
- Turn the signal converter housing through $\pm 90^0$ or 180^0 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

SANDWICH VERSION

FLANGED VERSION

- 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 gases, a filter or strainer may be used to remove solid particles. This is specially important for meter sizes below 1".

2.2 Sandwich type to DIN 19205 / ANSI

- Meter sizes DN25, 40, 50, 80, 100 and 150 (1" to 6")
- Pipe flanges

  (Pressure Ratings

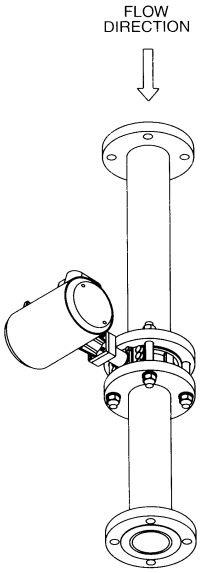
  DIN: DN25/PN40, 100; DN40/PN40, 100;

  DN50/PN40, 64, 100; DN80/PN40, 64, 100;

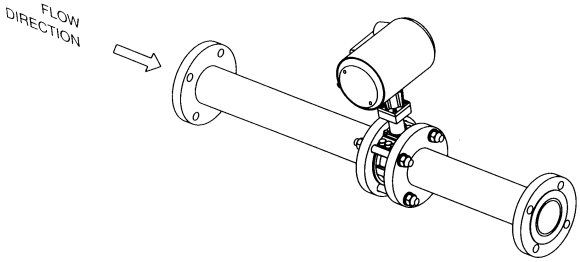
  DN100/PN16, 40, 64 and DN150 / PN16, 40.

  ANSI: 1" to 6" / #150, 300 SORF)
- Gaskets inside diameter must be greater than the inside diameter of the Primary head, e.g. Use flat gaskets to DIN 2690, **Gaskets must not project into the effective pipe cross sectional area.** washers, nuts and bolts are
- Bolts, nuts and washers are supplied with meter, check flange connection for leak-tightness after flowmeter installation.

Installation in vertical pipe run



Installation in horizontal pipe run



2.3 Flanged type to DIN 2501 / ANSI B 16.5(SCH-40)

- Meter sizes DN10S, 10, 15, 20, 25, 40, 50, 80, 100, 150 and 200 (3/8"S to 8")
- Pipe flanges
  (Pressure ratings
  DIN: DN25/PN40, 100, DN40/PN40, 100; DN50/PN40, 64, 100; DN80/ PN40, 64, 100, DN 100 /PN16, 40, 64; DN150/PN16, PN40, DN200/PN10, 16 and
  ANSI: 1/2" to 8" / # 150, 300 SORF)
- Gaskets are supplied by us with flanged unit.
- check flange connection for leak-tightness after flowmeter installation.

2.4 Temperature / Pressure measurement for External density compensation

To measure the temperature and pressure of the medium for either mass flow/normalized f1ow computation using external flow computer or measure operating density using external pressure and temperature measurement (e.g. to feed the density value in the VFM off-line mass or normalized flow computation) suitable measuring points should

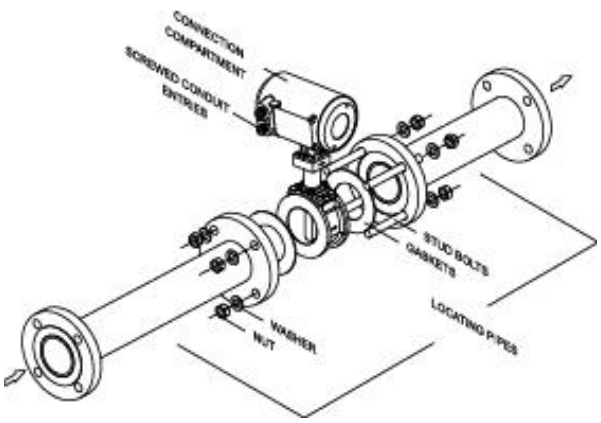
Installation upstream of f1owmeter

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

Assembly Diagram of Sandwich Units



3. Electrical Connection

3.1 Installation Location & 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 flowmeter.
- 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 PG16 and apply sealant to unused cable entries.
- Do not kink cables at conduit entries
- Provide water drip point (U bend in cable).

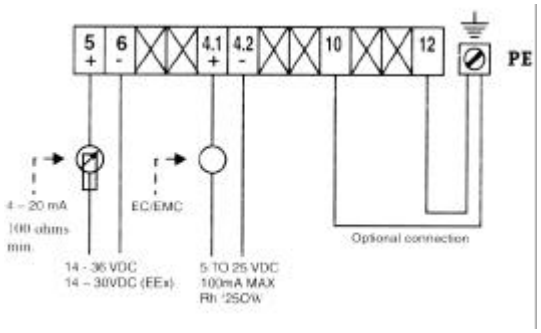
Conduit Installation, general wiring considerations

When electrical codes require conduit, it must be installed in such a manner that the meter connection compartment remains at all **dry** times.

3.2 Connection to loop power supply

- In case of functional extra low voltages (24VDC) protective separation in conformity with VDE 400 part 410, or equivalent national standard, must be ensured.
- Hazardous area application will require the connection of protective Earth.

- **Connection to power, VFM 1091 K**



- Current and frequency outputs are galvanically isolated when the optional ground above is not used and can therefore be simultaneously connected to a receiver instrument which is grounded or separately connected to two receiver instruments.
- Ensure that 24V, 4-20 mA loop is grounded at one point only (i.e. either at the input of the signal converter or at the input of the indicator, or at the output of the Power Supply). Do not ground the loop at more than one point.

3.3 Outputs

3.3.l Abbreviations

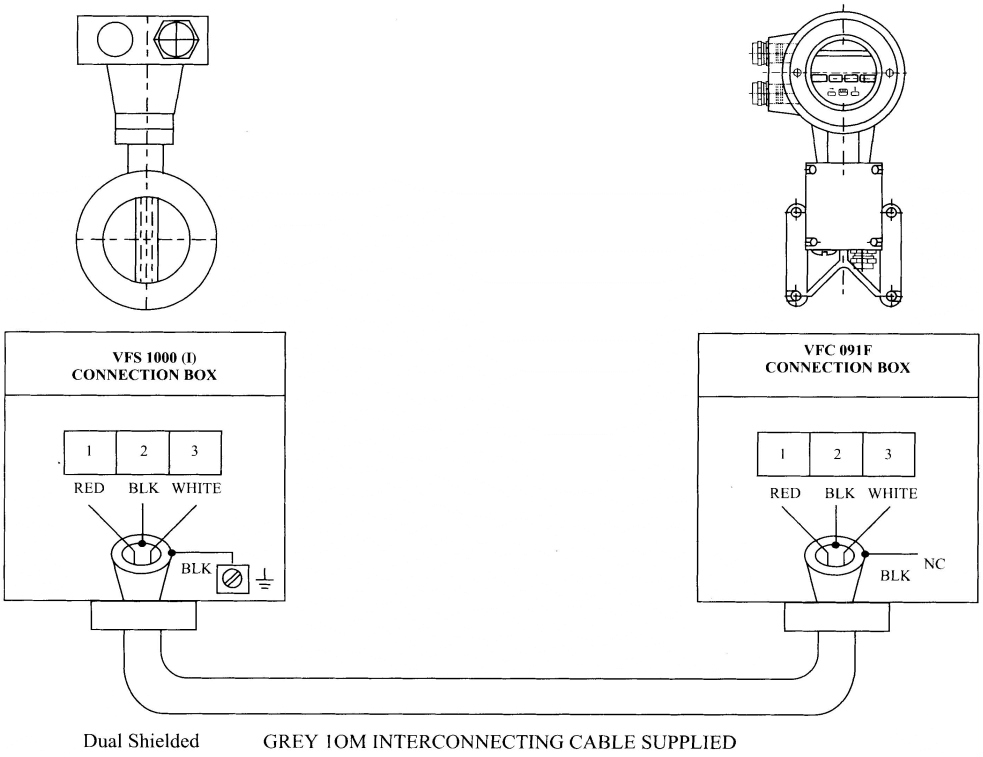
	Abbreviation Stands for	Programming via Fct. No....	Description see Sect....
EC	Electronic counter	-	3.2+3.3.4
EMC	Electro-mechanical counter	-	3.2
P	Pulse output	1.3.X	6.1+6.2.9
$P_{100\%}$	Pulses for Q =100% flow rate	1.3.2	6.2.9
$Q_{0\%}$	0% flow rate	1.1.2	6.1
$Q_{100\%}$	Full-scale range, 100%. flow rate.	1.1.2+1.3.2	6.1+6.2.9

3.3.2 Current (analog) output I

- **The current output is galvanically isolated from Pulse output P.**
- **Max. load at terminals 5/6**

max. load in Kohms $R_B = \frac{U_B - 12\ V}{20mA} \leq 1200$ ohms

3.3.3 Connection between VFS1091 & VFC 091F



3.3.4 Pulse out put

- **The pulse output is galvanically isolated** from the 4-20mA current output and may be optionally grounded.
- **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.
- **Passive frequency output,** open collector for connection of active electronic counters EC or switchgear, input voltage 5 to 25V, load current max. 100 mA, min load resistance RL 250, selectable pulse width duty cycle or 250 mSec

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 ***Fct3.1.1,*** 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 medium 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 1091 " 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 091

5. Opening of the signal converter

5.1 General

5.1.1 Starting up signal converter

When power is switched ON to signal converter it displays ***TEST, VFM, 1091 & Ver.x.x.x and*** then goes to measurement mode. In this initial sequence VFM 1091 (I) carries out self-diagnostics to check its own functiona1elements and loads the configuration data from non-volatile memory. If any error(s) are detected in power on diagnostics converter displays ***FATAL. ERROR*** since instrument has critical error(s) and is not able to carry normal measurements. 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 converter measures/computes are shown on 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 parameters one after another, wherein each parameter is displayed for about 6 seconds.

While in the measurement mode, the flow and the current values can be monitored using the HART® Communicator. Other than flow and current values, the communicator also displays the minimum and maximum values of flow values, which are programmed into the device.

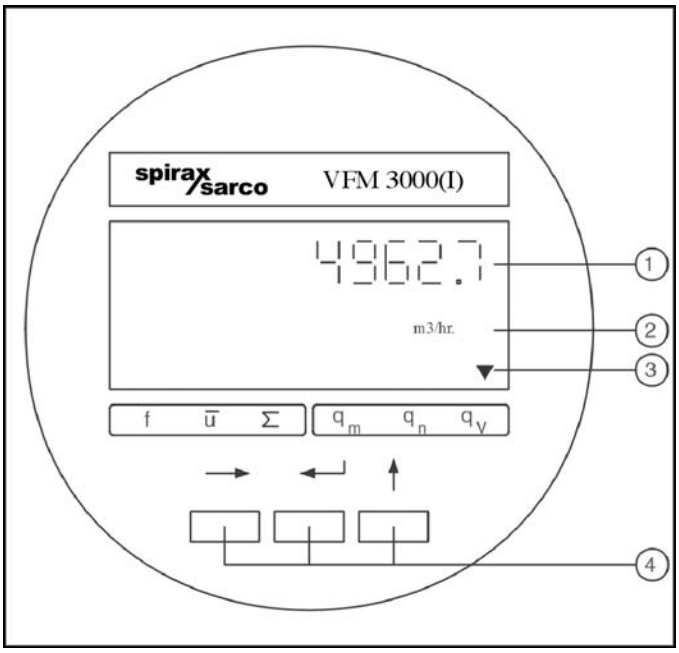
5.1.3 Programming or menu mode

All the configuration/settings/test functions are grouped in the form of menu having a tree structure (see Sect. 5.3.1 for details) and are accessible in the programming mode. Operator can view or alter the present settings, data values by the use of functions available in this mode. VFC091 implements all the universal commands and relevant common practice commands of HART® this enables you to program some of the main parameters using HART ® Communicator. These are mainly flow-related parameters.
All changes made in programming mode are stored in non-volatile memory and have appropriate effect on the operation of signal converter. While being programmed (i.e. while in the menu), the instrument will stop making further measurements and the current O/P will be frozen to the last value, pulse O/P will also stop. The changes made using the HART® communicator are stored in the communicator till you request to "Send" the data to the device. After data is received, VFC091 updates the configuration n with thenewly received data. During the updation period, the measurement is interrupted. (The updation time is less than half second).

5.1.4 Error handling

Converter can detect errors during power-on diagnostics as well as when in normal measurement mode. Errors are put 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 measurement mode) starts blinking. If programmed so, error information is shown on display interleaved between display of two parameters.

