
# SteaMon

## Installation and Operating Instructions

FORBES MARSHALL

## CONTENTS

## 1. System installation & Startup

### Safety

#### 1.1 Intended use

The Steam flowmeters manufactured by Forbes Marshall Pvt. Ltd. are used to measure the flow of saturated steam.

These flowmeters are particularly suitable for measuring steam.

The meters are available in Sizes :

- DN 25
  DN 40
  DN 50
  DN 80
  DN 100

For Flow velocities refer sizing sheet on page no 8/1.

**Warning :**

The operator shall bear sole responsibility for the use of the flowmeters in respect of suitability, intended use and corrosion resistance of the materials used to the process product.

The manufacturer shall not be liable for any damage resulting from improper use or deployment contrary to the prescribed purpose.

**Notes**

The sensors are fabricated from stainless steel CF8.

In your project planning, please take account of the data given in the corrosion tables.

The pressure-loaded components have been designed and rated for stationary operation taking account of maximum pressure and temperature.

External forces and moments, caused e.g. by pipe stresses, have not been taken into account.

Primarily, volumetric flow and temperature are measured, From these parameters the flowmeter calculates the mass flow or volumetric flow using pre-programmed density data and then issues the current o/p proportional to mass flow.

## 1.2 Certifications

- IBR approval
- IP65 approval

## 1.3 Safety instructions from the manufacturer

The flowmeter has been built and tested in accordance with the current state-of-the art design. It complies with the relevant safety standards.
However, risks can occur if used improperly or contrary to the intended application. Therefore please consistently observe all safety instructions given in this document.

### 1.3.1 Information concerning the documentation

In addition to the safety advice given in this documentation, national and regional safety regulations and occupational health and safety provisions must also be observed.

### 1.3.2 Display conventions

The following symbols are used to help you navigate this documentation more easily:

**Warning !**

These warning signs must be observed without fail. Even only partial disregarding such warnings can result in serious health damage, damage to the flowmeter itself or to parts of the operator's plant.

**Danger!**

This symbol designates safety advice on handling electric current.

**Information!**

This symbol designates important information for the handling of the flowmeter.

**Handling**

This symbol designates all instructions for actions to be carried out by the operator in the specified sequence.

### 1.3.3 Safety instructions for the operator

**Caution!**

Meters from Forbes Marshall Pvt. Ltd. may only be installed, commissioned, operated and maintained by properly trained and authorized personnel.

This document must be read and understood in its entirety by all users prior to installation, commissioning, operation and maintenance of the flowmeter.

### 1.3.4 Product Disposal:

It is necessary to dispose this product only in accordance with local regulations at the authorized, qualified collecting point specified for equipment's and its parts—Please refer the part details mentioned in the material table of this manual. Please follow all waste disposal guidelines (Management & Handling) as published by local governing authorities in India & abroad

## 1.4 Scope of supply

**Important information!**

Please check the contents of the consignment for completeness and intactness.

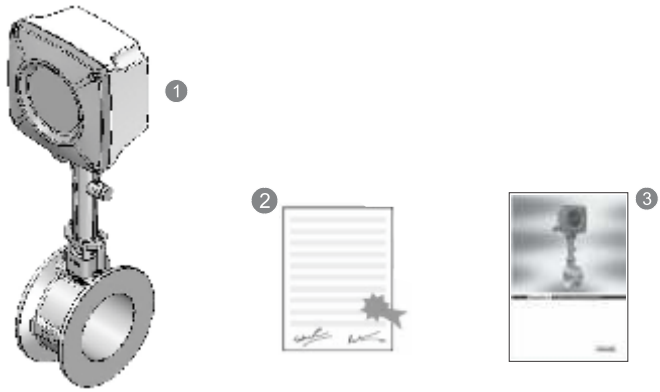



Fig. 1: Scope of supply

1 Meter
2 Certificates
3 Manual

## 1.5 Instrument versions

SteaMon comes only in Sandwich design with converter

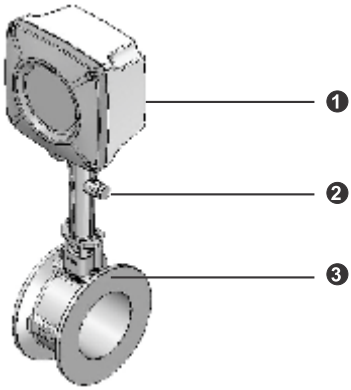



Fig. 2: STEAMON, Sandwitch-type meters.

**1** Converter

**2** Nozzle

**3** Primary Head with Sensor assembly

## 1.6 Nameplate

**Important information!**

Before installing the flowmeter, make sure that the information given on the nameplate complies with the ordering data.

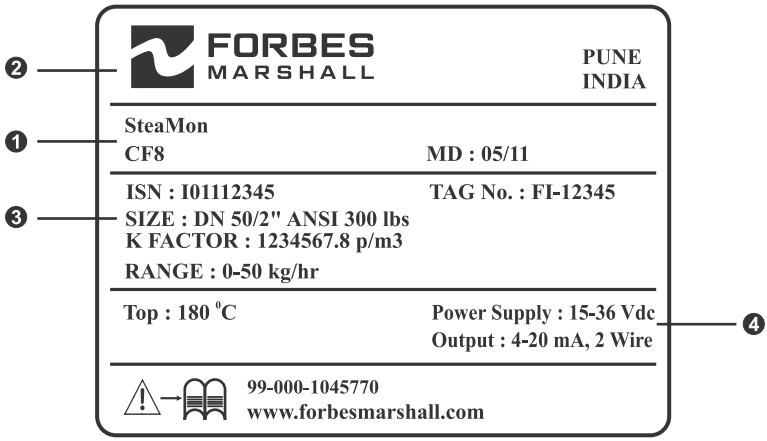



Fig. 3: STEAMON nameplate

**1** Type of meter

**2** Manufacturer

**3** Configuration

**4** Electrical connection data

## Mechanical Installation

### 1.7 General installation information

**Caution!**

Installation, assembly, start-up and maintenance may only be performed by appropriately trained personnel. The regional occupational health and safety directives and safety regulations must be observed without exception.

**The following procedures have to be carried out before installing the flowmeter!**

- Check the packing and the flowmeter itself for any damage.
- Check the contents of the consignment for completeness.
- Compare your order specification with the scope of delivery.

### 1.8 Storage

- Store the flowmeter in a dry and dust-free location.
- Avoid direct exposure to the sun.
- Store the flowmeter in its original packing.
- The admissible storage temperatures are -40 °C to +80 °C.

## 1.9 Installation requirements

**Important information!**

For accurate volumetric flow measurement the flowmeter has to have a completely filled pipe and a fully developed flow profile.

Please comply with the instructions regarding inlet and outlet pipe runs and installation position.

In the case of **vibrations** on the piping choose the installation site in such a way that the vibrations are at their lowest in transverse direction to the flowmeter.

**Caution**

When installing the flowmeter in the piping please observe the following points:

- Nominal diameter of connection pipe flange = nominal diameter of the meter!
- Use flanges with smooth holes, e.g. welding neck flanges.
- Carefully align the ID of the connecting flange with the meter.
- Check the compatibility of the gasket with the process product.
- Make sure that the gaskets are arranged concentrically. The flange gaskets must not project into the pipe cross-section.
- The flanges have to be concentric.
- There must not be any pipe bends, valves, flaps or other internals in the immediate inlet run.
- Do not lay signal cable directly next to cable for power supply.

### 1.9.1 General

- A sufficient distance around the flowmeter in all directions must be kept free to allow servicing.
- Protect the flowmeter from direct exposure to the sun.

