

**Wilson Engineering Services, PC**

902 Market Street  
Meadville, PA 16335  
Office: (814) 337-8223

**WES**  
Energy • Environment • Enterprise

PUC 100001540002

July 9, 2015

Deborah A. Howland  
Executive Director  
New Hampshire Public Utilities Commission  
21 South Fruit Street, Suite 10  
Concord, NH 03301-2429

**Re: Warwick Mills – Thermal REC Final Application**

Dear Ms. Howland,

Enclosed is Warwick Mills' final application for Renewable Energy Source eligibility for their facility in New Ipswich, NH. This facility completed its installation in June 2014, and has implemented a metering protocol to meet the metering accuracy requirements as per PUC 2506. Warwick Mills is seeking approval for an alternative metering method, with a minor change in the metering method, the details of which are included with this application.

The original application was for qualifying the facility through an Interim Alternative Metering Method for the period from January 1, 2014 through when the period for use of the Interim Method expires. Warwick Mills is submitting this revised application which describes ultimate metering protocol now in place.

WES thanks the PUC staff for all their efforts in making the Thermal RECs in NH a reality, and is pleased to submit this application. Please do not hesitate to call either Warwick Mills or me with any questions or clarifications on the application.

Sincerely,

Wilson Engineering Services, PC



Daniel A. Wilson, P.E.  
Vice President

**Attachments:**

- Warwick Mills Thermal REC Application



State of New Hampshire  
Public Utilities Commission  
21 S. Fruit Street, Suite 10, Concord, NH 03301-2429



**DRAFT**

APPLICATION FORM FOR

**RENEWABLE ENERGY SOURCE ELIGIBILITY FOR  
CLASS I THERMAL SOURCES WITH RENEWABLE THERMAL ENERGY CAPACITY GREATER THAN  
150,000 BTU/HR**

*Pursuant to New Hampshire Administrative Code [PUC 2500](#) Rules*

- Please submit one (1) original and two (2) paper copies of the completed application and cover letter\* to:

Debra A. Howland  
Executive Director  
New Hampshire Public Utilities Commission  
21 South Fruit Street, Suite 10  
Concord, NH 03301-2429

- Send an electronic version of the completed application and the cover letter electronically to [executive.director@puc.nh.gov](mailto:executive.director@puc.nh.gov).

\* The cover letter must include complete contact information and identify the renewable energy class for which the applicant seeks eligibility. Pursuant to PUC 2505.01, the Commission is required to render a decision on an application within 45 days of receiving a completed application.

If you have any questions please contact Barbara Bernstein at (603) 271-6011 or  
[Barbara.Bernstein@puc.nh.gov](mailto:Barbara.Bernstein@puc.nh.gov).

**Only facilities that began operation after January 1, 2013 are eligible.**

Is this facility part of a Commission approved aggregation?

Yes   X                        No           

Aggregator's Company Name:   WES Energy & Environment, LLC  

Aggregator Contact Information:   902 Market St, Meadville, PA 16335          (814) 337-8223

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## Attachment Labeling Instructions

**Please label all attachments by Part and Question number to which they apply (e.g. Part 3-7). For electronic submission, name each attachment file using the Owner Name and Part and Question number (e.g. Pearson Part 3-7).**

## Part 1. General Application Information

Please provide the following information:

### Applicant

Name: Charlie Howland

Mailing Address: 22 Woodcock Run

Town/City: Temple State: NH Zip Code: 03084

Primary Contact: Marcel Alix

Telephone: (603) 291-1056 Cell: (603) 731-7101

Email Address: malix@warwickmills.com

### Facility

Name: Warwick Mills Inc.

Physical Address: 301 Turnpike Road

Town/City: New Ipswich State: NH Zip Code: 03071

If the facility does not have a physical address, the Latitude: \_\_\_\_\_ & Longitude \_\_\_\_\_

### Installer

Name: Warwick Mills Inc.