5.2 Operating & check elements



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

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

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

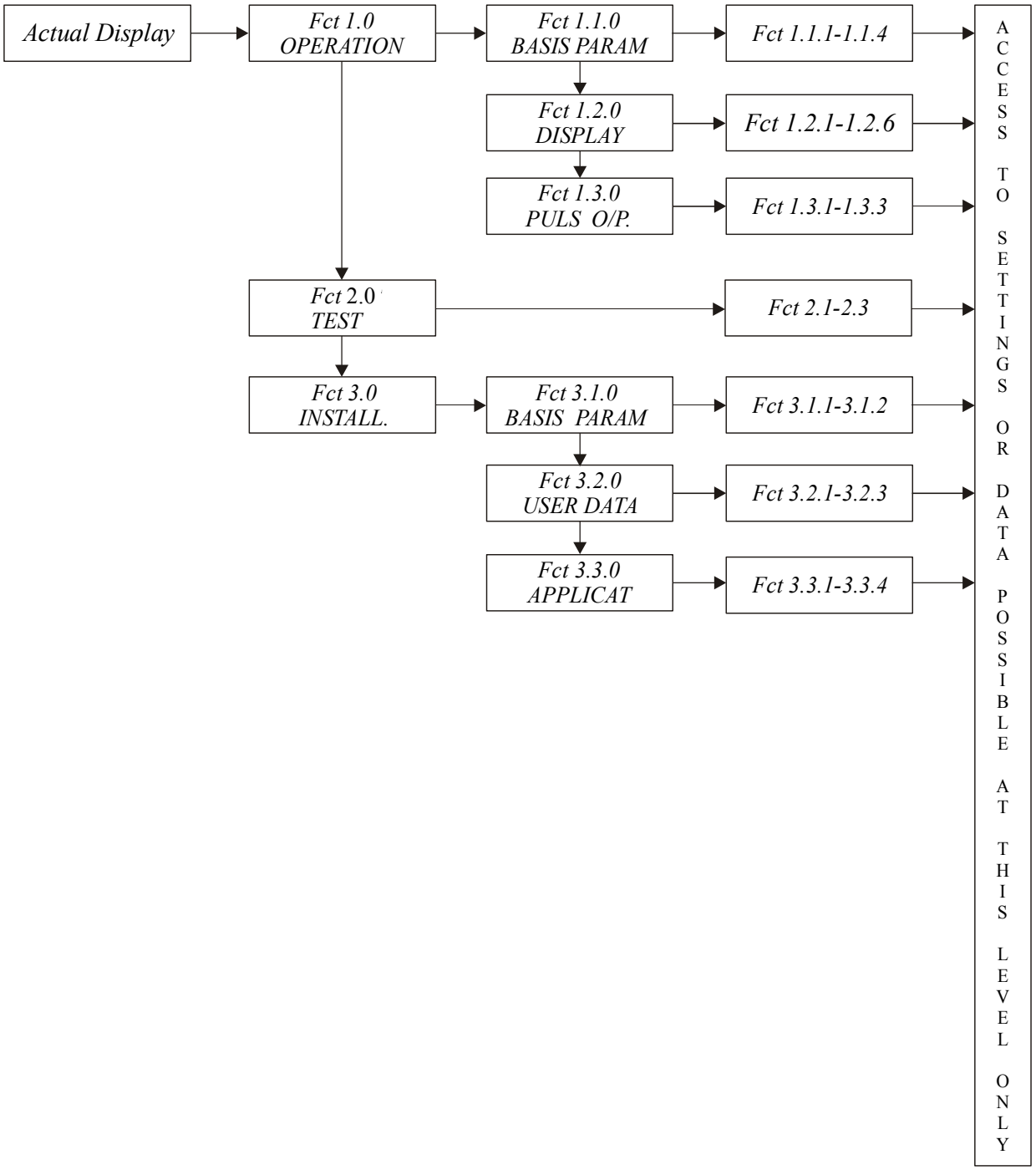
θ ϖ	Volumetric flow rate
θ ν	Normalised volumetric flow rate
θ μ	Massflow rate
Σ	Totalizer value
$\overline{\upsilon}$	Velocity of medium
Φ	Vortex frequency

④ Keys for Programming the Signal Converter, refer To Sect.5.4 for function of keys.

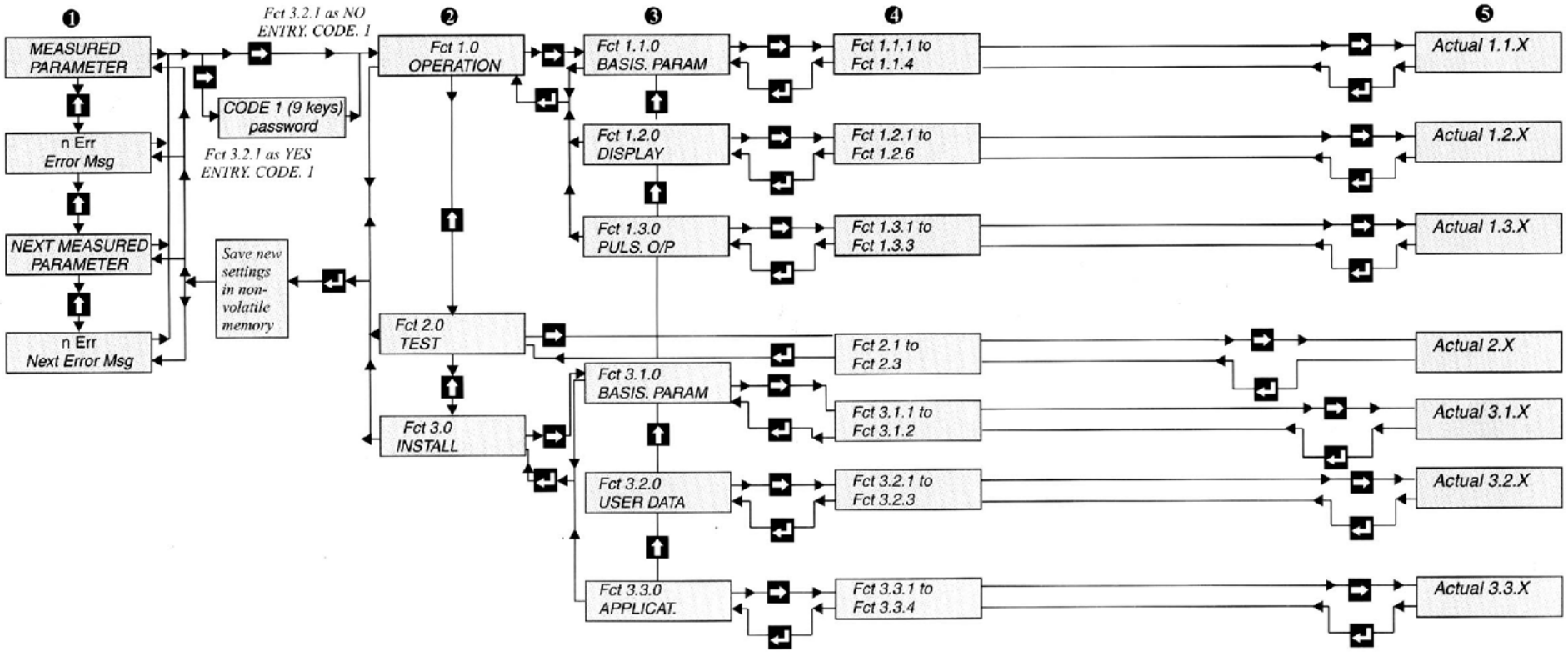
5.3 Program organization & programming chart

5.3.1 Menu levels

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



5.3.2 Programming chart



5.3.2 programming chart

❶ Measuring mode level

- displaying measured parameters/error messages
- Enter programming mode

❷ Main menu level

- Select main menu
- Enter main menu displayed
- Return to measuring mode level

❸ Submenu level

- Select submenu
- Enter submenu displayed
- Return to main menu level

❹ Functional Level

- Select function
- Enter/execute function displayed. Then continue as under ❺ data level
- Return to submenu level or main menu level

❺ Data level

	Units/Options	Numerical/ alphanumerical values
	Select next proposal	Change the flashing digit/character
		Change flashing (cursor) position
	Temporarily save selected proposal then continue with further data entry, if any, or return to function ❹ level.	Stores edited value /string temporarily. Continue with further data entry, if any,or return to ❹ function level.

Important

1. All changes made in programing mode are stored in non volatile memory
2. VFM 3000 (I) stops measurement when in programming mode.

5.4 Program organization & function 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 ↑ key to get the next parameter on display. If display is in cyclic mode ***(Fct 1.2.6 CYCLE DISP as YES)*** the next parameter is displayed after every 6 seconds and ↑ key has no function.

Use the → key to go to the programming mode If ***Fct.3.2.1 ENTRY. CODE.1 is YES*** then converter will ask for the Code 1 password. Password is the following sequence of 9 key operations → → → ↑ ↑ ↑ ↵ ↵ ↵ Press ↵ key to go back to normal display.

Use the ↵ key results in prompt for Code 2 password. Code 2 password is predefined and reserved for Khrone Marshall service person. Operator should not use ↵ 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	Without / With } Coding, dependent on programming Fct.3.2.1. Go to programming mode.
↑	Displaying next parameter measured or next error message (Fct.1.2.5 as ***YES*** for error message) if in non cyclic mode (Fct.1.2.6 as ***NO***) In cyclic mode the key has no function
↵	Reserved for use by Khrone Marshall

Functions of keys in programming mode:

Programming and other functions are grouped in a menu having 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 go were already at function level then that function will be executed.

↑ Selects other options/branches at the same level.

↵ 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 displayed and display blinks to indicate that there are other choices. Use the key to scroll through all options one by one. Using will cause that option to be selected and also completes selection process.

2. Entering a numeric value-You can enter +ve or –ve number in floating point with exponent notation.
   Rang : 0.0001×10^{-9} to 9.9999×10^{9}
   Format: d.dddd E-d
   e.g 1.2345 E-3, 1.2345E6

Method of entry: Initially present value is displayed in the first line display. A flashing digit will change by using ↑ key. → Select next digit position in sequence and ↵ terminates entry of the number.

Note:

a) Digits cycle through 0-9 values. A sign fields cycles as " " and " – " for exponent negative

b) When you enter a value beyond its limit then you get message d.ddddEd (***MIN. VALUE***) or d.ddddEd (***MAX VALUE***). Press ↵ after you have noted limit and then correct value to be in valid limits.

c) If you don't want to change value press ↵ at the beginning itself !

Using keys in programming mode				
Key	Main menu level	Submenu Function level	Data level	
			Option/Units	Numerical values / strings
↑	Select main menu	Select submenu or function	select next Proposal	Change flashing digit or Character Proposal
→	Enter displayed Main menu	Enter displayed submenu (execute) function		Shift flashing digit or character position
↵	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 return to function level if no further required by that function

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 ↵ key at main menu level quits the programming mode. Before exiting programming mode, device updates the configuration according to the changes done in the menu.

Programming using HART® based communicator

While in the measuring mode the communicator displays the measured values of flow, the computed current output value and Qmax, Qmin values programmed into the device. Using the communicator, you can see / modify many of the device parameters. For details of using HART® Communicator please refer the HART® Communicator manual. The Generic Online Menu of the communicator is given in 6.2.14 for your quick reference. Please refer 6.2.12 for details of HART® programmability.

5.5 Error messages

5.5.1 Error messages in Measurement mode

Error message	Type	Description	Corrective action required
INTL ERR. nn	*	Internal error in converter operation	Switch off the power and try again. If the problem persists contact KHRONE MARSHALL service.
NO SIGNAL	***N***	No signal from the vortex sensor	No flow through the primary or Vortex sensor problem. If sensor problem, contact KHRONE MARSHALL service.
LOW FREQ Service.	***N***	Vortex frequency too low	Check Flow rate>q min else call KHRONE MARSHALL
HIGH FREQ Service.	***N***	Vortex frequency too high	Check Flow rate<q max else call KHRONE MARSHALL
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.
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!
INV. CONFIG	***F***	Configuration date in non-volatile memory is not valid.	Check entire configuration again. If error persists-call KHRONE MARSHALL service.
UC FAIL	***F***	Micro-Controller failure	Contact KHRONE MARSHALL Service.
LCDC FAIL	***F***	LCD Controller IC (s) has failed (This error is applicable to users having display option)	Contact KHRONE MARSHALL Service.
KEY FAIL	***F***	Failure of Keys (applicable to instrument which have display option)	Contact KHRONE MARSHALL Service.
NOVRAM FAIL	***F***	Non Volatile Memory has failed	Contact KHRONE MARSHALL Service.
LINE INTER	***N***	Supply interrupted	Press ↵ ↑ → keys to reset this error.

- This text is displayed for Fatal Errors. The nature of error is beyond the scope of user (failure of IC or other hardware inside converter electronics etc.). All that can be done is to switch OFF power and then try again. If error message continues, call KHRONE MARSHALL service. internal error 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 that device makes flow rate equal to zero,
- Current output to minimum value 4m A & pulse output OFF.
- When errors are displayed during the measuring mode, 'n Err" (n = number) will appear in the 1st line. n gives the number of momentarily occurring 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 " n.nnn E n" in 1st line and ***MIN. VALUE*** or ***MAX VALVE*** or in the 2nd line ***("MIN VALUE"*** if entered value is less than lower limit and "***MAX VALVE*** " if higher limit is crossed*)*. Note the message indicating permissible limit then press the ↵ key to continue.