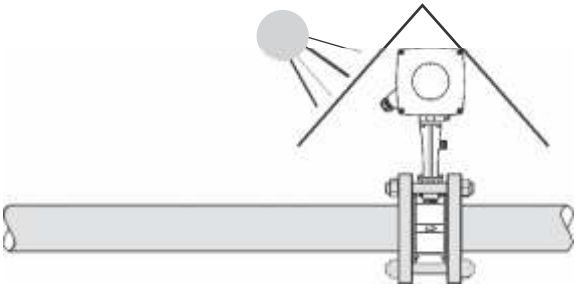


Fig. 4: General installation instructions

### 1.9.2 Important installation instructions, vapor measurement

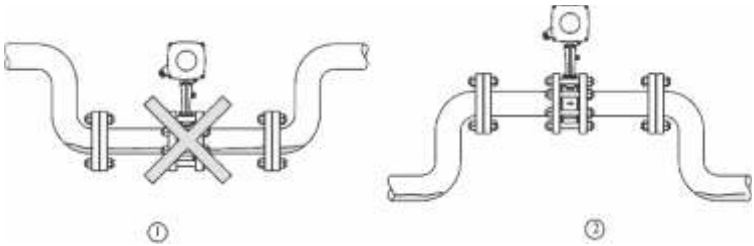


Fig. 5: Fundamental installation advice

**1** Prohibited: Installing the flowmeter in the lower pipe bend, risk of condensate formation

**2** Recommended: Installing the flowmeter in the top pipe bend

**Caution!**

Condensate can lead to cavitation and inaccurate measurement.

### 1.9.3 Important installation instructions, piping with control valves

Important information!

To ensure trouble-free and accurate measurement, Forbes Marshall Pvt. Ltd. recommends not installing the flowmeter after a control valve. There is a risk of turbulence occurring that falsifies the measuring result.

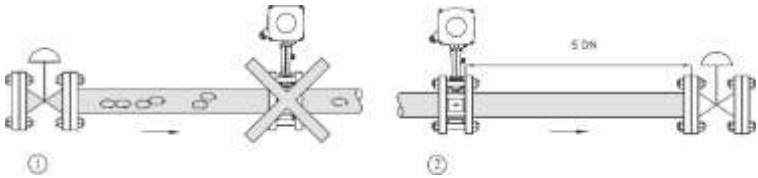



Fig. 6: Fundamental installation advice

**1** Not recommended: Installing the flowmeter directly after control valves

**2** Recommended: Installing the flowmeter upstream of the control valve, distance 5 DN

### 1.9.4 Preferred installation location

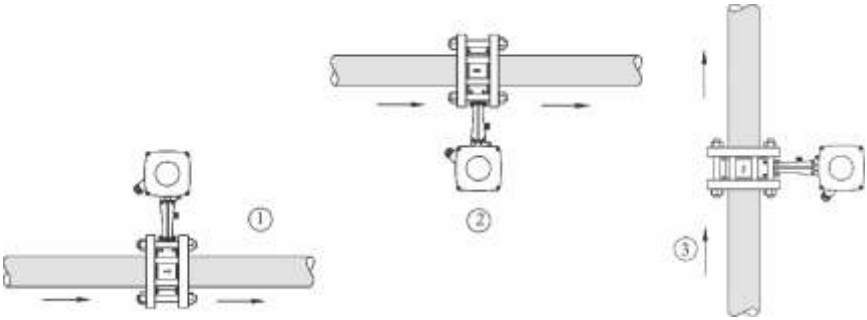



Fig. 7: Preferred installation locations

1 Above a horizontal pipe

2 Below a horizontal pipe

3 On a vertical pipe

### 1.9.5 Insulation

**Caution!**

The area above the converter support must not be thermally insulated.
The thermal insulation (2) may only extend to the maximum height (1) shown below up to the connecting screws of the sensor.

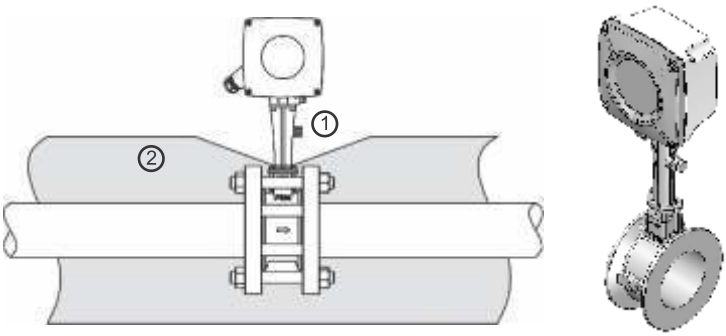



Fig. 8: Thermal insulation on connection piece

## 1.10 Inlet and outlet runs

### 1.10.1 Minimum inlet runs

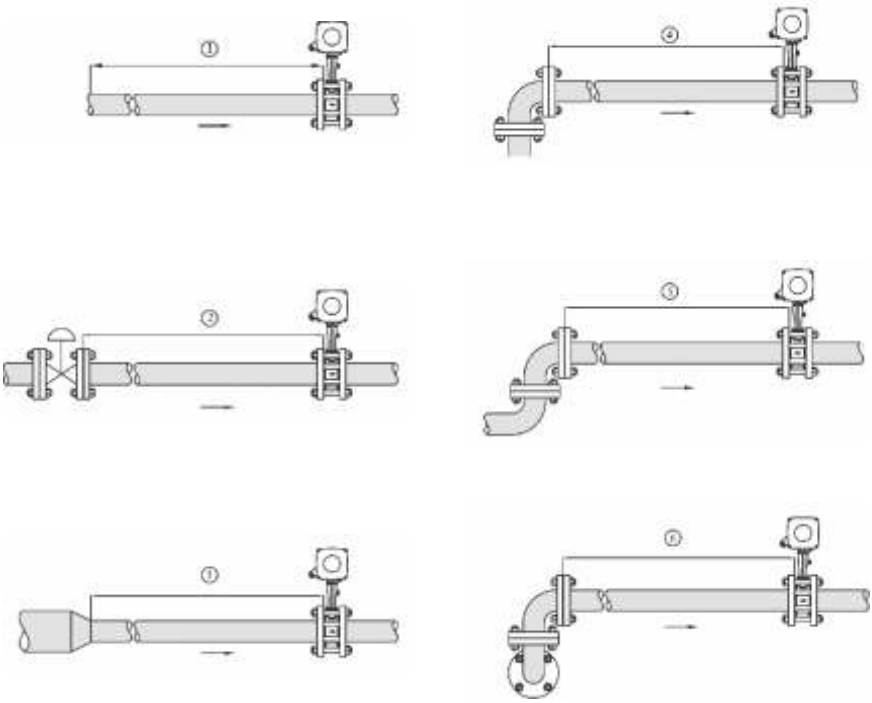


Fig. 9: Minimum inlet runs

1. General inlet run without flow disturbances ≥ 20 DN
2. After a control valve ≥ 50 DN
3. After a pipe diameter reduction ≥ 20 DN
4. After a single 90° bend ≥ 20 DN
5. After a double bend 2x90° ≥ 30 DN
6. After a double three-dimensional 2x90° bend ≥ 40 DN

DN is meter diameter

### 1.10.2 Flow straightener

If, due to the type of installation, the required inlet runs are not available, FORBES MARSHALL PVT. LTD. recommends using flow straighteners. Flow straighteners are installed between two flanges in front of the flowmeter and shorten the required inlet run.

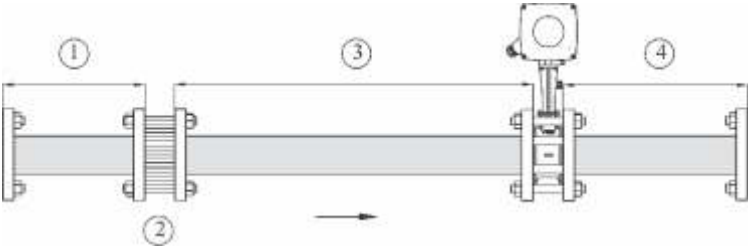



Fig. 10: with Flow Straightener

**1** Straight inlet run upstream of flow straighteners ≥ 2DN

**2** Flow straightener

**3** Straight pipe section between flow straigtener and flowmeter ≥ 8DN

**4** Minimum straight outlet run 5DN

### 1.10.3 Minimum outlet runs

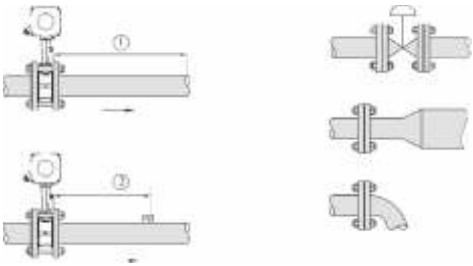



Fig. 11: Minimum outlet runs

**1** General outlet run in front of pipe widening, pipe bends, control valves etc. ≥ 5 DN

**2** In front of metering points ≥ 5 DN

**Important information!**

The interior of the pipe at the metering points must be free of burrs and other flow impediments. The flowmeter has an internal temperature sensor. It must be located ≥ 5 DN away from extraneous temperature sensors. Use sensors that are as short as possible to avoid disturbing the flow profile.