Installer License Number: N/A

Mailing Address: 301 Turnpike Road

Town/City: New Ipswich State: NH Zip Code: 03071

Primary Contact: Marcel Alix

Telephone: (603) 291-1056 Cell: (603) 731-7101

Email Address: malix@warwickmills.com

If the equipment was installed by the facility owner, check here:

### Facility Operator

If the facility operator is different from the owner, please provide the following:

Name: Marcel Alix

Facility Operator Telephone Number: (603) 731-7101

## Independent Monitor

Name: Wayne G. Fillion, P.E.  
Mailing Address: 66 Jackson Street  
Town/City: Littleton State: NH Zip Code: 03561  
Primary Contact: Wayne G. Fillion, P.E.  
Telephone: (603) 444-6578 Cell: \_\_\_\_\_  
Email Address: wfillion@yeatonassociates.com

## NEPOOL/GIS Asset ID and Facility Code

***In order to qualify your facility's thermal energy production for RECs, you must register with the NEPOOL – GIS. Contact information for the GIS administrator follows:***

**James Webb**  
**Registry Administrator, APX Environmental Markets**  
224 Airport Parkway, Suite 600, San Jose, CA 95110  
Office: 408.517.2174  
[jwebb@apx.com](mailto:jwebb@apx.com)

Mr. Webb will assist you in obtaining a GIS facility code and an ISO-New England asset ID number.  
GIS Facility Code # NON47531 Asset ID # \_\_\_\_\_

1. Has the facility been certified under another non-federal jurisdiction's renewable portfolio standards?  
Yes  No

If you selected yes, *please provide proof of certification in the form of an attached document as Attachment 1-1.*

2. *Attach any supplementary documentation that will help in classification of the facility as Attachment 1-9*

## Part 2. Technology Specific Data

### All Technologies

Fuel type (solar, geothermal, or biomass): biomass  
Rated Thermal Capacity (Btu/hr): 6.8 mmBtu/hr  
Date of initial operation using renewable fuels: 6/25/2014

## Biomass

If a thermal biomass facility, provide proof of New Hampshire Department of Environmental Services approval that the facility meets the emissions requirements set forth in Puc 2500, as Attachment 2-1.

## Solar Thermal

If a solar thermal facility, please provide the Solar Rating and Certification Corporation rating based on Mildly Cloudy C (kBtu/day): \_\_\_\_\_

## Geothermal

If a geothermal facility, please provide the following:

The coefficient of performance (COP): \_\_\_\_\_

The energy efficiency ratio of the system: \_\_\_\_\_

## Part 3. Metering and Measurement of Thermal Energy and REC Calculations

This section deals with the thermal metering system including methods for calculation and reporting useful thermal energy. **A copy of PUC 2506.04 of the RPS rules is included as Appendix A.**

Using the table below, identify the thermal metering system or custom components (e.g., heat meters, flow meters, pressure and temperature sensors) used to measure the useful thermal energy and enter the accuracy of measurement for the entire system:

System or Component	Product name	Product Manufacturer	Model No.
Steam Flow Meter	Steam Flow Meter	Spirax Sarco	TVA, 3"
Pressure Sensor	Pressure Sensor	Prosense	SPT25-20-0100D
Temperature Sensor	Type K ungrounded	Omega	CAIN-14U-24-NHX
Temperature Sensor	Type K ungrounded	Omega	88402K
Total System Accuracy (Percent)			

See Attachments 3-1 and 3-3 for more information on these components

Attach component specification sheets (Accuracy, Operating Ranges) as Attachment 3-1.

Attach a simple schematic identifying the location of each sensor that is part of the metering system as Attachment 3-2.

Check the applicable standard for meter accuracy prescribed in Puc 2506.04 among the six choices below (compliance with Puc 2506.04 shall be certified by a professional engineer licensed by the state of New Hampshire and in good standing):

*If the facility is a large thermal source using a liquid or air based system, check the method that applies:*

- A. Installation and use of heat meters capable of meeting the accuracy provisions of European Standard EN 1434 published by CEN, the European Committee for Standardization. The heat meter shall have the highest Class flow meter that will cover the design flow range at the point of measurement and a temperature sensor pair of Class 5K or lower.
- B. Installation and use of meters that do not comply with European Standard EN 1434, provided that the manufacturers' guaranteed accuracy of the meters is  $\pm 5.0\%$  or better,
- C. Use of an alternative metering method approved pursuant to Puc 2506.06.

*If the facility is a large thermal source using a steam-based system, check the method that applies:*

- D. Installation and use of meters with accuracy of  $\pm 3.0\%$  or better.
- E. Installation and use of meters with system accuracy that do not meet D but are  $\pm 5\%$  or better.
- F. Use of an alternative metering method approved pursuant to Puc 2506.06.   
please see Attachment 3-4 for description of alternative metering method

Please summarize the manufacturer's recommended methods and frequency for metering system calibration and provide reference for source document (e.g. owners/operators manual):

please see Attachment 3-3

REC Calculation Discount factor for meter accuracy (Enter 0 if no discount is required): 0 %

If the meters used to measure useful thermal energy comply with the accuracy of the European Standard EN 1434 for liquid systems or use of meters with accuracy of  $\pm 3.0\%$  or better for steam systems enter zero, for all other systems enter the sum total of the manufacturer's guaranteed accuracy of the meters used or the accuracy of the alternative method approved pursuant to Puc 2506.06.