6. Description of program function

6.1. Numerical order description

This section describes all the functions which can be programmed locally. Some of the parameters of the device can be programmed using the HART® based communicator (For example HHC 275). These are given with their corresponding Generic Online Menu (GOM) steps for HHC275. For more details of GOM refer to 6.2.12 and 6.2.14. Program functions are given in numeric

order as follows:

- Function number & title
- Description of the function

  Limits – Applicable limits for numerical input

Fct. 1.0 OPERATION

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

- flow range to measure.
- display settings of measured values, units, errors etc.
- pulse output programming.

Fct. 1.1.0 BASIC.PARAM

This submenu groups functions that:

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

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 initially used only once. 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, RANGE P, TOTAL. VALUE***

HART: GOM 1,3,2

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.l.x functions) and application data (3.3.x functions).

After setting the Qmax value, set range P value Fct. 1.3.2 to ensure that the Pulse output function works normally. The current output range (4-20mA) corresponds to 0% flow ($Q_{0\%}$) and 100% flow ($Q_{100\%}$) respectively. The value of $Q_{100\%}$ is entered at the ***MAX. FLOW*** Function.

If the flowrate exceeds the ***MAX FLOW*** an error condition ***(HIGH FLOW)*** is generated

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*	• *UK Gal/Sec*
• *Litre/hr*	• *Litre/min*	• *Litre/Sec*
• *ft3/hr*	• *ft^3/min*	• *ft^3/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 1 x 10

HART : GOM 1,3,3

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 (3.3.X functions). If flow is below min.flow then an error condition (LOW FLOW) will be generated. Note that this value should not be zero for vortex flowmeters. This value is normally set to the minimum flowrate (determined from sizing) for the size of primary used.

LIMITS –Greater than zero to (0.5*max flow.) Higher limit is 50% of the value entered ***Fct. 2.1.2 MAX FLOW,***

HART: GOM 1,3,3

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 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

HART : GOM 1,3,6

Fct. 1.2.0 DISPLAY

This submenu group the display function 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/not to appear in display cycle

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.1.1.1 MEAS. INST.***

For volumetric flow -

- *m3/hr* • *m3/min* • *m3/Sec*
- *Litre/hr* • *Litre/min* • *Litre/Sec*
- *ft^3/hr* • *ft^3/min* • *ft^3/Sec*
- *cft/hr* • *cft/min* • *cft/Sec*
- *cuft/hr* • *cuft/min* • *cuftSec*
- *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*

or 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).

HART: GOM 1,3,2

Fct.1.2.2 ***TOTAL UNITS*** totalizes 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 from display cycle.

Fct.. 1.2.3 ***VELO.UNITS*** velocity unit for display
You can choose from

- *m/Sec* • *ft/Sec* • *NO DISPLAY*

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

Fct. 1.2.4 FREQ UNITS frequency unit for displays
You can choose from

- *Hz* • *kHz* • *NO DISPLAY*

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

Fct. 1.2.5 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.***

Fct. 1.2.6 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. 1.2.5 ERROR MSG.*** is ***YES***

Fct. 1.3.0 PULSE O/P

This submenu groups Pulse output related functions.

Fct. 1.3.1 FUNCTION P Pulse output

Choose ***YES*** to make Pulse output active as per

functions ***Fct. 1.3.2*** to ***Fct. 1.3.3.NO*** makes Pulse

output inactive (0 Hz).

Fct. 1.3.2 RANGE P Pulse output range value

Enter a value here for the number of pulses required per unit volume/mass. This must always be set after max flow value Fct. 1.1.2. is set.

Example –

For a value of 0.1 Kg, 10 pulses per Kg = 1 pulse per 0.1 Kg. Pulse output programming is independent of max. flow. The various options of units for are given below. ***RANGE P*** are given below.

for volumetric flow –

- ***PULSE/m3*** • ***PULS/litre*** • ***PULS/ft3***
- ***PULS/cft*** • ***PULS/cuft*** • ***PULS/US.Gal***
- ***PULS/UK.Gal***

for normalized volumetric flow –

- ***PUL./Norm.m3*** • ***PULS/Norm.L*** • ***PULS/Sft3***
- ***PULS/Scft***

for mass flow –

- *PULS/kg* • *PULS/t* • *PULS/Lb*

LIMITS - (0 TO 0.5 Hz) / $Q_{100\%}$ pulse/unit volume or mass, where $Q_{100\%}$ is flowrate in Volume or Mass units per second

Fct 1.3.3 P. WIDTH.LIM pulse width

You can limit the duration of active pulse width of the Pulse output. You can choose -

• YES ***• NO***

YES limits the pulse width to 250 mSec

NO keeps the Pulse output at 50% duty cycle.

This function helps to minimize the overheating of

totalizer coils.

Fct. 2.0 TEST

This second main menu level groups test functions for display, current output and Pulse 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.

Fct. 2.1 TESTDISP. display test

All segments of the display are flashed together. You can press ↵ key at any time to terminate display test.

Fct. 2.2 TEST I current ouput test

Caution: during this test current output will change to set test values so you should take appropriate action depending on your current output application

Place current meter in series with current loop. Then enter integer value of current output desired.

Entering a value will cause that current to flow so that you can check it with a meter. Select ***CONT YES*** to test other current value or ***CONT NO*** to end. When you exit the menu, normal current value depending on flow rate and programming of current output functions will be restored.

LIMITS - 4 to 20 mA.

HART: GOM 1,2,2

Fac. 2.3 TEST P Pulse output test

Caution: during this test frequency output will change to set test values so you should take appropriate action depending on your pulse output application

Connect voltmeter to pulse output. With supply & load connected select –

• Pulse OFF ***• Pulse ON***

Selecting Pulse ON/OFF will cause the output to change accordingly so that you can check it on the meter. Select ***CONT. YES*** to test further or ***CONT. NO*** to end. When you exit the menu normal pulse output depending on flow rate and programming of pulse output functions will be restored.

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 (password, totaliser setting etc.)
- Application data (medium, density operating and normal and amplifier gain)

Fct. 3.1.0 BASIS. PARAM

This submenu functions allow user to enter the vortex

primary sensor data viz. nominal diameter and k- factor

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 10s	***• DN 10***	***• DN 15***	***• DN 20***
• DN 25	***• DN 40***	***• DN 50***	***• DN 80***
• DN 100	***• DN 150***	***• DN 200***	***• ANSI 3/8"s***
•ANSI 3/8"	***• ANSI 1/2"***	***• ANSI 3/4"***	***• ANSI 1"***
• ANSI 1.5"	***• ANSI 2"***	***• ANSI 3"***	***• ANSI 4"***
• ANSI 6"	***• ANSI 8"***		

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 and 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 1/2"	290000	330000
DN 20/ANSI 3/4"	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

Fct. 3.2.0 USER DATA
This is submenu level. 3.2.x functions allow enabling of password code 1, enabling and resetting of built-in electronic totalizer.

Fct. 3.2.1 ENTRY.CODE.1 **enable 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.

Fct. 3.2.2 TOT. RESET **totalizer reset**
This function on can be used to reset the totalizer (to zero) Two options are presented

• YES ***• NO***

To reset totalizer - Select ***YES***
To keep totalizer value unchanged – Select ***NO.***

Fct. 3.2.3 TOT ON/OFF *TOT. 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.

Fct. 3.3.0 APPLICAT.
This submenu groups functions which allow you to view/enter the application data. These functions give the following information to the instrument.
– process medium
– operating and normalised density values
– amplifier gain

Fct.3.3.1 FLUID fluid type
Select whether process medium is steam or gas or liquid.
- ***GAS/ STEAM*** - ***LIQUID***

Fct. 3.3.2 DENS. OPR. density at operating P&T Enter the density of medium at operating pressure and temperature conditions. The value can be entered in one of the following units –

- ***Kg/m3*** - ***Kg /Litre*** - ***Lb/F***
- ***Lb/cft3***

LIMITS - 0.05 TO 2000Kg/m

Fct. 3.3.3 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/ft***
- ***Lb/cft3***

LIMITS – 0.05 to 2000Kg/m 3

Fct. 3.3.4 GAIN Gain Setting
The gain of the preamplifier can be changed to change the sensitivity of the meter. The values that can be selected are

- ***1*** - ***5*** - ***11*** - ***23***

The factory set value is 5 for ***LIQUID*** and 11 for ***GAS*** / ***STEAM***

6.2. Functional order description.21

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

Units for flow rate-
for volumetric flow-

- ***m3/hr*** - ***m3/min*** - ***m3/Sec***
- ***Litre/hr*** - ***Litre/min*** - ***Litre/Sec***
- ***ft^3/hr*** - ***ft^3/min*** - ***ft^3/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 FLOWUNITS***)

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*** (only for ***Fct 1.2.1 FLOWUNITS***)

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 FLOWUNITS***)

TOTALIZER UNITS
Refer to functions-
Fct. 1.2.2 TOTAL.UNITS totalizer unit for display

units for totalizer-

- ***M3*** - ***Litre*** - ***ft3***
- ***cft*** - ***cuft*** - ***US Gal***
- ***UK Gal***

VELOCITY UNITS
Refer to functions-
Fct. 1.2.3 VELO.UNITS velocity unit for display

Units for velocity-

- ***m.sec*** - ***ft/Sec***

PULSE OUTPUT UNITS
Refer to functions-
Fct. 1.2.3 RANGE P Pulse output range value

Units for ***RANGE P-***
For volumetric flow -

- ***PULSE/m3*** - ***PULS/Litre*** - ***PULS/Ft3***
- ***PULS/cFt*** - ***PULS/cuFt*** - ***PULS/US Gal***
- ***PULS/UK.Gal***

for normalized volumetric flow -

- ***PULS/Norm.m3*** - ***PULS/Norm.L*** - ***PULS/Sft3***
- ***PULS/Scft***

for mass flow-

- ***PULS/KG*** - ***PULS/T*** - ***PULS/Lb***

DENSITY UNITS
Refer to functions-
Fct. 3.3.2 DENS.OPR. Density at operating **P&T**
Fct. 3.3.3 DENS.NORM. density at normal **P&T**
Units for density-

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

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. 56.

Exponent format: 1.234E-10

In most practical applications, it is very rare that parameters need be displayed in exponent format.

The number of significant figures displayed is 6.

• Input of numerical values

Entry of numerical values is in the following format n.nnnnEn

Examp les: 1.2345 E + 3

Programming: refer to section 5.4

6.2.3 Display

Organization - 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 and [b] key-field at the top left of the display which is used to acknowledge the keys.

Programming – Measurement mode setting are as follows.

- To allow selection of units for all measured parameters.
  Refer to Sect. 6.1 ***Fct. 1.2.1 to 1.2.4***
- Select what parameters to include in display cycle.
  Refer to Sect. 6.1 ***Fct. 1.2.2 to 1.2.5***
- Select display mode (cyclic / non-cyclic) and error messages to / not to appear in display cycle.
  Refer to Sect. 6.1 ***Fct. 1.2.5 to1.2.6***

Measurement mode - Display shows measured parameter(s) in its selected unit. The ▼ marker identifies the parameter being displayed. Parameter is displayed continuously in non-cyclic mode. [refer sect. 6.1 ***Fct. 1.2.6***]. To select other parameter(s) of the display cycle, if any, use ↑ 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/function 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 measurement mode indicates that error(s) are present. Error messages are displayed interleaved between changing from one display parameter to other, if ***Fct. 1.2.5 ERROR.MSG*** is ***YES.*** For description of error message refer Sect. 5.5.

Testing of display – Use ***Fct. 2.1 TEST DISP*** for display test. All segments of the display are flashed. You can press ↵ key at any time to terminate display test.

6.2.4 Flow range and meter

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 (3.3.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 the meter for that application. If flow rate exceeds max. flow an error condition ***(HIGH FLOW)*** is generated. When the flow rate falls below the min. flow an error condition is generated. Vortex sensor signal l is weak at this condition ***LOW FLOW*** and if flow rate reduces further, vortex signal related errors such as ***NO SIGNAL, LOW FREQ.*** will occur.

6.2.5 Primary information

Primary data gives VFC 091 the basic information about the vortex primary sensor. Use ***Fct. 3.1.1 NOMINAL.DIA*** for specification of the nominal DIN/ANSI size and ***Fct. 3.1.2 K-FACTOR*** for the calibration factor of the primary.