## 1.11 Installation

### 1.11.1 General installation instructions

**Caution!**

Installation, assembly, start-up & maintenance may only be performed by appropriately trained personnel. The regional occupational health and safety directives and safety regulations must be observed without exception.

**The following procedures have to be carried out before installing the flowmeter in the piping:**

- Remove all transport locks and protective coverings from the flowmeter.
- Make sure that the gaskets have the same diameter as the piping.
- Make sure that the flowmeter is in the correct flow direction. This is indicated by an arrow on the sensor housing.

**Caution !**

On metering points with varying thermal loads the flowmeters are to be mounted with stress bolts.

Stress bolts and/or nuts and bolts are not included in the scope of delivery.

Make absolutely certain that the mating flanges are sitting concentrically.

When preparing the metering point, keep in mind the exact installed length of the flowmeter.

The dimensions are given in Section 7 “Technical Data”.

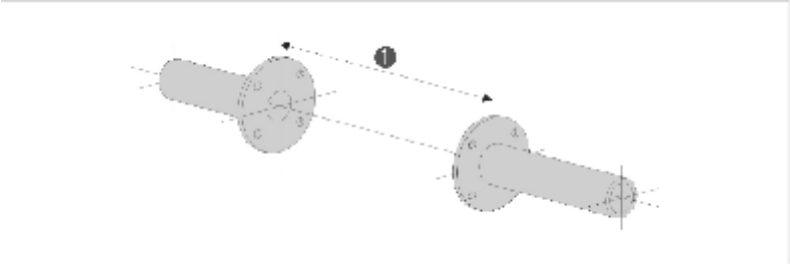



Fig. 12: Preparing the metering point

**1** Installed length of flowmeter + thickness of gaskets.

**Caution!**

The inside diameters of the connection pipe, of the flowmeter and of the gaskets must be the same! The gaskets must not project into the pipe cross-section.

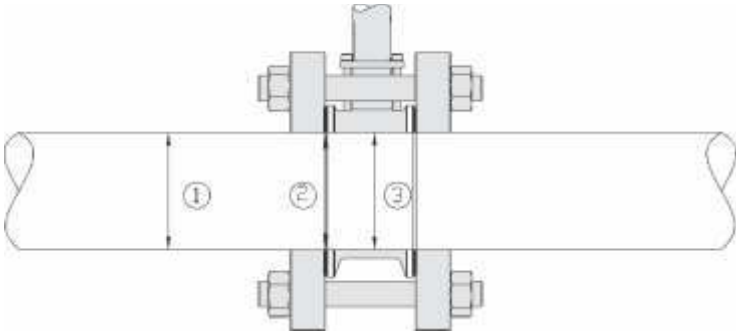



Fig. 13: Preparing the metering point

**1** Inside diameter connection pipe

**2** Inside diameter gasket

**3** Inside diameter of meter

### 1.11.2 Installing instruments in sandwich design

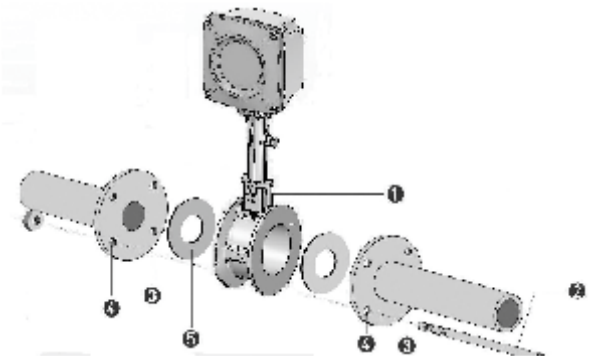


Fig. 14 : Installing Instruments in sandwich design

1. Sandwich design sensor
2. Bolts with fixing nuts
3. Hole A
4. Hole B
5. Gasket

**Install the flowmeter as follows:**

- Push the first bolt through hole **4** of both flanges.
- Screw on the nuts with washers at both ends of the bolt but do not tighten them.
- Screw on the nuts with washers at both ends of the bolt but do not tighten them.
- Mount the second bolt through the holes **3**.
- Place the sensor between the two flanges.
- Insert the gaskets between sensor and flanges and align them.
- Check that the flanges are sitting concentrically.
- Install the remaining bolts, nuts and washers. But do not tighten the nuts yet.
- Align the flowmeter.
- Check that the gaskets are concentric, they must not project into the pipe.
- Now tighten all nuts bit by bit alternately across the diagonal.

## 1.12 Start-up

- Check that the system has been correctly installed as described in Section 1.
- Before the initial start-up check that the following details on the name plate agree with the data specified in the report of settings for the signal converter. If not, reprogramming will be necessary.
- Avoid abrupt changes in pressure in the pipeline.
- As the process product is steam, condensate may form initially and cause faulty measurements when the system is started up for the first time.
- When powered, the signal converter normally operates in the measurement mode.
- Ensure that LED indicating power supply is ON & Loop current is present.

## 2. STEAM FLOW METER

### 2.1 Basic Features

- 2-wire loop powered convertor 24 V DC supply (4-20 mA)
- **Temperature measurement as standard**
- **Online density compensation and mass flow calculations for saturated steam**
- 4-20 mA programmable current output
- All measured and calculated parameters such as volumetric flow & mass flow, etc. **are fully programmable at factory.**
- Notch Filter Algorithm for predicting correct input frequency for improved vibration and noise immunity
- Simple single level user-friendly menu - optional with configurator.
- Integral version

### 2.2 Connection Diagram

**Connection to power - SteaMon**

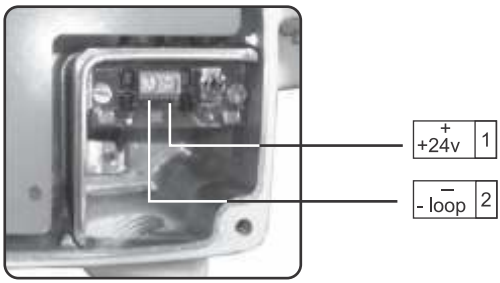



Fig. 15 : Connection Diagram

- Loop Current is galvanically isolated and can, therefore, be simultaneously connected to a receiver instrument which is grounded or separately connected to two receiver instruments.
- Ensure that the 24 V, 4-20 mA loop is grounded at one point only (i.e. either at the input of the signal convertor 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.

### 2.2.1 Current Output

- The current output is galvanically isolated from the sensors.
- The maximum load at terminals.

$$\text{Max. load in } R_B = \frac{U_B - 15\ V^*}{20\ mA} \leq 1000\ \Omega$$

Where $U_B$ =Applied Loop Power supply, Normally 24VDC

## 3. Operation of the signal convertor with configurator (optional)

### 3.1 General

Display indication is possible by connecting configurator only.

#### 3.1.1 Starting up signal convertor with Configurator

When the power is switched ON to the signal convertor Configurator displays soft "Ver X.Y.Z" and then goes to the measurement mode. In this initial sequence, carries out self diagnostics to check the preamplifier section, sensor integrity and then loads the configuration data from the non-volatile memory.The first measured parameter displayed is the one being displayed when the power supply was switched off the last time. It is possible to enter the programming mode by pressing the → key.

#### 3.1.2 Measurement Mode

In the measurement mode, the parameters that the convertor measures/computes are shown on the display in the appropriate units. As per the configuration, the display can be either in the non cyclic/cyclic mode. In the non-cyclic mode of display, use key to see the next parameter or error message on the display. In the cyclic mode, the display shows all the parameters one after another, wherein each parameter/ error message is displayed for about 6 seconds.