REC Calculation Discount factor for operating energy and thermal energy losses: 2.0 %

*Check the method used for determining the operating energy and thermal loss factor among the choices below:*

**Default Factor**

- For sources using solar thermal technology, the discount factor shall be 3.0% of the useful thermal energy produced;
- For sources using geothermal technology, the discount factor shall be 3.6% of the useful thermal energy produced;
- For sources using thermal biomass renewable energy technology, the discount factor shall be

2.0% of the useful thermal energy produced.

**Actual Metering**

- Include a simple schematic identifying the operating energy and thermal energy losses and placement of the meters.

### **Interim Alternative Metering Method**

Until such time as the Puc 2500 rule is finalized applicants may utilize an alternative method as described in the draft rule 2505.02(e)(2):

*In lieu of the information required by Puc 2505.02 (d) (11) through (13), a thermal source may submit a detailed explanation of the methodology used to measure and calculate thermal energy and an attestation by a professional engineer that is licensed in New Hampshire and in good standing that the methodology for measuring useful thermal energy and calculating certificates is sound.*

**Part 4. Affidavits**

**Owners Affidavit**

The following affidavit must be completed by the owner attesting to the accuracy of the contents of the application pursuant to PUC 2505.02 (b) (14).

**AFFIDAVIT**

I, Marcel P. Alix have reviewed the contents of this application and attest that it is accurate and is signed under the pains and penalties of perjury.

Applicant's Signature Marcel P. Alix Date 7/9/15

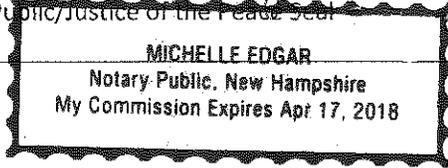
Applicant's Printed Name Marcel P. Alix

Subscribed and sworn before me this 9 Day of July (month) in the year 2015

County of Hillsborough State of New Ipswich

Michelle Edgar  
Notary Public/Justice of the Peace Seal

My Commission Expires \_\_\_\_\_



**NH Professional Engineer Affidavit**

**AFFIDAVIT**

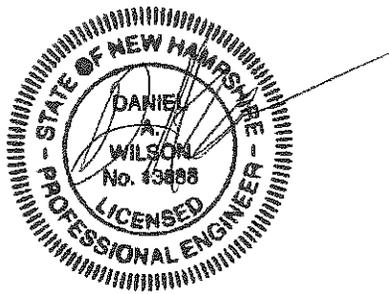
I, Daniel A. Wilson attest that this facility meets the requirements of the thermal REC eligibility requirements of Puc 2500, including the thermal metering and measurement methodologies and standards and REC calculation methodologies.

Professional Engineer's Signature D. Wilson Date 7/9/15

Professional Engineer's Printed Name Daniel A. Wilson

NH Professional Engineer License Number 13688

PE Stamp





The State of New Hampshire  
**DEPARTMENT OF ENVIRONMENTAL SERVICES**



**Thomas S. Burack, Commissioner**

February 27, 2015

Debra A. Howland  
 Executive Director and Secretary  
 New Hampshire Public Utilities Commission  
 21 South Fruit Street, Suite 10  
 Concord, NH 03301-2429

**Re: Recommended Certification as a Class I Thermal Renewable Energy Source  
 Warwick Mills (WM)  
 New Ipswich, NH**

Dear Ms. Howland:

The New Hampshire Department of Environmental Services (DES) was contacted by Charles Niebling of Innovative Natural Resource Solutions on behalf of Warwick Mills (WM) requesting certification of the wood-fired boiler located at WM as a Class I thermal renewable energy source. DES recommends that the Public Utilities Commission (PUC) grant approval to WM as a Class I thermal renewable energy source eligible to generate renewable energy certificates. A summary of the facility description, DES's review of particulate and NOx emission rates and monitoring requirements, and a recommendation for approval are presented below.