6.2.6 Application information

This is the data of process medium, it's operating conditions and physical properties. It consists of

- process medium ***Fct.*** 3.3.1 ***FLUID***

- operating and normal density conditions. Refer ***Fct. 3.3.2DENS. OPR*** and ***Fct. 3.3.3DENS NORM This*** is required only if ***Fct. 1.1.1. MEAS INST.*** Is ***NORM. VOLUME*** or ***MASS.***

6.2.7 Internal Electronic Totalizer

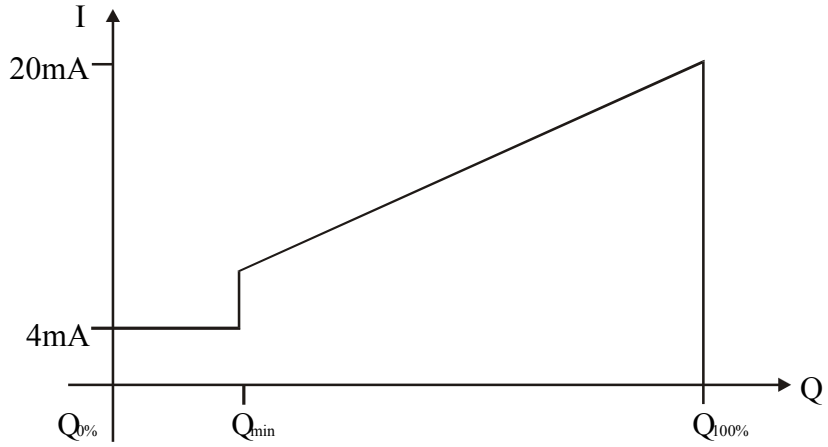
- The internal electronic totalizer counts volume, normalized- volume or mass. Totalizer value is saved in the non-volatile memory upon power failure. Totalizer can be displayed in the units desired as per the programming of ***Fct. 1.2.2 TOTAL. UNITS.*** Totalizer counting is interrupted for the duration of power failure. Counting may optionally be stopped and thereafter restarted by the use of ***Fct. 3.2.3 TOT. ON/OFF.*** Totaliser counting is also interrupted when in programming mode (in Menu)

- Resetting [to 0] of the totalizer is possible by using ***Fct. 3.2.2 TOT. RESET.***

6.2.8 Current (analog) output I

Current (Analog) Output I – The current output gives an analog representation of the flow-rate. An output of 20mA always corresponds to $Q_{100\,\%}$ & 4mA to Q 0 %The current output between $Q_{0\,\%}$ and Qmin is 4mA.

CHARACTERISTICS OF CURRENT OUTPUT I



TESTING OF CURRENT OUTPUT I

Fct. 2.2 TEST I can be used to check current output. Integer values between 4 and 20mA are possible to be monitored on a current meter. During the test, current output changes to the test values(s). The normal current value is restored automatically [as per programming of current output] when the measurement mode is resumed.

6.2.9 Pulse output P

Programming of Pulse output value is provided by 1.3.x functions.

Fct. 1.3.1 FUNCTION P **Pulse output**

Choose ***YES*** -to make Pulse output active as per functions ***Fct. 1.3.1*** **to** ***Fct.1.3.3 NO*** makes Pulse output inactive (0 Hz). When Pulse output function is not required choose the option ***NO.***

Fct. 1.3.2 RANGE P Pulse output range value
Pulse output is 0 Hz for 0 flow rate and a value ($P_{100\%}$) equal to $Q_{100\%}$ * RANGE P value.
Example of pulses/unit volume or mass
Full scale setting, $Q_{100\%}$: 1000 Litre/hr (set via ***Fct. 1.1.2***)
RANGE P : 1PULS/Litre (set via ***Fct. 1.3.2***)
at 1000 litres per hour : 1000 pulses per hour would be the pulse output.
For limits on programming of ***RANGE P*** refer to Sect. 6.

Fct.1.3.3 PULS. WIDTH pulse width
This is used to limit the active duration of the Pulse output, to 250mSec and thereforc
reduce the overheating of external electromechanical totalizers coil.
For details refer to Sect. 6.

TESTING OF PULSE OUTPUT P

Fct.2.3 TEST P can be used to check Pulse output. The Pulse output may be set to **ON** or **OFF** state. This may be monitored with the help of a voltmeter connected across the pulse output which is wired to a power supply & load in series. The normal pulse output function is restored automatically [as per programming of Pulse output] when the measurement mode is resumed.

6.2.10 Coding desired for entry into programming mode

Fct. 3.2.1 ENTRY. CODE.1 set to ***YES*** for enabling Code l.

The entry code consists of 9 keystrokes of the 3 keys as follows

6.2.11 Behavior of outputs during programming

Programming of the VFM 1091(I) is "off-line" meaning that the instrument stops making measurements when it is in the programming mode. This means VFM 1091(I) will keep totaliser value and Current/Pulse output as per the last value output before entering the programming mode.

6.2.12 Hart programmability

VFM 1091(I) supports all the Universal commands and the Common practice commands which are applicable to the meter.
The HART® compatibility of VFM 1091(I) program functions is tabulated below. For functions which are HART® programmable, corresponding Generic On-line Menu (GOM) step of HART® Communicator is also given. Details of Generic On- line menu is given in 6.2.14.

PROGRAMMING FUNCTION	HART PROGRAMMABILITY	HHC MENU
FST 1.0 OPERATION		
FCT. 1.1.0 BASIS.PARAM		
FCT. 1.1.1 MEAS.INST	YES	GOM 1,2,3
FCT.1.1.2 MAX. FLOW	YES	GOM 1,3,2
FCT 1.1.3 MIN. FLOW	YES	GOM 1,3,3
FCT. 1.1.4 TIME CONST	YES	GOM 1,3,6
FCT. 1.2.0 DISPLAY		
FCT 1.2.1 FLOW UNITS	YES	GOM 1,3,2
FCT 1.2.2 TOTAL UNITS		
TO		
FCT. 1.2.6 CYCLE DISP	NO	
FCT 1.3.1.0 PULS.OUTP	NO	
FCT. 1.3.1 FUNCTION P		
TO		
FCT. 1.3.3 PULS. WIDTH	NO	
FCT 2.0 TEST		
FCT. 2.1 TEST DISP	NO	
FCT 2.2 TEST 1	YES	GOM 1,2,2
FCT 2.3 TEST P	NO	
FCT 1.1. MEAS.INST	YES	
FCT 3.0 INSTALL	**NO**	**

Notes:
* GOM 1,3,2 is used to set the primary sensor unit. When primary sensor unit is changed, device automatically updates the MEAS.INST. As an example, if the unit is changed to Kg/hr, then MEAS.INST will be set to MASS.
** **Fct 3.0** install menu contains the device specific set up.

6.2.13 Functions through HHC

The special functions which are accessible only through HART® communicator include Device Information and Multidrop Operation

DEVICE INFORMATION

This is used to identify the devices in the field. This is stored in the device and shown to you on request but has no effect on the functionality of the flowmeter. None of these parameters are used for computational purpose during the measurement.

Manufacturer : This is a factory-programmed name. For VFM1091 (I) the manufacturer is KHRONE MARSHALL.

Tag : The maximum number of characters allowed for tag is eight. Tag can be effectively used to distinguish between different flowmeters in the field.

Descriptor : This parameter provides 16 characters which can be used to store more descriptive data of a flowmeter.

Message : This provides 32 characters. This may be used for identification or display of other important information regarding the flowmeter.

Revision Numbers: These are factory programmed and cannot be changed by the user.

Universal Rev - Gives the HART® Universal command revision which the flow meter should conform to.

Transmitter Rev - Gives the revision for the device specific VFC091 model.

Software Rev - Gives the internal software revision.

Hardware Rev - Gives the revision number for the hardware.

Final Assembly - Refers to the factory set value of the electronic assembly.

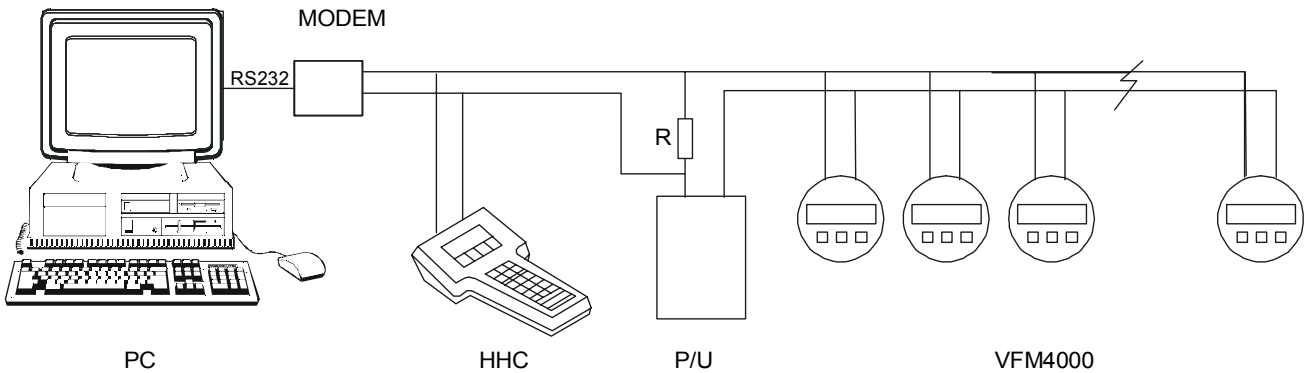
Device ID - Gives unique identifier for transmitter.

MULTIDROP CONFIGURATION

In multidrop configuration, upto 15 flow meters can be connected to a single communications transmission line. If the device is configured for multidrop operation, the current output is parked to the minimum value (4mA) and the communication occurs digitally between the flowmeters and the control system. Since the speed of communication for HART® is not fast enough for control applications, update rate should be considered before multidroping the flowmeters. The other factors like the number of different models used the transmission line specifications, safety considerations etc. should also be taken into account. In multidrop mode, the control system/communicator identifies each of the devices by means of the polling address which can be programmed into the device.

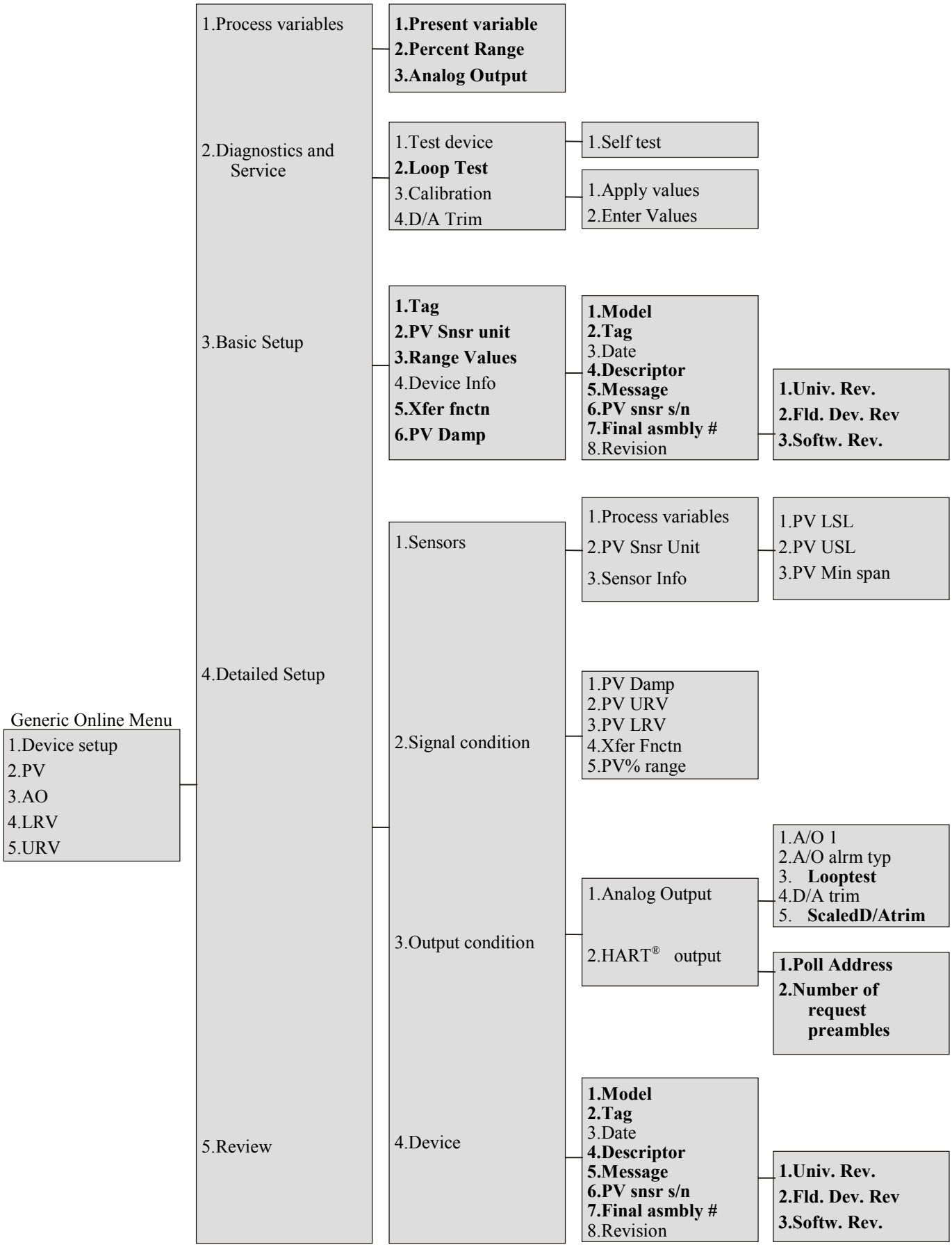
POLL ADDRESS

This gives the identification number for the flowmeter in multidrop mode. The value of the number should be between 1 and 15. Please note that the flowmeter should be in loop mode while entering the poll address. Use Generic Online Menu 1,4, 3, 4, 1 to change the polling address of the meter.



MULTI-DROP CONFIGURATION

6.2.14 Generic On-line Menu Tree



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 all the functions of the primary head or the signal converter.