#### 3.1.3 Error Handling

The convertor can detect errors during the power-on diagnostics as well as when in the normal measurement mode. If one or more errors are present, the vertical bar in the top left corner of the display (in the measurement mode) starts blinking. If enabled, the error information is shown on the display interleaved between the display of two parameters. The first line displays the total number of errors and the second line displays the error message. Refer to the list of Error Messages.

#### 3.1.4 Programming or menu mode

All the configuration/settings/test functions in the form of a menu function x.x.x are accessible in the programming mode. The operator can view or alter the present settings, data values by the use of functions available in this mode. All changes made in the programming mode are stored in the non-volatile memory after exiting the menu and have appropriate effect on the operation of the signal convertor. While being programmed (i.e. while in the menu), the instrument will stop making further measurements and the current output will be frozen to the last value.

### 3.1.5 Error messages

## Error messages in the measurement mode

| Error message (display second line) | Type Description | Corrective action required |
|---|---|---|
| *NO SIGNAL* | No signal from the sensor | No flow through the primary or check for any other errors during. power-on diagnostics. If sensor problem, contact Forbes Marshall Service. |
| *LOW FREQ* | Sensor frequency too low | Check flow rate > q min else call Forbes Marshall Service. |
| *HIGH FREQ* | Sensor frequency too high | Check flow rate < q max else call Forbes Marshall Service. |
| *LOW FLOW* | 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* | Actual flow rate higher than q max. | Corrective action depends on application process. If the flow rate exceeds the max. value it may damage the sensor physically . |
| *INV. CONFIG* | Configuration data in non-volatile memory is not valid. | Check entire configuration again. If error persists call Forbes Marshall Service. |
| *CHECK INST* | Flow signal quality is bad | Check that 1) Flow rate>q min if OK. 2) Check for excessive pipe vibration and upstream flow disturbances. |
| *LOW SIGNAL* | Sensor signal amplitude too low | Check that 1) Flow rate>q min if OK contact Forbes Marshall Service. |
| *HIGH SIGNAL* | Sensor signal amplitude too high | This occurs in cases of high density medium. Check 1) Flow rate < qmax, if OK contact Forbes Marshall Service. |
| *LOW.TEMP.PHY.* | Operating temp. lower than physical limit | Take corrective action depending on the process. |
| *HIGH.TEMP.PHY* | Operating temp. higher than physical limit | Take corrective action immediately. Will cause damage to the primary as well as to signal convertor! |
| *T.SENS.SHORT* | Temp. sensor/wires short circuit | Indicates a fault in the temperature sensor. Contact Forbes Marshall Service. |
| *T.SENS.OPEN* | Temp. sensor open circuit | |

### 3.1.6 SteaMon Configurator (Optional)


Fig. 16 SteaMon configurator

1. Flat Ribbon Cable.
2. Configurator Display.
3. Function Keys.
4. Cable compartment.
5. Cable compartment cover.

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

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

**Connection of Configurator to the Signal Converter**

1. Open the converter Lid by removing four no's of screw's.
2. Switch off the converter by pushing toggle switch on up side (Refer fig. for connection).
3. Insert flat cable of the configurator into the 10 pin socket.
4. Switch on the Signal Converter.
5. Now one can program the parameters of the signal converter through configurator.

## 4. Description of Keys with configurator

### 4.1 Menu structure

❶ **Measuring mode level**

- ↑ Displaying measured parameters/error messages
- → Enter programming mode

❷ **Menu Function Level**

- → Select scroll position
- ↑ Select function
- ← Select function displayed
- → Enter the function. Then continue as under❸ data level
- ← Return to sub-menu level or main menu level after choosing YES/NO with ↑ key
- ↵ Confirm function selected

❸ **Data level**

| Options | Numerical/ alpha-numerical values |
|---|---|
| ↑ Scroll through option | |
| → | Change the flashing digit/character |
| ← | Change flashing (cursor) position |
| ↵ Temporarily save selected proposal then continue with further data entry, if any, or return to function❷ level. | Stores edited value /string temporarily. Continue with further data entry, if any,or return to ❷ function level. |

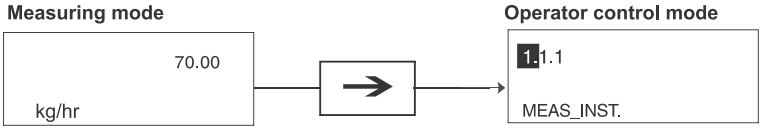
**Important**

1. All changes made in programing mode are stored in non volatile memory upon quitting menu.
2. Steam Flow Converter stops measurement when in programming mode, but holds the last measured output current.

## 4.2 Functionality of keys

The cursor position is indicated by an “inverse video” character.

**To start operator control**




Please note when ‘Yes’ is set under the entry code of Fct.3.2.2 then on pressing the key will prompt you to enter the Entry Code 1 which is fixed. Here, the software is modified in such a way that thekey is taken as the first key out of the nine and you have to enter the remaining eight keys in the sequenceThis will take you to the function level.

**To go to the next function**

1.


Pressing thekey will result in scrolling through all the functions sequentially as given in the menu level chart. Here the right most digit of the function goes on incrementing.

2


Pressing thekey when the middle digit is selected will result in an increment of that second LSB. Logically, the function should go to Fct.1.2.1. However, Functions 1.2.1 up to 1.2.5 do no exist on the menu level chart. Hence, on pressing the key, the function will go directly to Fct.1.2.6

3

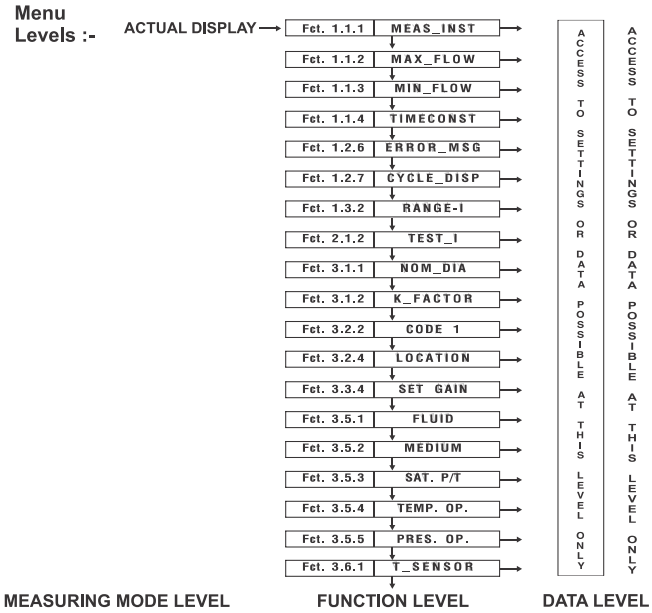

Here pressing thekey results in incrementing the left most digit. Logically, the function should go to Fct.2.1.1. However, since Fct.2.1.1 does not exist on the menu level chart, the function will go to the next function which is Fct.2.1.2

**To select the function**

To modify any menu, first make that function available on the display. Then press the key to confirm the function selected. Next, press the key to enter that function. To scroll through the different options available, use thekey. To select the option chosen, press the key. You are then prompted with the CONT YES/NO. On selecting YES, you will proceed to the next menu level. If you select NO, it will update the data you entered and will go to the measuring mode.

# 5 Program Functions for SteaMon with configurator

## 5.1 Program Organization and Programming Chart for SteaMon



## 5.1.1 Program function description

The program functions are described below in a numerical order.

### 1.1.1 MEAS. INST

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

- **VOLUME**
- **MASS**

Usually, this function is used only once - initially. If you need to change the measurement type later on, you should reprogram **MAX. FLOW** and **MIN. FLOW**

### 1.1.2 MAX. FLOW

Enter the flow measurement unit, followed by the maximum flow rate required. The maximum flow must not exceed the maximum flow specified in the Sizing Sheet. The current output range (4-20 mA) corresponds to zero flow and the max flow respectively. If the flow rate exceeds the **MAX. FLOW**, an error HIGH FLOW is annunciated on the display with an error symbol flashing at the top left corner.