**Facility Description**

**Facility Name:** Warwick Mills (WM)  
**Facility Location:** 301 Turnpike Road  
 New Ipswich, NH 03071  
**Gross Nameplate Capacity:** 8 MMBtu/hr  
**Temporary (construction) Permit:** TP-0088  
**Re-Issue Date:** February 6, 2014  
**Primary Fuel:** Biomass as defined in RSA 125-C:2, III-a

**Particulate Matter (PM) Emissions**

By definition, "*Thermal biomass renewable energy technologies*", requires units rated between 3 and 30 MMBtu/hr gross heat input to meet a particulate matter (PM) emission rate limit of 0.10 pounds/million British thermal units (lb/MMBtu).

**Emission Rate Confirmation**

A PM emission test has been performed for WM, and the test results have been reported in writing to DES. The emission test was performed for PM in accordance with the pre-test protocol

reviewed by DES. The results of the emission test indicate the actual PM emission rate in lb/MMBtu meets the required 0.10 lb/MMBtu.

### **Nitrogen Oxides (NOx) Emissions**

By definition, "*Thermal biomass renewable energy technologies*", requires units rated less than 100 MMBtu/hr gross heat input to meet best management practices (BMP) as established by DES for control of nitrogen oxides (NOx) emissions. DES herein establishes BMP as conducting boiler tune-ups annually and conducting combustion efficiency testing initially and annually demonstrating results equal to or greater than 99%.

### **BMP Confirmation**

WM measured actual carbon monoxide (CO) and carbon dioxide (CO<sub>2</sub>) concentrations in the exhaust gas using a hand-held portable analyzer (or alternative method approved by DES) to determine combustion efficiency using the following equation:

$$CE(\%) = 100 \times CO_2 / (CO_2 + CO)$$

Where:

CE = combustion efficiency

CO<sub>2</sub> = % by volume of carbon dioxide in the flue gas, and

CO = % by volume of carbon monoxide in the flue gas.

The results of the initial test indicate that the combustion efficiency meets the required 99%. DES anticipates that WM will be able to meet ongoing BMP annually.

### **Conclusion and Recommendation for Approval**

DES believes that WM currently meets, and annually will meet, the requirements to be certified as a Class I - New Biomass thermal renewable energy source. DES recommends that the PUC certify WM as a Class I thermal renewable energy source eligible to generate thermal renewable energy certificates, because WM has demonstrated that the following conditions have been met:

- 1) WM emits PM at an average rate less than or equal to 0.10 lb/MMBtu; and
- 2) WM currently maintains CE equal to or greater than 99%.

If you have any questions, please contact me at [joseph.fontaine@des.nh.gov](mailto:joseph.fontaine@des.nh.gov) or (603) 271-6794.

Sincerely



Joseph T. Fontaine  
Trading Programs Manager  
Air Resources Division

## Part 3 Table

Item	System or Component	Location	Product Name	Product Manufacturer	Model No.	Operating Range	Maximum Error
1	Steam Flow Meter	FT-1, FT-2, FT-3	Flowmeter for saturated steam	Spirax Sarco	TVA, 3"	97 - 4859 lbs/hr at 44 psig, see attached	0.2% for 2-10% of max flow 2.0% for 10-100% of max flow
2	Pressure Transducer	PT-1	Pressure Transmitter	ProSense	SPT25-20-0100D	0 to 100 psig	+/- 0.50% of full range
3	Condensate Temp. Sensor	TT-2	Type K Thermocouple Probe	Omega	KQXL-14U-6	32°F to 2,282°F	+/- 4°F or 0.4%
4	Steam Temp. Sensor	TT-1	Type K Thermocouple Probe	Omega	88402K	32°F to 752°F	+/- 4°F or 0.4%

### Attachment 3-1 (Component Specification Sheets)

Attachments with accuracy and operating ranges are provided and organized by item number from the above table.



# TVA Flowmeter for Saturated Steam Service

### Description

The Spirax Sarco TVA flowmeter is designed for use on saturated steam only and operates on the target principle, by measuring the force produced on a moving cone by the fluid flow. This strain is then converted into density compensated mass flowrate and is transmitted via a single loop powered 4-20 mA and pulsed output. TVA flowmeters also incorporate a totalised flow function and RS 232 Modbus communications.