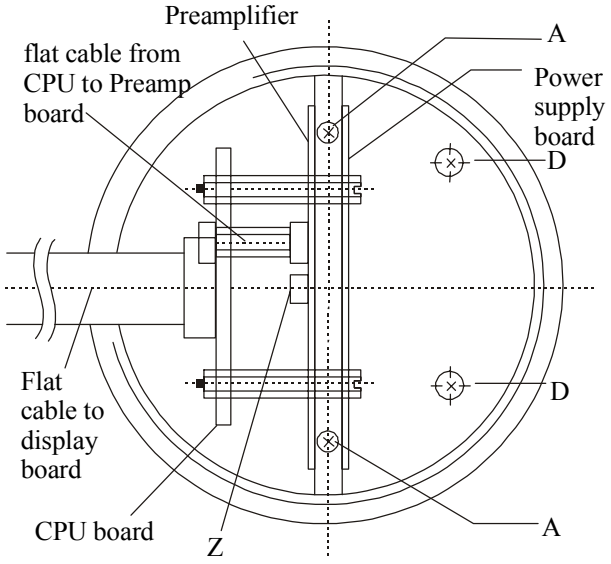
7. 1 Primary head functional checks

7.2 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.

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



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

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 center pin and each outer pin >200M ohm. Also resistance between each sensor wire pin and earth should be >200 M ohm. Also short out all three pins & measure resistance between these pins & Earth. This should be > 200 M W

5. Reassemble converter.

7. 2 Signal converter functional checks

7. 2 .1 Self diagnostics

On power-on VFC 091 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.

7. 2 .2 Display check

Display functionality can be checked by the use of ***Fct 2.1 TESTDISP.***
This function flashes all the segments of the display.

7. 2 .3 Current output check

Fct.2.2 TEST I can be used to test current output function of VFC 091. With this function it is possible to generate following test values- between 4 and 20mA (integer values only)
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 Pulse output check

Fct. 2.2 TEST P is meant for checking the pulse output function with a power supply (24VDC) connected through a load of lk/1W to pulse output terminals 4.1 & 4.2, and the output level (high or low) monitored with a voltmeter.

7. 2 .5 Frequency measurement check

Disconnect the sensor cable from the electronics as indicated in section 7.1.1 and feed a signal (sine or square wave) to the sensor connector Z on the preamplifier board. The signal should be fed between the center pin and one of the outer pins of the connector Z. The value of frequency fed should be indicated on the display when frequency measurement is enabled. This can also be checked with the help of the VS1 or VS2 Vortex Simulator in place of the signal source. The amplitude of the signal l should be 50mVp-p and the frequency between 2Hz and a value

equal to $\frac{\text{Qmax (m/hr) x K-factor (Pulses/m) max}}{3600}$

8. Trouble shooting hints

It is assumed in this section that flowmeter has already been installed. (for installation details refer Sect. 2+3)
Following are some trouble shooting hints.

SYMPTOMS: **Display is blank.**

- DC Supply voltage (between term. 5/6) is not available (voltage range 12-36 Vd.c).
- Supply connected with reverse polarity

Important: Ensure that the screw threads of the covers on the electronics and connection compartments are well greased at all times

- Electronics faulty

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

- Check current output electronics (refer Sect.7.2.3)
- Check that current output loop resistance is less than Rmax specified by Section 3.3.2

SYMPTOM: **Pulse output is incorrect**

- Check the Pulse output electronics (refer Sect.7.2.4)
- Check programming of pulse output. (Functions **Fct1.3.x**)
- Check that pulse output is not overloaded. For load ratings of pulse 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 pipe and the axis of bluff body.

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
- Electronics faulty (preamplifier)
- **Fct. 3.3.4** Gain too low: Set gain to value of 5 or greater & check.

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 Forbes 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.**

- Check programming of ***Fct.3.1.2 K-Factor*** which should be same as on the nameplate.
- Meter not properly centered on the pipeline. The axis of meter bore should be aligned with that of pipe.
- Gaskets 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 (1) 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 & direction of arrow on the primary!

Part D VFM 1091 (I) Ex

9. Description of the system

VFM 1091 (I) Ex is a two wire loop powered flow transmitter designed with electronic circuits incorporating Intrinsic safety features.

EEx [ib] IIC T2.... T6

Applicable standards: EN 50014 & EN 50020

9.1 Temperature class

The temperature class of the equipment operated in hazardous area is determined by the process or medium temperature. The relationship between the maximum process temperature and the temperature class is approved by PTB and stated as shown the following table.

Max. Process temperature	Temperature class
85 °C	T6
100 °C	T5
135 °C	T4
200 °C	T3
220 °C	T2

9.2 Electrical connection

VFM 1091 (I) Ex has two isolated Intrinsically safe circuits
1. Loop power / Current output circuit
2. Pulse output circuit

The entity parameters for both these circuits are approved by PTB and stated as: -

Ui= 30 V
Ii = 100 mA
Pi = 0.8 W
Li $\leq$mH
Ci $\leq$20 nF

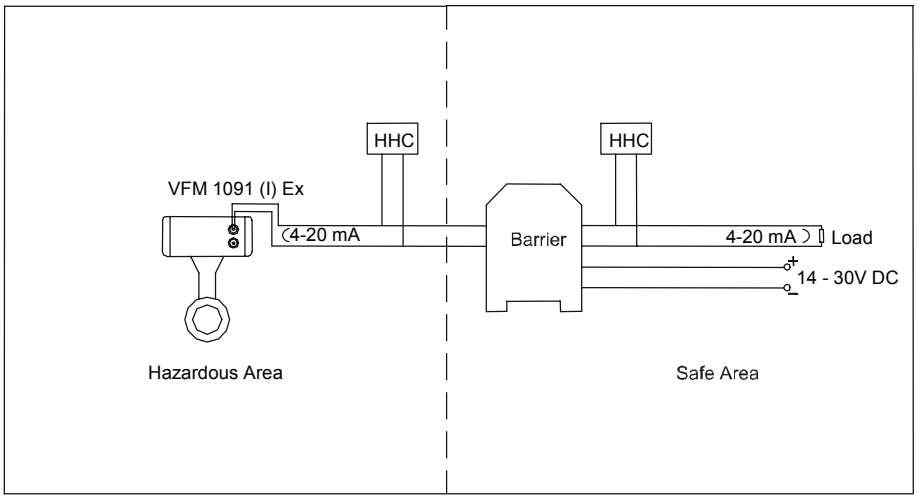
The loop power supply connections from safe area to the flow meter in hazardous area must be routed through a suitable Zener Barrier placed in safe area or the instrument should be powered through an Intrinsically safe power supply.

Note: On the current output lines, HART® signal is superimposed as an option. In such case compatible Barrier needs to be chosen which will pass the HART® signal for detection and processing in safe area.

The Hazardous and safe area connections are illustrated in diagram

The meter is provided with two cable entries in the terminal compartment of enclosure. Each cable entry must be used to insert cable to route loop power and pulse output circuit. Refer the schematic where the positions of the cable entries and cable routing is indicated.

10. Field connections diagram



11. Name plate & certificates VFM 1091 (I) Ex.

Certificate number of VFM 1091 (I) Ex.

FM, CSA, PTB approvals are pending

The purchaser is soley responsible for the suitability in accordance with the technical regulation and applicbility 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° C (68° F)

Meter size		Inside diameter f (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_ g		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

$$\rho x = \rho\, n \times \frac{Px}{Pn} \times \frac{Tn}{Tx}$$

ρ *x* , ρ n = density of the gas at normal & operating conditions respectively.
Pn, P*x* = pressure of the gas in absolute units at normal operating conditions respectively.
Tn, T *x* = temperature of the gas in Kelvin at normal & operating conditions respectively.

To obtain operating volumetric flow from normalized volumetric flow and vice-versa the following equation is used:

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

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

- Density ρ x of product at flowing conditions, in kg/m3
- Dynamic (absolute) viscosity of medium at flowing conditions, in mPA *s (or in centipoise)
- Maximum volumetric flowrate Q_{max} in m3/hr.
- Minimum volumetric flowrate Q_{min} in m3/hr.
- Refer to page 4 for dimension of meter inside diameter.

The following limits apply to operation

- Reynolds number at min flow, Re > 20000 for linear measurements.
- Minimum detectable flow velocity Vmin (See Page 36 Diagram IV)
- 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 75m/s. For densities,at and above 50kg/m3, Vmin is fixed to 0.94192 m/s for all sizes

- Calculating Reynolds number

$$Re = \frac{353.67\ Q\ min * (m^3/h) * (kg/m^3)}{Ø(mm) * h(mPa *s)}$$

- Calculating maximum flow

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

- Calculating maximum flow

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

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.

Primary head VFS 1000 (I)

Versions and meter sizes

Pressure ratings see "Dimensions" Table
(Note operating limits given in DIN 2501 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...	DIN 2515	DN 25 TO 150
	(Optional) ANSI	1" to 6"

Process and ambient temperature see Diagram III

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 240deg 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 = 1.5kg - 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

Max. allowable operating pressure (primary head) 40 bar (580 psig), optionally upto 100 bar (1450 psig)

Hazardous Duty Versions: FM, CSA, PTB approvals pending.

Error limits

Measuring error (in linear range)	± 1 % of measured value for DN 25 (1") & above ± 2 % of measured value for DN 10S (3/8"S) to DN 20 (3/4")
Repeatability (in measuring range)	± 0.5 % of measured value
Temperature Error	- 0.025 % of measured value per 10Kelvin (50^oF) variation

Pressure loss Δ p

at normal conditions		
for air[1.013 bar (14.7psig)/0^oc(32^oF) / ρ_n= 1.29 kg/m(0.081 lbs/ft)]	see Diagram I	
for water [20^o C (68^o F) / ρ_n = 998.2 kg/m (63.32 lbs/ft)]	see Diagram II	
at operating conditions		
for gases and liquid	$DP = C * Q_{v2} * \rho_{op}$	DP = Pressure loss in Pa C = A constant (values: see Table) Qv = Flow rate in m/hr Qm = Flow rate in kg/hr ρ_{op} =operating density in kg/m
for saturated steam	$DP = \frac{C * Qm2}{\rho op}$	

Diagram I

Pressure loss □p for air 1.013 bar / 0°C (32°F) / n = 1.29 kg/m3 (14.69 psig/0°C/ρn = 0.081 lbs/ft)

□p (psig) p(mbr)

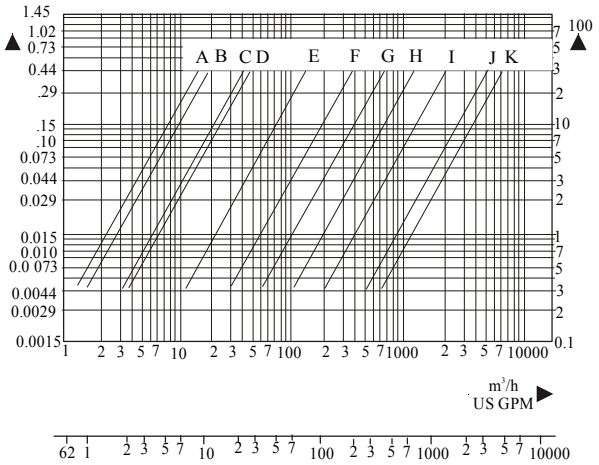


Diagram II

Pressure loss p for water 20°C / ρn = 998.2 kg/m3 (680°F/n = 62317 lbs/ft)

p (psig) p(mbr)

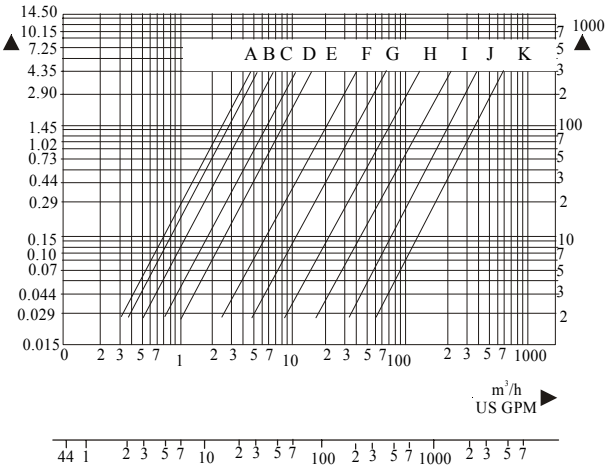


Table for diagrams I + II and constantC

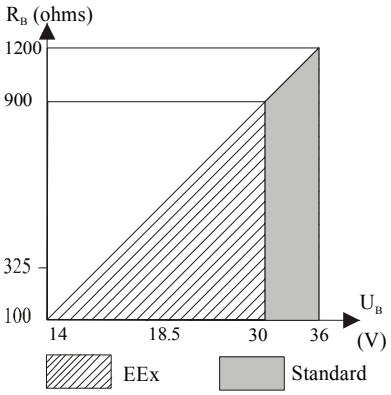
Curve	Meter size	Constant C
A	DN 10 S / 3/8"S	13.7
B	DN 10 / 3/8"	3.42
C	DN 15 / 1/2"	1.75
D	DN 20 / 3/4"	0.45
E	DN 25 / 1"	1.50×10^{-1}
F	DN 40 / 1-1/2"	3.30×10^{-2}