The following units are available.

**For volumetric flow**

- M3/HR
- M3/MIN
- M3/SEC
- LITRE/HR
- LITRE/MIN
- LITRE/SEC
- CUFT/HR
- CUFT/MIN
- CUFT/SEC
- FT3/HR
- FT3/MIN
- FT3/SEC
- CFT/HR
- CFT/MIN
- CFT/SEC
- US GAL/HR
- US GAL/MIN
- US GAL/SEC
- UK GAL/HR
- UK GAL/MIN
- UK GAL/SEC
- SPECIAL

**For mass flow**

- KG/HR
- KG/MIN
- KG/SEC
- T/HR
- T/MIN
- T/SEC
- LB/HR
- LB/MIN
- LB/SEC
- SPECIAL

For **SPECIAL -**

The base units are $m^3$/hr and kg/hr respectively for Volume and Mass. For units other than the specified units, replace the base unit with the user unit by changing the literal text. Coefficients of the user unit need to be enetered with respect to the base unit as shown below:

Formula to be used: [User Unit] * [A1 coeff] + [A0 offset] = Base unit

Example
If the user unit is litre/hr, **A1 coeff** = Base unit / User unit = 1/1000 = 0.001 and **A0 offset** = 0

### 1.1.3 MIN. FLOW

Enter the minimum flow rate in the same units as of the **MAX. FLOW** set above. It is recommended that this value should not be zero. This value should be equal to or greater than the minimum flow rate

determined from the Sizing Sheet. If the measured flow is below the **MIN. FLOW,** an error **LOW FLOW** is annunciated on the display with an error symbol flashing at the top left corner.

**1.1.4 TIMECONST.**
Enter a low-pass filter time constant in seconds to be applied to the flow rate. A value of zero indicates that the low-pass filter is not to be applied. With this function, it is possible to tradeoff between a steady indication (on the display/current output) and the response time (to flow changes). It should normally be within 0-20 sec. The factory set value is 2 sec. You may increase it if you observe abnormal fluctuations on display.

**1.2.6 ERROR MSG.**
Select **YES** so that the error messages appear between the display of parameters in the normal measuring mode, otherwise select **NO**.

**1.2.7 CYCLE DISP**
**YES** means the display will cycle automatically. This means a measured parameter is displayed in the 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 a parameter is continuously shown on the display. You may see error messages in between the move from one parameter to next if error(s) are present and **1.2.6 ERROR MSG.** is **YES**.

**1.3.2 RANGE I**
You can select one of the three possible range options for the current output as follow:

- **4-20**
- **4-20/22E**
- **4-20/3.55E**

Select 4-20 for no error indication. Select 4-20/22E or 4-20/3.55E to enable error indication so that current output will give 22 mA or 3.55 mA as an error output if any error(s) are present in the instrument.

**2.1.2 TEST I**

**Caution**: During this test, the current output will change to the test values so appropriate actions should be taken depending on the purpose for which the current output is used.

Place the current meter in series with the current loop. Selecting any value given below will cause that current to flow so that you can check it on the meter. Select **CONT. YES** to test other current values or **CONT.NO** to exit the **TEST I** mode. On exiting this Menu, the normal current value depending on the flow rate and the programming of the current output function will be restored.

- **4 mA**
- **8 mA**
- **12 mA**
- **16 mA**
- **20 mA**

**3.1.1 NOM. DIA**
This value is factory set to **1" to 4"** and is not changeable.

**3.1.2 K-FACTOR**

Enter the primary constant k-factor value. This value is stamped on the instrument label in units of pulses/$m^3$.

**3.2.2 CODE 1**

Select **YES** if the password needs to be entered to access the complete menu. Use the 9-digit password to prevent configuration changes by an unauthorized person. Answering **NO** means the password is not required to enter the menu. (The password is normally available to the Forbes Marshall Service Engineer)

**3.2.4 LOCATION**

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

**3.3.4 SET GAIN**

The gain of the signal preamplifier can be changed to alter the sensitivity of the amplifier. The values available are:

**GAIN**

- 1
- 1.5
- 2
- 3
- 6
- 11
- 16

The factory set value is 11 for steam.

**3.5.1 FLUID**

This value is factory set to **STEAM** and is not changeable.

**3.5.2 MEDIUM**

This value is factory set to **SAT STEAM** and is not changeable.

**3.5.3 SAT. P/T**

This value is factory set to **SAT TEMP** and is not changeable.

**3.5.4 TEMP. OPR.** and **3.5.5 PRES. OPR.**

User must set only one of the above two process values. The other parameter value will be set, based on saturated steam and can be viewed on the display.

**3.5.4 TEMP. OPR.**

Enter the mean (average) operating temperature of the steam. The option available for units are.

**UNITS**

- DEG C
- DEG F
- KELVIN
- SPECIAL

To have SPECIAL unit, all the literal characters, coefficient and offset must be entered as shown in 1.1.2.
Base unit is Deg C

Here the selection of the Temperature Display can be done.
**DISP ON** displays whichever unit is selected
**OFF** No Temperature Display

**3.5.5 PRES. OPR.**
Enter the mean (average) operating pressure of the steam. The factory set unit for the temperature is **KG/CM2 G**.

**UNITS**

- KG/CM2 G
- IN HG G
- MM HG G
- MM WATER G
- PA G
- KPA G
- ATM G
- BAR G
- MILLI BARG
- PSI G
- LBF/FT2 G
- SPECIAL
- KG/CM2 ABS
- IN HG ABS
- MM HG ABS
- MM WAT. ABS
- PA ABS
- KPA ABS
- ATM ABS
- BAR ABS
- MILLI BARA
- PSI ABS
- LBF/FT2 A

**SPECIAL**
The base unit for pressure is Pascal. Enter all the characters, coefficients, and offset to obtain other units desired. Refer to the example for temperature given in Fct.3.5.4.

Here the selection of the Pressure Display can be done.
**DISP ON** displays the pressure in selected unit.
**OFF** No Pressure Display

**3.6.1 T-SENSOR**
If the inbuilt temperature sensor is to be used for density compensation, set this to **YES**. If the user selects **NO**, then the temperature value as indicated by (or set under) **3.5.4** will be used for density compensation.

## 6. Description of Program Menu Functions with configurator

### 6.1 Numerical format

- **Display of numerical values**
  Real (i.e. fractional) values are displayed in the first line of the display consisting of 8 digits. The number is displayed in the floating point format except the totalizer which is in an integer format (max. value... 4294967295) otherwise an exponent notation is used. See the examples given below.

  Floating format: 1234.5678, 100.00
  Exponent format: 1234E-10, 12345E12
  In most practical applications, it is very rare that the parameters need be displayed in the exponent format.

- **Input of numerical values**
  Entering a numeric value is very flexible. Enter a positive or a negative number in the floating point format or the exponent format as required or as convenient.
  Example: 1.2345678, -1234.567, 0.0001234
  123456E1, -12345E4, 1234E-4

## 6.2 Display

**Organization**: The display consists of the following two fields.

Field 1: 10-character, 5x7 dot matrix alphanumeric display used primarily for showing numeric values and also for messages.

Field 2: 10-character, 5x7 dot matrix alphanumeric display used for showing units, messages, etc.

**Programming**: The measurement mode settings are as follows:

- To allow the selection of the units for all the measured parameters
  Refer to ***Fct. 1.1.2, 3.5.4 and 3.5.5***
- Select display mode (cyclic/non-cyclic) and the error messages to/not to appear in the display cycle.
  Refer to Sect. ***Fct. 1.2.6 to 1.2.7***

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

**Programming mode**: The numeric line indicates the menu/functions level such as ***Fct. 1.1.1*** [current menu level digit blinks] and the alpha-numeric line indicates the menu/function title such as ***MEAS_INST.***

**Error indications**: A blinking bar at the upper left corner in the measurement mode indicates that error(s) are present. Error messages are displayed interleaved between changing from one display parameter to another, if ***Fct. 1.2.6 ERROR.MSG*** is ***YES***. For description of the error messages, refer to Sect. 4.1.5.