### Sizes and pipe connections

2", 3" and 4"

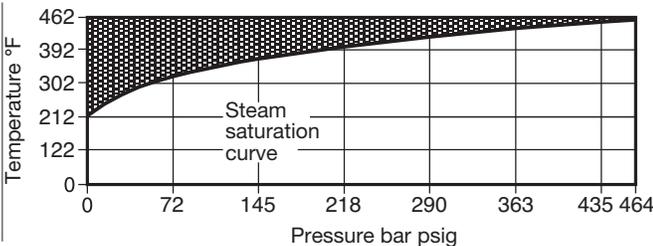
The TVA flowmeter is of wafer design, suitable for fitting between the following flanges: ASME (ANSI) B 16.5 Class 150 and Class 300

#### Note:

The Spirax Sarco TVA flowmeter should be installed in pipework manufactured to BS 1600 or ASME (ANSI) / ASME B 36.10 Schedule 40.

For systems with different standards/schedules, spool pieces manufactured from BS 1600 or ASME (ANSI) / ASME B 36.10 Schedule 40 pipe should be used. If this is not possible, please contact Spirax Sarco.

### Pressure/temperature limits

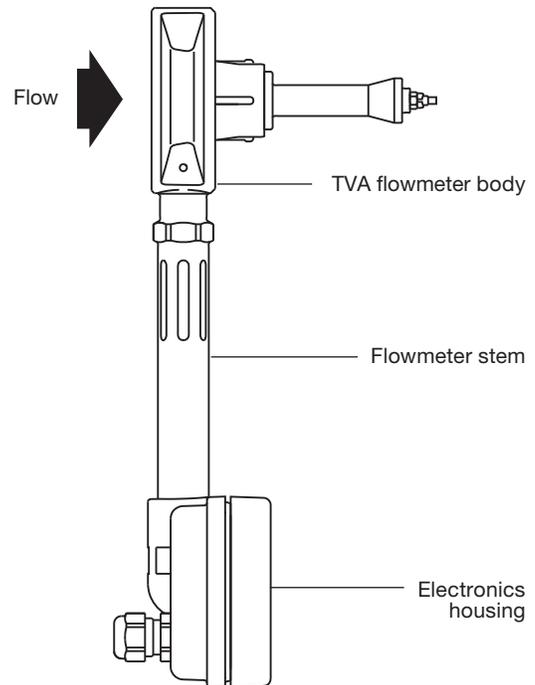


The product should not be used in this region due to software limitations.

Maximum design pressure	464 psig @ 462°F
Maximum design temperature	462°F
Minimum design temperature	32°F
Maximum operating pressure	Horizontal flow 464 psig @ 462°F Vertical flow 101 psig @ 338 F
Minimum operating pressure	9 psig
Maximum operating temperature (saturation)	462°F
Minimum operating temperature	32°F
<b>Note:</b> For lower operating temperatures consult Spirax Sarco	
Maximum electronics ambient temperature	131°F
Maximum electronics humidity level	90% RH (non-condensing)
Designed for a maximum cold hydraulic test pressure of	754 psig

### Materials

<b>Flowmeter body</b>	Stainless steel S.316 1.4408 CF8M
<b>Internals</b>	431 S29/S303/S304/S316
<b>Spring</b>	Inconel X750 or equivalent
<b>Flowmeter stem</b>	Stainless steel 300 series
<b>Electronics housing</b>	Aluminium LM25



### Technical data

IP rating	IP65 with correct cable glands
Power supply	Loop powered nominal 24 Vdc
Outputs	4 - 20 mA (proportional to mass flow) Pulsed output ( $V_{max}$ 28 Vdc $R_{min}$ 10 kΩ)
Communication port	Modbus EIA 232C (RS 232)

### Performance

The TVA flowmeter has inbuilt electronics which give a density compensated output. An LCD display is incorporated within the electronics head. The M750 display unit can be used to provide a remote display function if required, utilising the 4 - 20 mA output.

#### System uncertainty, to 95% confidence (2 STD): (in accordance with ISO 17025)

±2% of measured value from 10% to 100% of maximum rated flow.  
±0.2% FSD, from 2% to 10% of maximum rated flow.

Turndown : up to 50:1

As the TVA flowmeter is a self contained unit, the uncertainty quoted is for the complete system. Many flowmeters claim a pipeline unit uncertainty and for a true system uncertainty, the individual uncertainty values of any associated equipment, such as DP cells, need to be added to the pipeline value.

### Pressure drop

The pressure drop across the TVA is nominally 300 ins water gauge at maximum rated flow for the 2", and 200 inches water gauge for the 3" and 4".