Table for Diagrams I+II and constant C

Curve	Meter size	Constant C
G	DN50 / 2"	7.80×10^{-3}
H	DN80 / 3"	1.90×10^{-3}
I	DN100 / 4"	5.30×10^{-4}
J	DN150 / 6"	1.60×10^{-4}
K	DN200 / 8"	5.90×10^{-5}

Signal converter VFC 091

Full-scale	**rangeprogrammable in litres, m3, US gallons, kgs, tonnes, lbs or standard flow rate per second minute or hour**
Power supply U_B	14-36 V Dc with 100 ohms min in series EEx (ib) 14 - 30 V DC
Current output (term, 5/6)	4 - 20 mA, DC, 2-wire
Load	RB = U_B - 12 V 20 mA



Ambient temperature T_B	see Diagram III
Local display	3-field 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	Engineering units or % of full scale
Actual flowrate	liters, m^3, US gallons, kgs, tonnes, lbs or standard flow rate per second, minute or hour
Totalizer	liters, m^3, US gallons, kgs, tonnes, lbs, ft^3
Display :	
1st field (top)	8-digit, 7- segment display and sign, symbols for key acknowledgement
2nd field (middle)	10 character, 14 segment text display
3rd field (bottom)	6 markers ▼ to identify current display

Mass flow measurement (off-line) operating and standard density programmable

Housing

Material	Die-cast aluminium
Protection Category (EN 60529 / IEC 529)	IP 65 & 67 (better than NEMA 4 and 4X)
Frequency output (passive)	scalable pulse output, max, load current 100 mA DC Max. pulse rate : 0.5 Hz
Accuracy	
Linearity	+/- 0.1 % of full scale range
Power influence	+/-0.005 % of full-scale range per 1% variation in voltage supply
Temperature coefficient	100ppm of full-scale range per 1^0 C
Field mount converter	Signal cable length up to 10 m (30 ft) maximum

Diagram III

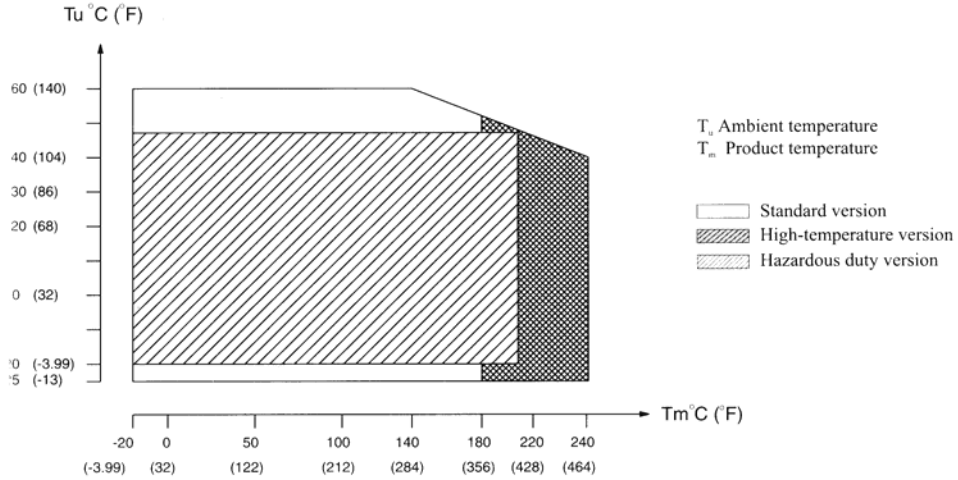
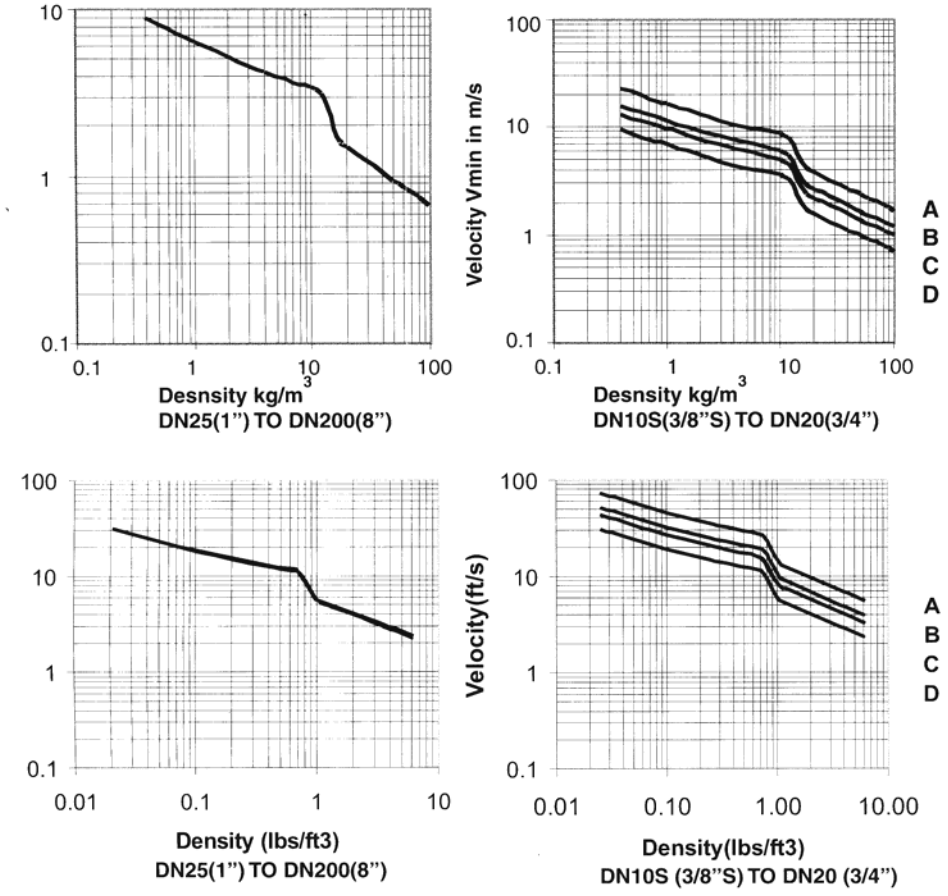


Diagram IV

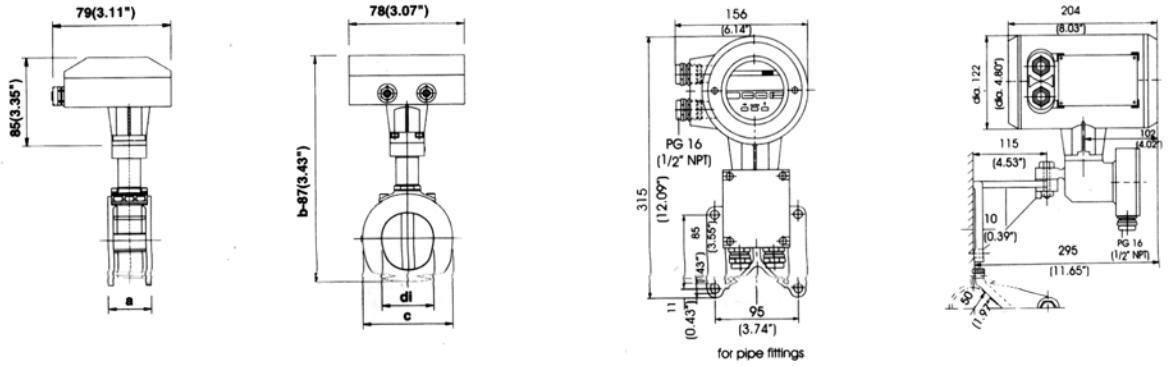
Min. flow velocity at various densities for gases and saturated steam.



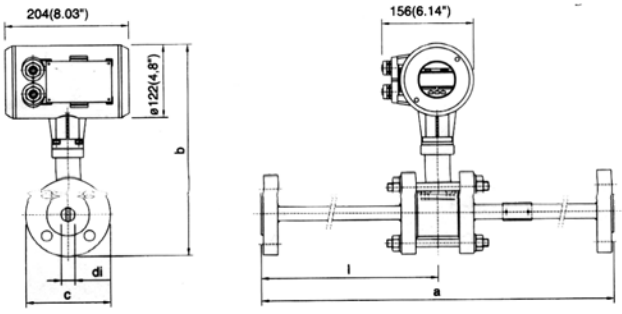
Curve	Meter size
A	DN 10 S/ ½" S
B	DN 10 S/ ½"
C	DN 15 / ½"
D	DN 20 / ½"

VHF 1091 (I) F

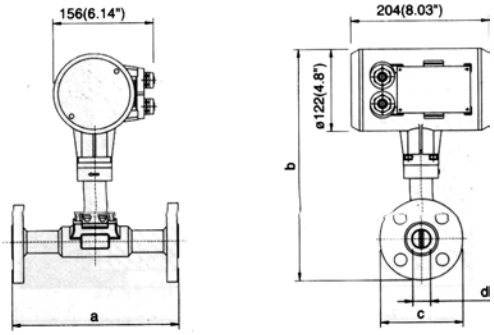
Primary head flanged versions same as for VFM 1091 (I) K versions



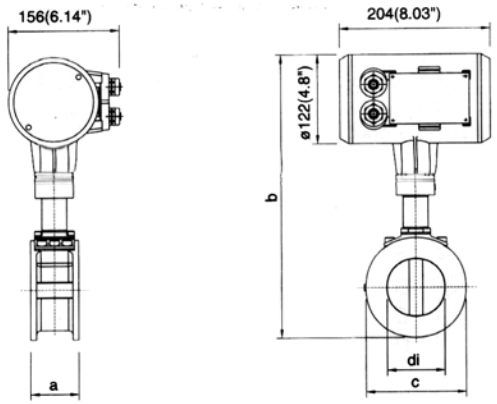
Small Size DN10s to DN20 (3/8"s to 3/4")



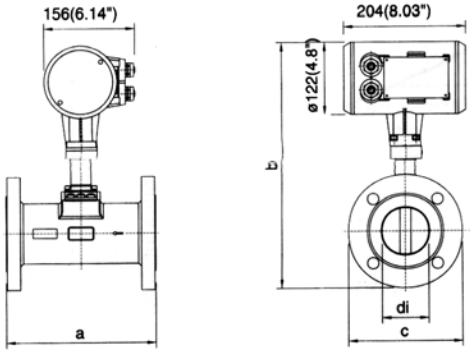
Flange Version DN25 to DN50 (1" to 2")



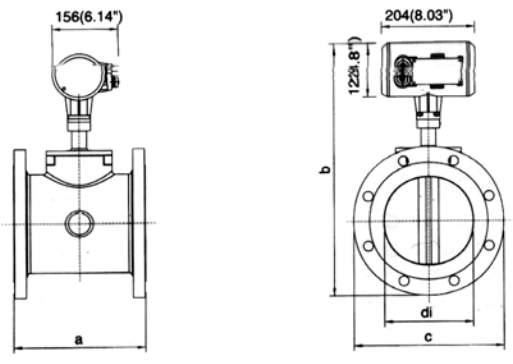
Sandwich Version DN25 to DN150 (1" to 6")



Flange version DN80 to DN150 (3" to 6")



Flange Version DN200 (8")



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

Dimensions and Weight :