## 6.3 Flow range and meter size

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

The flow range for any given application is determined by the sizing of the meter for that application. When the flow rate exceeds the max flow, an error condition ***-HIGH FLOW-*** is generated. When the flow rate falls below the min. flow, an error condition ***-LOW FLOW-*** is generated. The sensor signal is weak at this condition and if the flow rate reduces further, signal related errors such as ***CHECK INST., LOW SIGNAL*** will occur.

## 6.4 Primary information

The primary data gives STEAM FLOW METER the basic information about the primary sensor. Use ***Fct. 3.1.1 NOMINAL.DIA*** for specification of the nominal DN/ANSI size and ***Fct. 3.1.2 K-FACTOR*** for the calibration factor of the primary.

## 6.5 Application information

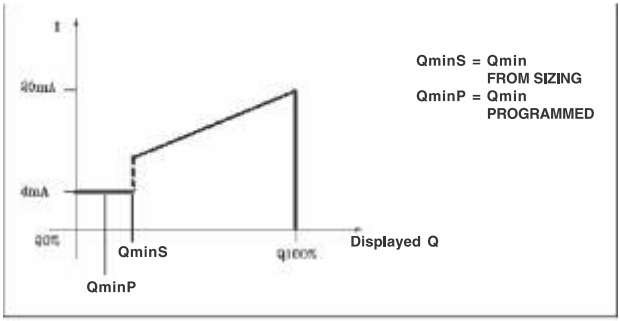
This is the data of the process medium, its operating conditions and physical properties. It consists of:

- Process medium ***Fct. 3.5.1 FLUID*** and ***Fct. 3.5.2 MEDIUM***
- Operating temperature and pressure conditions. Refer ***Fct. 3.5.4 TEMP. OPR*** and ***Fct. 3.5.5 PRES. OPR.***

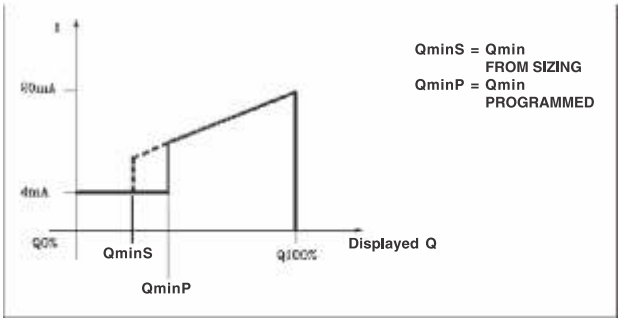
## 6.6 Current (analog) output I

The current output gives an analog representation of the flow rate. An output of 20 mA always corresponds to Max Flow 100% and that of 4 mA to Zero flow 0%. The current output between Zero flow 0% & min flow is 4 mA.

**FOR Qmin Programmed > = Qmin from Sizing**




FOR Qmin Programmed > = Qmin from Sizing




### TESTING OF CURRENT OUTPUT I

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

## 7. Technical Data

### 7.1 Technical Specifications

**Measuring system**

| | |
|---|---|
| Field of application | Flow measurement of Steam |
| Operating method / measuring principle | Shedding Frequency |
| **Measured value** | |
| Primary measured value: | Shedding frequency |
| Secondary measured value: | Operating volumetric flow, mass flow |

**Measuring accuracy**

| | |
|---|---|
| Accuracy | ±2% of reading for flow rate measurement |

**Operating conditions**

| | |
|---|---|
| Ambient temperature | -20 to 70°C |
| Operating temperature | -20…+210°C max |
| Process products | Dry Saturated Steam |
| Density Compensation | Internal for Saturated Steam |
| Product pressure limit | max. 17.5 bar |

**Installation requirements**

| | |
|---|---|
| Inlet run | ≥ 20 x DN |
| Outlet run: | ≥ 5 x DN |
| Dimensions and Weights | see table 8/1, 9/1 |

**Materials**

| | |
|---|---|
| Sensor | CF8 |
| Electronics casing | Aluminium |
| Sensor gasket | 1.4435 |

**Type of Meter**

| | |
|---|---|
| Sandwich version | DN 25, DN 40, DN 50, DN 80, DN 100 |

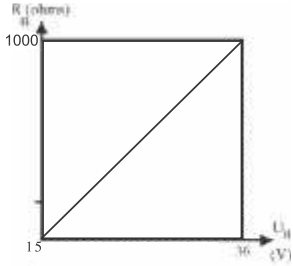
**Protection category**

| | |
|---|---|
| Protection category | IP 65 |

| | |
|---|---|
| **Approvals** | IBR |
| | EMI / EMC (Criteria A) as per IEC 61000-4-2 to 6 & 8 |
| | IP 65 |
| | Vibration IEC 60068-2-6 |
| | BUMP IEC 60068-2-29 |

## 7.2 Signal Convertor STEAM FLOW METER– Technical Data

| | |
|---|---|
| **Full-scale range** | Units text of 10-characters freely programmable. Conversion factor coefficient and intercept (offset) programmable for accepting any unit required. |
| **Power supply $U_B$ (2-wire)** | 15-36 V DC |
| Current output terminals, | 4-20 mA, DC, 2-wire |
| Maximum load resistance | $R_B = \frac{U_B - 15\ V}{20\ mA}$ |




**Mass flow measurement** Online for saturated steam 210 deg. C. Temperature sensor standard built-in with STEAM FLOW SENSOR primary.

Temp measurement Accuracy ± 0.3°C of measured value

| | |
|---|---|
| **Current output** | Operating data programmable, galvanically isolated from **power terminals** |
| Current | 4-20 mA corresponding to zero and the maximum flow value programmed |
| Accuracy | ± 0.02 mA |
| Temperature coefficient | ± 0.002 mA per °K change |
| Power Supply influence | ± 0.0001% of full-scale range for 15-36 V variation in the voltage |

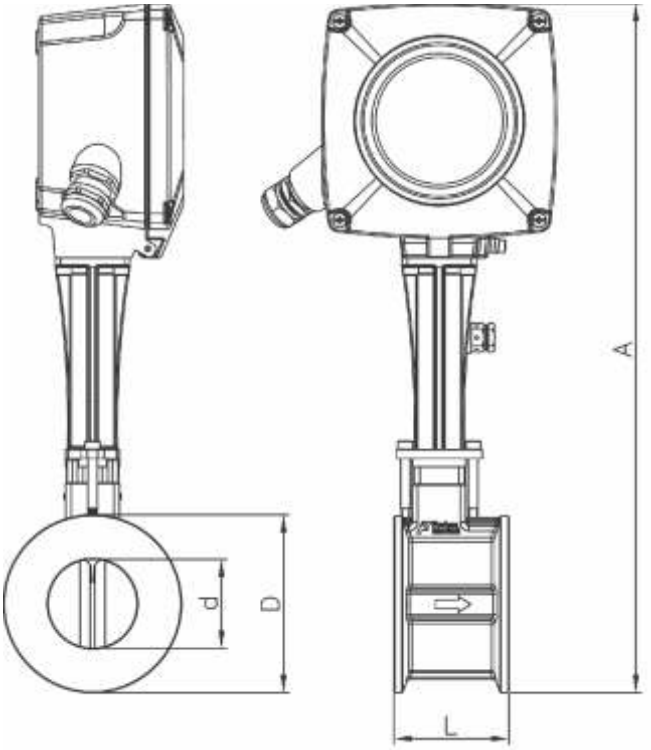
## 8. SteaMon Sizing Sheet

### for dry saturated steam

| P | T | ρ | Suitable meter size | | | | | | | | | | V* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mass flow Min - Max flow ( Kg/hr ) | | | | | Volumetric flow Min - Max flow ($m^3$/hr) | | | | | Min - Max (m/s) |
| g | °C | kg/$m^3$ | 1 inch | 1.5 inch | 2 inch | 3 inch | 4 inch | 1 inch | 1.5 inch | 2 inch | 3 inch | 4 inch | |
| 0.5 | 111.6 | 0.87 | 10 - 71 | 26 - 284 | 45 - 492 | 98 - 1077 | 169 - 1851 | 12 - 81 | 30 - 327 | 52 - 565 | 113 - 1239 | 194 - 2128 | 7.3 - 80.0 |
| 1.0 | 120.4 | 1.14 | 12 - 92 | 30 - 371 | 51 - 642 | 112 - 1407 | 193 - 2417 | 10 - 81 | 26 - 327 | 45 - 565 | 99 - 1239 | 170 - 2128 | 6.4 - 80.0 |
| 1.5 | 127.6 | 1.40 | 13 - 114 | 33 - 457 | 57 - 791 | 125 - 1732 | 214 - 2976 | 9 - 81 | 24 - 327 | 41 - 565 | 89 - 1239 | 153 - 2128 | 5.8 - 80.0 |
| 2.0 | 133.7 | 1.66 | 14 - 135 | 36 - 541 | 62 - 937 | 136 - 2053 | 233 - 3527 | 9 - 81 | 22 - 327 | 37 - 565 | 82 - 1239 | 141 - 2128 | 5.3 - 80.0 |
| 2.5 | 139.0 | 1.91 | 15 - 156 | 38 - 625 | 67 - 1082 | 146 - 2371 | 251 - 4074 | 8 - 81 | 20 - 327 | 35 - 565 | 76 - 1239 | 131 - 2128 | 4.9 - 80.0 |
| 3.0 | 143.8 | 2.17 | 16 - 177 | 41 - 708 | 71 - 1227 | 155 - 2687 | 267 - 4616 | 8 - 81 | 19 - 327 | 33 - 565 | 72 - 1239 | 123 - 2128 | 4.6 - 80.0 |
| 3.5 | 148.0 | 2.42 | 17 - 197 | 43 - 791 | 75 - 1370 | 164 - 3000 | 282 - 5155 | 7 - 81 | 18 - 327 | 31 - 565 | 68 - 1239 | 116 - 2128 | 4.4 - 80.0 |
| 4.0 | 152.0 | 2.67 | 18 - 218 | 46 - 874 | 79 - 1512 | 173 - 3313 | 296 - 5692 | 7 - 81 | 17 - 327 | 29 - 565 | 65 - 1239 | 111 - 2128 | 4.2 - 80.0 |
| 4.5 | 155.6 | 2.93 | 19 - 238 | 48 - 955 | 82 - 1654 | 180 - 3623 | 310 - 6225 | 6 - 81 | 16 - 327 | 28 - 565 | 62 - 1239 | 106 - 2128 | 4.0 - 80.0 |
| 5.0 | 158.9 | 3.17 | 20 - 259 | 50 - 1037 | 86 - 1795 | 188 - 3933 | 323 - 6757 | 6 - 81 | 16 - 327 | 27 - 565 | 59 - 1239 | 102 - 2128 | 3.8 - 80.0 |
| 5.5 | 162.1 | 3.42 | 21 - 279 | 51 - 1118 | 89 - 1936 | 195 - 4241 | 335 - 7287 | 6 - 81 | 15 - 327 | 26 - 565 | 57 - 1239 | 98 - 2128 | 3.7 - 80.0 |
| 6.0 | 165.1 | 3.67 | 21 - 299 | 53 - 1199 | 92 - 2077 | 202 - 4548 | 347 - 7815 | 6 - 81 | 15 - 327 | 25 - 565 | 55 - 1239 | 95 - 2128 | 3.6 - 80.0 |
| 6.5 | 167.9 | 3.92 | 22 - 319 | 55 - 1280 | 95 - 2217 | 209 - 4855 | 359 - 8342 | 6 - 81 | 14 - 327 | 24 - 565 | 53 - 1239 | 92 - 2128 | 3.4 - 80.0 |
| 7.0 | 170.5 | 4.17 | 23 - 339 | 57 - 1361 | 98 - 2356 | 215 - 5161 | 370 - 8868 | 5 - 81 | 14 - 327 | 24 - 565 | 52 - 1239 | 89 - 2128 | 3.3 - 80.0 |
| 7.5 | 173.0 | 4.41 | 23 - 359 | 58 - 1442 | 101 - 2496 | 222 - 5467 | 381 - 9393 | 5 - 81 | 13 - 327 | 23 - 565 | 50 - 1239 | 86 - 2128 | 3.2 - 80.0 |
| 8.0 | 175.5 | 4.66 | 24 - 379 | 60 - 1522 | 104 - 2635 | 228 - 5772 | 391 - 9917 | 5 - 81 | 13 - 327 | 22 - 565 | 49 - 1239 | 84 - 2128 | 3.2 - 80.0 |
| 8.5 | 177.8 | 4.91 | 25 - 399 | 62 - 1602 | 107 - 2774 | 234 - 6076 | 402 - 10440 | 5 - 81 | 13 - 327 | 22 - 565 | 48 - 1239 | 82 - 2128 | 3.1 - 80.0 |
| 9.0 | 180.0 | 5.15 | 25 - 419 | 63 - 1682 | 109 - 2913 | 239 - 6380 | 411 - 10963 | 5 - 81 | 12 - 327 | 21 - 565 | 46 - 1239 | 80 - 2128 | 3.0 - 80.0 |
| 9.5 | 182.1 | 5.40 | 26 - 439 | 65 - 1763 | 112 - 3052 | 245 - 6684 | 421 - 11485 | 5 - 81 | 12 - 327 | 21 - 565 | 45 - 1239 | 78 - 2128 | 2.9 - 80.0 |
| 10.0 | 184.2 | 5.64 | 26 - 459 | 66 - 1843 | 114 - 3190 | 251 - 6988 | 431 - 12006 | 5 - 81 | 12 - 327 | 20 - 565 | 44 - 1239 | 76 - 2128 | 2.9 - 80.0 |
| 10.5 | 186.1 | 5.89 | 27 - 479 | 68 - 1904 | 117 - 3296 | 256 - 7220 | 440 - 12406 | 5 - 81 | 11 - 323 | 20 - 560 | 43 - 1227 | 75 - 2108 | 2.8 - 79.2 |
| 11.0 | 188.0 | 6.13 | 27 - 499 | 69 - 1943 | 119 - 3364 | 261 - 7369 | 449 - 12661 | 4 - 81 | 11 - 317 | 19 - 549 | 43 - 1202 | 73 - 2065 | 2.8 - 77.6 |
| 11.5 | 189.9 | 6.38 | 28 - 519 | 70 - 1982 | 122 - 3431 | 266 - 7514 | 458 - 12911 | 4 - 81 | 11 - 311 | 19 - 538 | 42 - 1179 | 72 - 2025 | 2.7 - 76.1 |
| 12.0 | 191.7 | 6.62 | 29 - 539 | 72 - 2019 | 124 - 3496 | 271 - 7657 | 466 - 13157 | 4 - 81 | 11 - 305 | 19 - 528 | 41 - 1157 | 70 - 1987 | 2.6 - 74.7 |
| 12.5 | 193.4 | 6.86 | 29 - 559 | 73 - 2056 | 126 - 3560 | 276 - 7797 | 475 - 13397 | 4 - 81 | 11 - 300 | 18 - 519 | 40 - 1136 | 69 - 1952 | 2.6 - 73.4 |
| 13.0 | 195.1 | 7.11 | 30 - 579 | 74 - 2092 | 128 - 3623 | 281 - 7935 | 483 - 13634 | 4 - 81 | 10 - 294 | 18 - 510 | 40 - 1116 | 68 - 1918 | 2.6 - 72.1 |
| 13.5 | 196.8 | 7.35 | 30 - 599 | 75 - 2128 | 131 - 3684 | 286 - 8070 | 492 - 13866 | 4 - 81 | 10 - 289 | 18 - 501 | 39 - 1097 | 67 - 1886 | 2.5 - 70.9 |
| 14.0 | 198.4 | 7.60 | 31 - 619 | 77 - 2163 | 133 - 3745 | 291 - 8203 | 500 - 14095 | 4 - 81 | 10 - 285 | 17 - 493 | 38 - 1080 | 66 - 1855 | 2.5 - 69.7 |
| 14.5 | 199.9 | 7.84 | 31 - 639 | 78 - 2198 | 135 - 3805 | 296 - 8334 | 508 - 14320 | 4 - 81 | 10 - 280 | 17 - 485 | 38 - 1063 | 65 - 1826 | 2.4 - 68.6 |
| 15.0 | 201.5 | 8.09 | 32 - 659 | 79 - 2232 | 137 - 3864 | 300 - 8463 | 516 - 14542 | 4 - 81 | 10 - 276 | 17 - 478 | 37 - 1046 | 64 - 1798 | 2.4 - 67.6 |
| 15.5 | 202.9 | 8.33 | 32 - 678 | 80 - 2265 | 139 - 3922 | 305 - 8590 | 523 - 14760 | 4 - 81 | 10 - 272 | 17 - 471 | 37 - 1031 | 63 - 1771 | 2.4 - 66.6 |
| 16.0 | 204.4 | 8.58 | 33 - 698 | 81 - 2298 | 141 - 3979 | 309 - 8715 | 531 - 14975 | 4 - 81 | 10 - 268 | 16 - 464 | 36 - 1016 | 62 - 1746 | 2.3 - 65.6 |
| 16.5 | 205.8 | 8.82 | 33 - 718 | 83 - 2331 | 143 - 4035 | 313 - 8839 | 538 - 15187 | 4 - 81 | 9 - 264 | 16 - 457 | 36 - 1002 | 61 - 1722 | 2.3 - 64.7 |
| 17.0 | 207.2 | 9.07 | 33 - 738 | 84 - 2363 | 145 - 4091 | 318 - 8961 | 546 - 15397 | 4 - 81 | 9 - 261 | 16 - 451 | 35 - 988 | 60 - 1698 | 2.3 - 63.8 |
| 17.5 | 208.5 | 9.31 | 34 - 758 | 85 - 2395 | 147 - 4146 | 322 - 9081 | 553 - 15604 | 4 - 81 | 9 - 257 | 16 - 445 | 35 - 975 | 59 - 1676 | 2.2 - 63.0 |