Meter size DIN: mm ANSI: inch	Pressure rating of flanges	Dimensions in mm/inches														Approximate weight			
				flanged				water											
		di		a		b		a		a with U/S & D/S		b		c		flanged		water	
		mm	inch	mm	inch	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	65	2.56	365	14.37	318	12.52	69	2.72	5.3	11.6	4.4	9.8
DN25	PN100	28.5	1.12	250	9.84	354	13.92	65	2.56	365	14.37	318	12.52	69	2.72	6.5	14.3	4.4	9.8
1"	150LBS	26.7	1.05	250	9.84	338	13.32	-	-	-	-	-	-	-	-	4.8	10.6	-	-
1"	300LBS	26.7	1.05	250	9.84	346	13.64	65	2.56	365	14.37	319	12.56	69	2.72	5.3	11.7	4.4	9.8
DN40	PN40	43.1	1.70	250	9.84	370	14.55	65	2.56	545	21.46	339	13.35	89	3.50	6.3	13.8	4.9	10.7
DN40	PN100	43.1	1.70	250	9.84	380	14.94	65	2.56	545	21.46	339	13.35	89	3.50	8.0	17.7	4.9	10.7
1.5"	150LBS	40.9	1.61	250	9.84	359	14.14	-	-	-	-	-	-	-	-	5.9	13.0	-	-
1.5"	300LBS	40.9	1.61	250	9.84	373	14.70	65	2.56	545	21.46	340	13.39	89	3.50	7.0	15.4	4.9	10.7
DN50	PN40	54.5	2.15	250	9.84	381	14.98	65	2.56	665	26.18	348	13.70	100	3.94	7.6	16.7	5.1	11.3
DN50	PN64	54.5	2.15	250	9.84	396	15.57	65	2.56	665	26.18	348	13.70	100	3.94	9.1	20.0	5.1	11.3
DN50	PN100	54.5	2.15	250	9.84	388	15.28	65	2.56	665	26.18	348	13.70	100	3.94	10.2	22.4	5.1	11.3
2"	150LBS	52.6	2.07	250	9.84	375	14.77	65	2.56	665	26.18	349	13.74	100	3.94	7.4	16.3	5.1	11.3
2"	300LBS	52.6	2.07	250	9.84	382	15.02	65	2.56	665	26.18	349	13.74	100	3.94	8.1	17.9	5.1	11.3
DN80	PN40	82.5	3.25	250	9.84	412	16.21	65	2.56	1025	40.35	380	14.95	136	5.35	11.9	26.3	6.9	15.1
DN80	PN64	82.5	3.25	250	9.84	427	16.80	65	2.56	1025	40.35	380	14.95	136	5.35	13.4	29.6	6.9	15.1
DN80	PN100	82.5	3.25	250	9.84	419	16.50	65	2.56	1025	40.35	380	14.95	136	5.35	15.1	33.3	6.9	15.1
3"	150LBS	78	3.07	250	9.84	414	16.30	65	2.56	1025	40.35	387	15.23	136	5.35	12.7	27.9	6.9	15.1
3"	300LBS	78	3.07	250	9.84	423	16.66	65	2.56	1025	40.35	387	15.23	136	5.35	14.2	31.2	6.9	15.1
DN100	PN16	107.1	4.22	250	9.84	444	17.48	80	3.15	1280	50.39	406	15.98	159	6.26	12.5	27.5	7.9	17.4
DN100	PN40	107.1	4.22	250	9.84	416	16.36	80	3.15	1280	50.39	406	15.98	159	6.26	14.0	30.9	7.9	17.4
DN100	PN64	107.1	4.22	250	9.84	437	17.19	80	3.15	1280	50.39	406	15.98	159	6.26	16.4	36.1	7.9	17.4
4"	150LBS	102.4	4.03	250	9.84	443	17.45	80	3.15	1280	50.39	408	16.08	159	6.26	15.2	33.5	7.9	17.4
4"	300LBS	102.4	4.03	250	9.84	456	17.95	80	3.15	1280	50.39	408	16.08	159	6.26	19.0	41.9	7.9	17.4
DN150	PN16	159.3	6.27	250	9.84	507	19.96	145	5.71	1945	76.57	473	18.60	216	8.50	17.3	38.2	17.2	37.9
DN150	PN40	159.3	6.27	250	9.84	514	20.24	145	5.71	1945	76.57	473	18.60	216	8.50	20.2	44.6	17.2	37.9
6"	150LBS	154.2	6.07	250	9.84	507	19.95	145	5.71	1945	76.57	475	18.70	216	8.50	20.4	44.9	17.2	37.9
6"	300LBS	154.2	6.07	250	9.84	526	20.70	145	5.71	1945	76.57	475	18.70	216	8.50	27.9	61.6	17.2	37.9
DN200	PN10	206.5	8.13	300	11.81	573	22.55	-	-	-	-	-	-	-	-	44.1	97.2	-	-
DN200	PN16	206.5	8.13	300	11.81	573	22.55	-	-	-	-	-	-	-	-	43.6	96.1	-	-
8"	150LBS	202.7	7.98	300	11.81	576	22.68	-	-	-	-	-	-	-	-	51.2	112.8	-	-
8"	300LBS	202.7	7.98	300	11.81	595	23.43	-	-	-	-	-	-	-	-	72.5	159.8	-	-

Dimensions and Weight (continued) :

Meter size DIN: mm ANSI: inch	Pressure rating of flanges	Dimensions in mm/inches										Approximate weight	
		di		a		b		c		i			
		mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	kg.	ibs
DN 10S	DN10,PN40	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	11.6	25.6
	DN10PN100	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	12.4	27.3
	DN15,PN40	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	11.7	25.8
	DN15,PN100	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	12.6	27.8
	DN20,PN40	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	12.3	27.1
	DN25,PN40	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	12.8	28.2
	DN25,NP100	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	15.5	34.2
3/8"S	1/2"NB,ANSI150	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	11.1	24.5
	1/2"NB,ANSI300	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	11.6	25.6
	3/4"NB,ANSI150	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	11.5	25.4
	3/4"NB,ANSI300	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	12.6	27.8
	1"NB,ANSI150	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	12	26.5
	1"NB,ANSI300	8.9	0.35	606	23.9	354	13.95	140	5.51	480	18.9	13.2	29.1
DN10	DN10,PN40	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	12.2	26.9
	DN10,PN100	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	13	28.7
	DN15,PN40	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	12.3	27.1
	DN15,PN100	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	13.2	29.1
	DN20,PN40	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	12.9	28.4
	DN25, PN40	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	13.4	29.5
	DN25,PN100	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	16	35.3
3/8"	1/2"NB,ANSI150	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	11.7	25.8
	1/2"NB,ANSI300	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	12.2	26.9
	3/4"NB,ANSI150	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	12.1	26.7
	3/4"NB,ANSI300	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	13.2	29.1
	1"NB,ANSI150	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	12.6	27.8
	1"NB,ANSI300	12.6	0.5	826	32.5	356	14.02	140	5.51	665	26.2	13.8	30.4
DN15	DN15,PN40	14.9	0.59	966	38	357	14.06	140	5.51	780	30.7	12.6	27.8
	DN15,PN100	14.9	0.59	966	38	357	14.06	140	5.51	780	30.7	13.5	29.8
	DN20,PN40	14.9	0.59	966	38	357	14.06	140	5.51	780	30.7	13.2	29.1
	DN25,PN40	14.9	0.59	966	38	357	14.06	140	5.51	780	30.7	13.6	30.0
	DN25,PN100	14.9	0.59	966	38	357	14.06	140	5.51	780	30.7	16.3	35.9
1/2"	1/2"NB,ANSI150	14.9	0.59	966	38	357	14.06	140	5.51	780	30.7	12	26.5
	1/2"NB,ANSI300	14.9	0.59	966	38	357	14.06	140	5.51	780	30.7	12.4	27.3
	3/4"NB,ANSI150	14.9	0.59	966	38	357	14.06	140	5.51	780	30.7	12.4	27.3
	3/4"NB,ANSI300	14.9	0.59	966	38	357	14.06	140	5.51	780	30.7	13.4	29.5
	1"NB,ANSI150	14.9	0.59	966	38	357	14.06	140	5.51	780	30.7	12.8	28.2
	1"NB,ANSI300	14.9	0.59	966	38	357	14.06	140	5.51	780	30.7	14	30.9
DN20	DN20,PN40	20.9	0.82	1326	52.2	360	14.19	140	5.51	780	30.7	14	30.9
	DN25,PN40	20.9	0.82	1326	52.2	360	14.19	140	5.51	780	30.7	14.5	32.0
	DN25,PN100	20.9	0.82	1326	52.2	360	14.19	140	5.51	780	30.7	17.1	37.7
3/4"	3/4"NB,ANSI150	20.9	0.82	1326	52.2	360	14.19	140	5.51	780	30.7	13.2	29.1
	3/4"NB,ANSI300	20.9	0.82	1326	52.2	360	14.19	140	5.51	780	30.7	14.3	31.5
	1"NB,ANSI150	20.9	0.82	1326	52.2	360	14.19	140	5.51	780	30.7	13.7	30.2
	1"NB,ANSI300	20.9	0.82	1326	52.2	360	14.19	140	5.51	780	30.7	14.8	32.6

Dimensions and weights

- 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.

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 > 1091, but linear measurements are only possible where Re > 20 000.

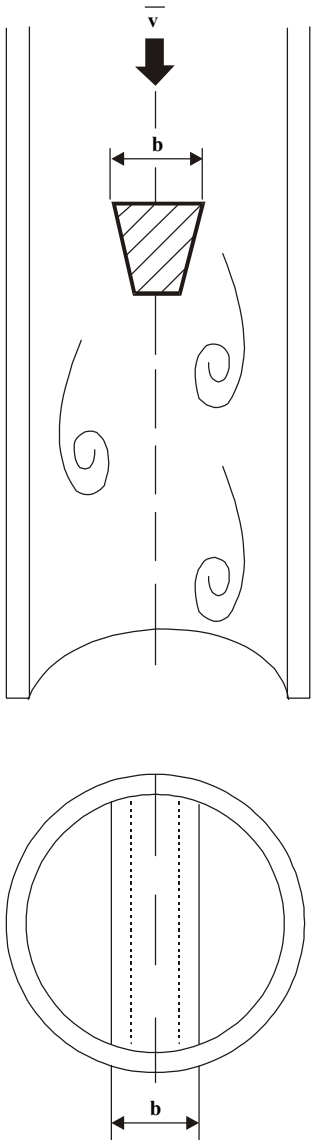
The periodic shedding occurs first from the one side and then from the other side of a bluff body (Vortex- shedding body) installed perpendicular to the axis. Vortex shedding generates a so-called "Karman Vortex Street" with alternating pressure conditions whose frequency f is proportional to the flow velocity v. The non dimensional 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)

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

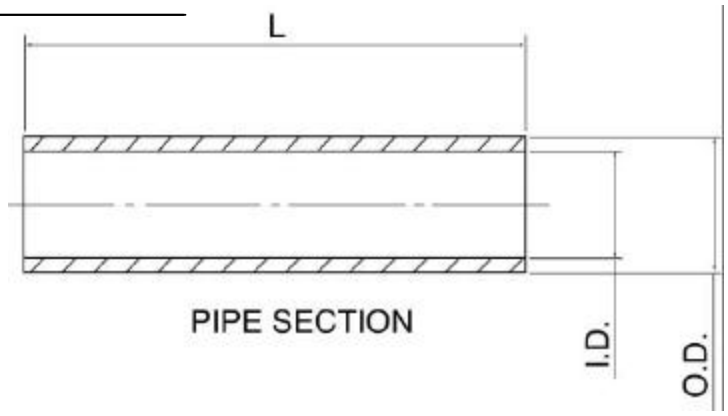
The flexural vibration of the vortex-shedding body is picked up in the primary head via sensors and analysed in the signal converter. In the case of gaseous, flowing media, the vibration frequency ranges between 10 and 7000 Hz.

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

Karman Vortex Street



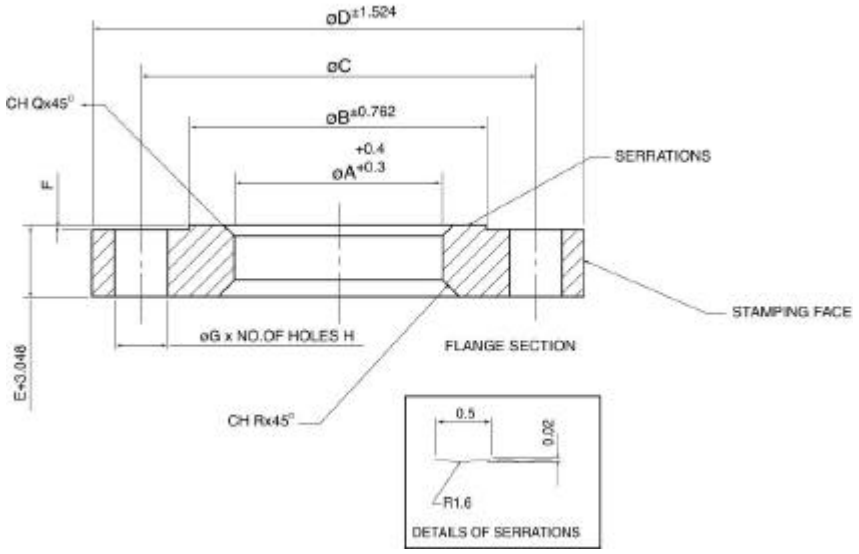
Pipe for U/S, D/S Assembly



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

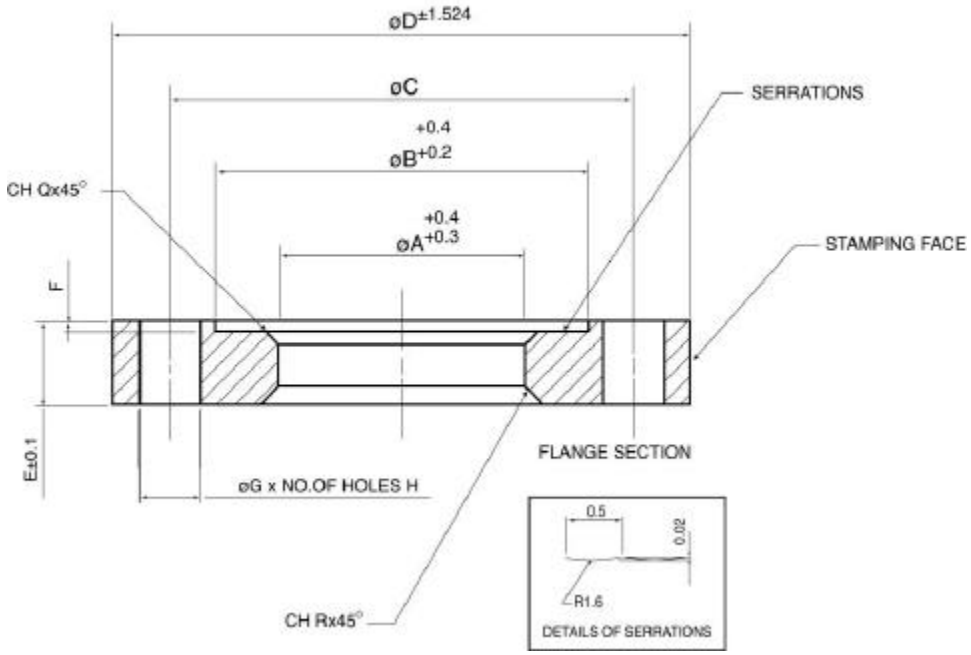
R/F Flanges for U/S, D/S Assembly ANSI SW



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

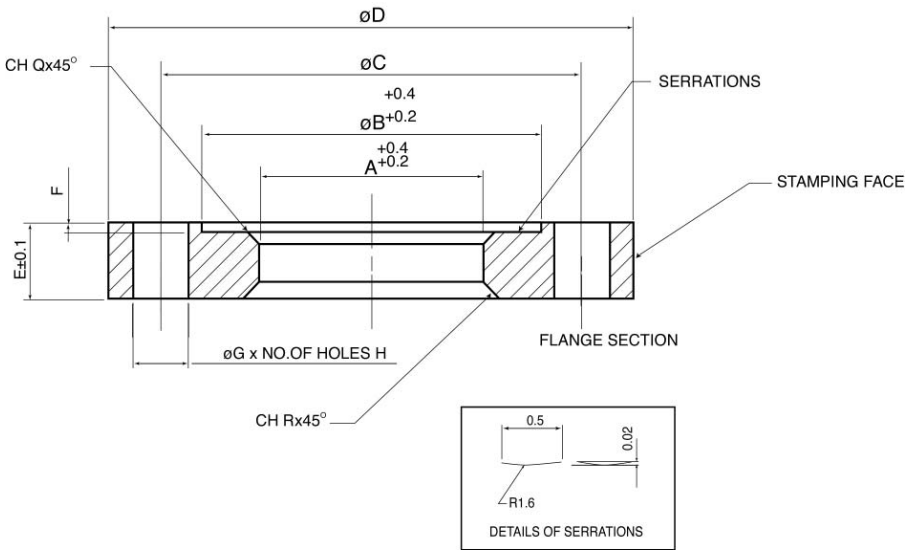
Recess Flanges for U/S, D/S Assembly ANSI, SW



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

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

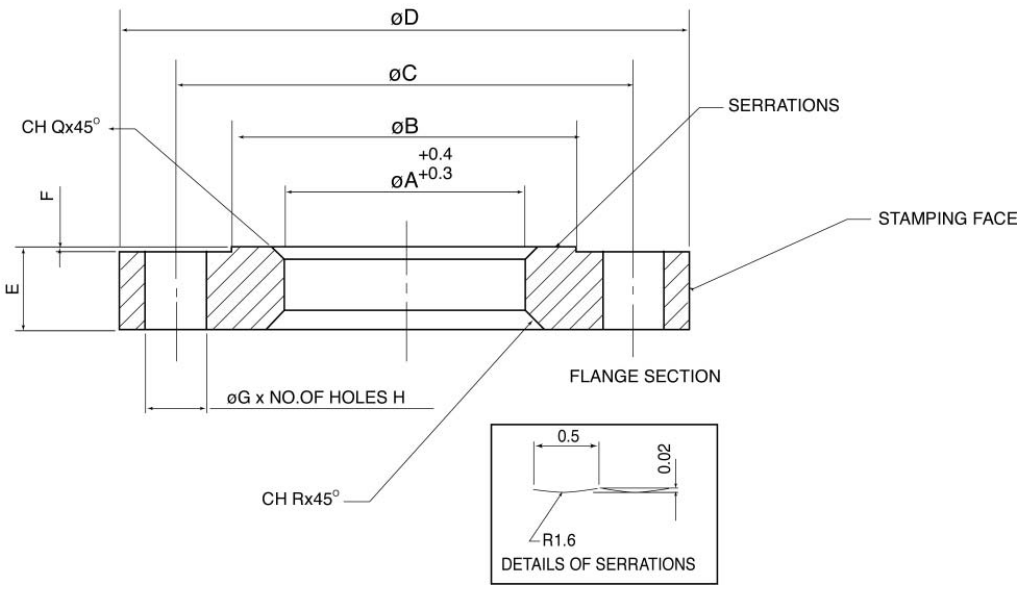


Tolerance Details			
Size	**B**	**D**	**E**
DN25/PN40	-1	±1	+0.8
DN25/PN100			+0.1
DN40/PN40	-2		+0.8
DN40/PN100			+0.1
DN50/PN40			+0.8
DN50/PN64			+1
DN50/PN100			
DN80/PN40			
DN80/PN64		±1.5	
DN80/PN100			
DN100/PN16			
DN100/PN40			
DN100/PN64			
DN150/PN16			
DN150/PN40			
DN200/PN10		±2	
DN200/PN16			

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

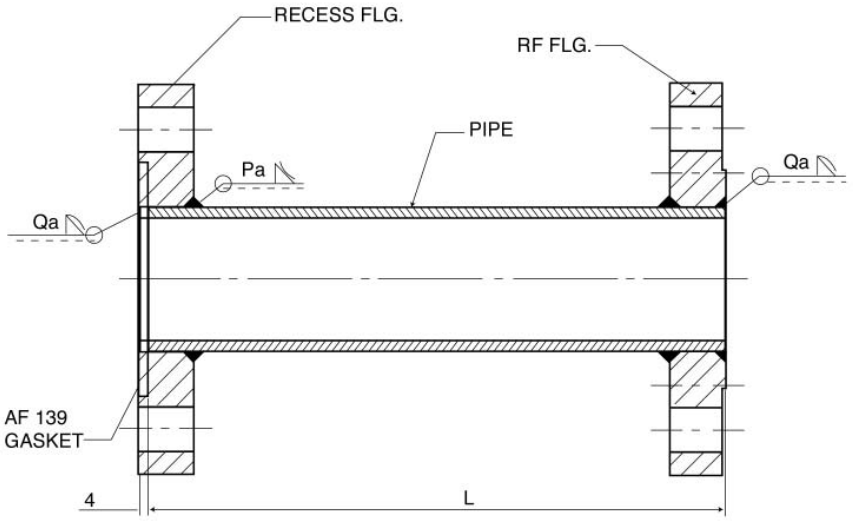


Tolerance Details	
Size	**D**
DN25/PN40	± 1
DN25/PN100	
DN40/PN40	
DN40/PN100	
DN50/PN40	
DN50/PN64	
DN50/PN100	
DN80/PN40	
DN80/PN64	± 1.5
DN80/PN100	
DN100/PN16	
DN100/PN40	
DN100/PN64	
DN150/PN16	
DN150/PN40	
DN200/PN10	± 2
DN200/PN16	

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

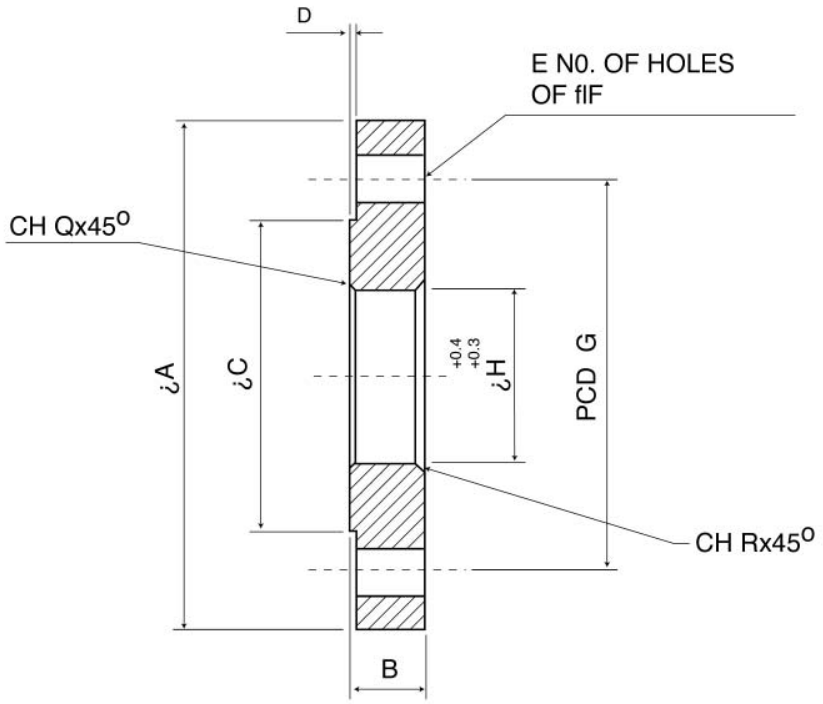
Meter Size	Pa	Qa	Pipe Length in mm											
			7D	5D	10D	5D	20D	5D	30D	5D	40D	5D	50D	5D
1" /300	3	4	175	125	250	125	500	125	750	125	1000	125	1250	125
1.5" /300	3	4	280	200	400	200	800	200	1200	200	1600	200	2000	200
2" /150	3.5	4.5	350	250	500	250	1000	250	1500	250	2000	250	2500	250
2" /300	3.5	4.5	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

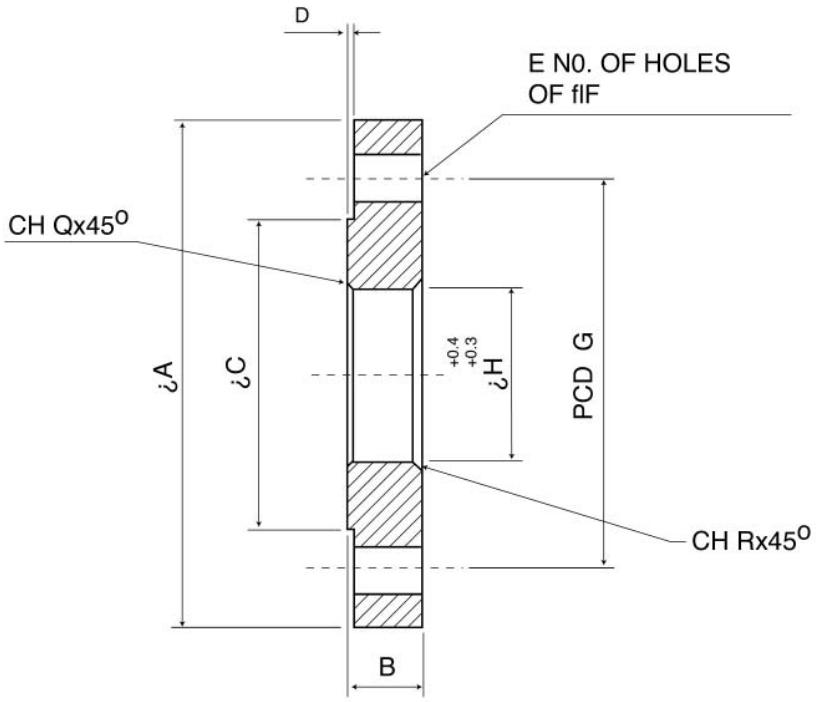
End Connection JIS Flanges for U/S, D/S pipes for SW VFM



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



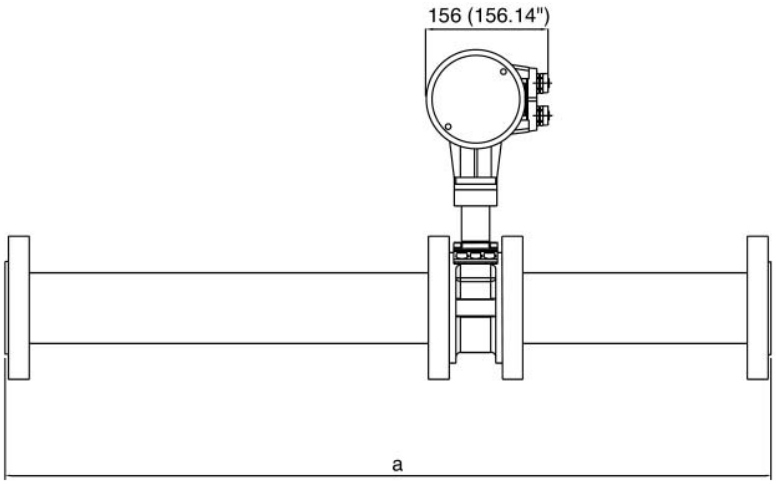
Size	JIS FLG.	øA	B	øC	D	No. of Holes E	øF	PCD G	Bore øH	Q	R
1" SW	25A 10K	125	14	67	1	4	19	90	33.7	3	4.5
1.5" SW	40A 10K	140	16	81	2	4	19	105	48.3	3	4.5
2" SW	50A 10K	155	16	96	2	4	19	120	60.3	3	4.5
3" SW	80A 10K	185	18	126	2	8	19	150	88.9	3	4.5
4" SW	100A 10K	210	18	151	2	8	19	175	114.3	3	4.5
6" SW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