* For 1 inch size, maximum velocity is limited to 50 m/s for all pressures

## 9. Dimensions & Weight




| SIZE | ϕd | ϕD | A | L | W(Kgs.) |
|---|---|---|---|---|---|
| 1" | 24 | 60 | 353 | 65 | 2.7 |
| 1 1/2" | 38 | 80 | 370 | 65 | 3.4 |
| 2" | 50 | 100 | 386 | 65 | 4 |
| 3" | 74 | 130 | 413 | 65 | 4.7 |
| 4" | 97 | 158 | 438.5 | 65 | 5.6 |

## 10. Function Checks

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

### 10.1 Current output check

***Fct. 2.1.2 TEST I*** can be used to test the current output function of STEAM FLOW CONVERTER. With this function, it is possible to generate following test values: ***8/12/16/20 mA.*** Refer to section 1.2 for the connection diagram.

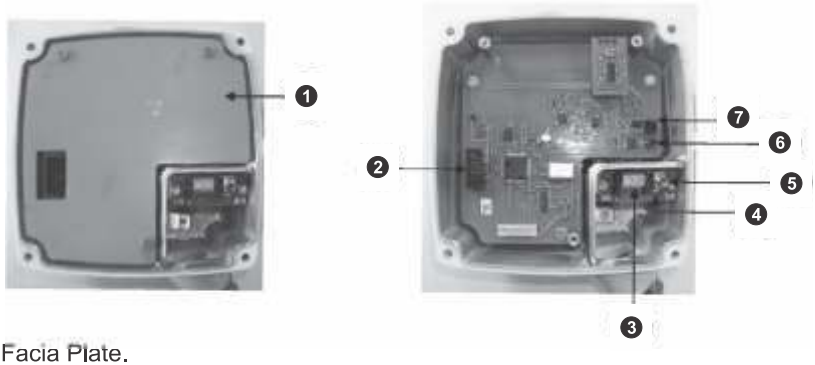
The current output electronics is factory-calibrated and should be within ± 0.02 mA. Otherwise re-calibration of the current output is necessary by Forbes Marshall Service.

## 10.2 Primary head functional checks

### 10.2.1 Steam sensor

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

1. remove the cover & facia plate from the electronic compartment. Ensure that the screw threads of the electronic compartment cover are well greased at all times!




1. Facia Plate.
2. Connector for Configurator.
3. +24 VDC Supply Terminals.
4. Power ON Indication.
5. Power ON Switch.
6. Temp. Sensor Input.
7. Piezo Sensor Input.

Do the following tests
Capacitance between the centre pin and each outer pin is from **3.3 to 4.3 nF**

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

2. Reassemble the converter in the reverse order

### 10.2.2 Temperature sensor

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

**Always switch OFF power source before commencing work!**

Follow the step 1 i.e. the same as in the above

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

## 11 Trouble-shooting

### 11.1 Trouble-shooting hints with configurator

It is assumed in this section that the flowmeter has already been installed. (for installation details, refer to Sections 2 and 3).

Given below are some trouble-shooting hints.

SYMPTOM: **A non-zero flow indicated when no actual flow in the pipe.**

- Mains interference due to improper earthing.

  The protective earth PE terminal should be properly grounded.
- Excessive mechanical vibration in the pipe. If so, support the pipeline near the flowmeter perpendicular to both the axis of the pipe and the axis of the bluff body.
- This problem can be solved by reducing the factory set gain.
  For e.g. Factory set gain for Steam is 11. This can be reduced to 6 for Steam.

**Caution:** By reducing the gain, the minimum measurable flow rate will go up by the factor which is approx. equal to square root of ratio of the gains. (old gains/ new gain). If the min. flow with reduced gain is above the min. flow which is required to be measured, then reducing the gain is not the permanent solution. Then the installation should be corrected and also the vibrations should be eliminated.

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

The display should normally indicate 0.0 flow rate, ***LOW FLOW*** and ***LOW SIGNAL*** errors when there is no flow in the pipe. The additional ***CHECK INSTALL*** error (flow rate = 0.0 or some steady or fluctuating value) is an indication of:

- Improper/inadequate earthing
- Excessive pipe vibration

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

- The Steam sensor cable disconnected or is not properly connected.
- Flow sensor faulty – some checks are given in Sect. 10.1 & 10.2
- Change the gain setting through the configurator.

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

- Check the programming of ***Fct. 3.1.2 K-Factor*** which should be same as that on the name plate
- The meter is not properly centered on the pipeline. The axis of the meter bore should be aligned with that of the pipe.
- Gaskets at the meter are protruding into the pipe bore. The gaskets must not project into the 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.
- The Steam 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 the 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. 2.10 for the allowable mounting positions.
- Insufficient upstream/downstream pipe lengths. Check that the upstream/downstream pipe lengths are of the correct minimum length as given in Sect. 2.11.
- Check the flow direction and the direction of the arrow on the primary.

# Addendum to Installation and Operating Instructions
# Precautions for "Safe and Desired" operation of SteaMon signal converter

## Do

- Ensure that sufficient Upstream and Downstream straight lengths are provided
- Check that the housing of the primary head is perfectly centred between the process flanges
- Provide proper supports to the pipeline at both ends of the meter to keep the pipe vibration level well below the maximum limit specified
- Ensure that the unit is installed in the process pipeline with fasteners securely and firmly tightened causing no leakage of the process fluid through the gaskets

## DO NOT

- Use the meter with the process fluid being bi-phase like Gases-Vapours with liquid droplets or solid particles.
- Install the meter where the process medium is pulsating with fluctuations in the process pressure
- Allow any of the parameters like Flow-Density-Pressure-Temperature-specified for the meter on the Nameplate and the Test and Guarantee Certificate
- Tamper with any parts of the primary head of the meter
- Replace the fasteners with any other make or brand without the consent of the manufacturer
- Allow the process pressure to exceed the pressure rating.

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