Local regulation may restrict the use of this product below the conditions quoted. Limiting conditions refer to standard connections only.

In the interests of development and improvement of the product, we reserve the right to change the specification.

# TVA

## Flowmeter for Saturated Steam Service

### Dimensions/weights (approximate) in inches and pounds

Size	A	B	C	D	E	Weight
2"	1.4	4.1	12.7	6.3	2.6	5.9
3"	1.8	5.4	13.1	6.3	2.6	9.7
4"	2.4	6.4	13.5	8.5	2.6	16.0

### TVA flowmeter flow capacities and pressure drops

Flowmeter Type	Maximum QE US gal/min	Maximum DP Wg
2"	80	300
3"	203	200
4"	317	200

### Sizing the TVA flowmeter for saturated steam (lb/hr)

#### (Horizontal orientation)

Maximum flowrates in lb/hr at different pressures (psig).

#### Notes:

- 1 - Maximum steam flowrates are calculated at maximum differential pressure.
- 2 - For vertical capacities please contact Spirax Sarco.
- 3 - The table below is a guide only.

Size	Steam pressure psig	15	44	73	102	145	174	218	290	363	435	464	psig
2"	Maximum flow	1,365	1,894	2,297	2,637	3,075	3,336	3,695	4,228	4,707	5,148	5,311	lb/hr
	Minimum flow	26	37	46	53	62	66	73	84	95	104	132	lb/hr
3"	Maximum flow	3,501	4,859	5,895	6,768	7,895	8,565	9,482	10,851	12,081	13,215	13,633	lb/hr
	Minimum flow	71	97	117	134	159	172	190	216	243	265	284	lb/hr
4"	Maximum flow	5,456	7,573	9,187	10,547	12,304	13,347	14,778	16,912	18,827	20,593	21,246	lb/hr
	Minimum flow	108	152	183	212	247	267	295	337	377	412	425	lb/hr

### Safety information, installation and maintenance

For full details see the Installation and Maintenance Instructions (IM-P337-51 and IM-P337-52) supplied with the product.

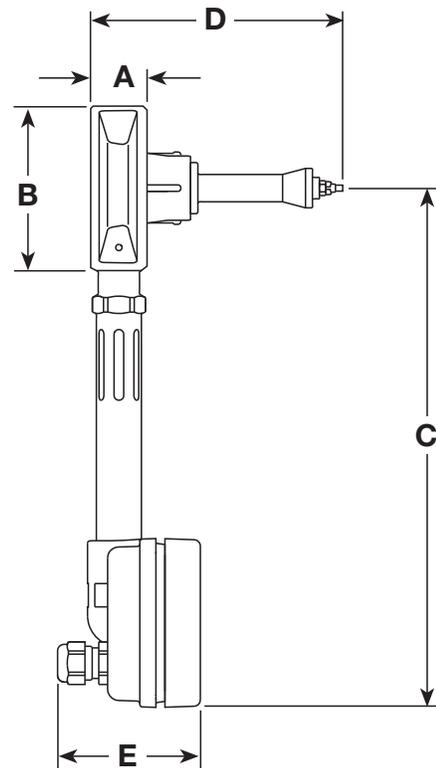
#### The following main points are given for guidance only:

1. The TVA flowmeter should be mounted with a minimum of 6 straight pipe diameters upstream and 3 downstream. No valves, fittings or cross sectional changes are permitted within these pipe lengths. Where an increase in nominal pipe diameter is required, upstream of the flowmeter, the length of straight pipe should be increased to 12 diameters. Similarly, where a Spirax Sarco TVA is installed downstream of two 90 degree bends in two planes, a pressure reducing valve or a partly open valve, 12 upstream pipe diameters should be allowed.
2. It is important that the internal upstream and downstream diameters of pipe are smooth. Ideally seamless pipes should be used and there should be no intrusive weld beads on the internal diameter. It is also recommended that slip-on flanges are used to avoid this.
3. Care should be taken to install the TVA flowmeter concentrically in the line. If this is not done, flow measurement errors may occur.
4. The TVA flowmeter can be installed in any orientation up to a line pressure of 101 psig.
5. As for all steam flowmetering installations, good basic steam engineering practices should be followed:
  - Correct line drainage through adequate trapping.
  - Good alignment and support of associated pipework.
  - Line size changes achieved by the use of eccentric reducers.
  - Do not lag (insulate) the TVA body or the mating flanges.

### How to order

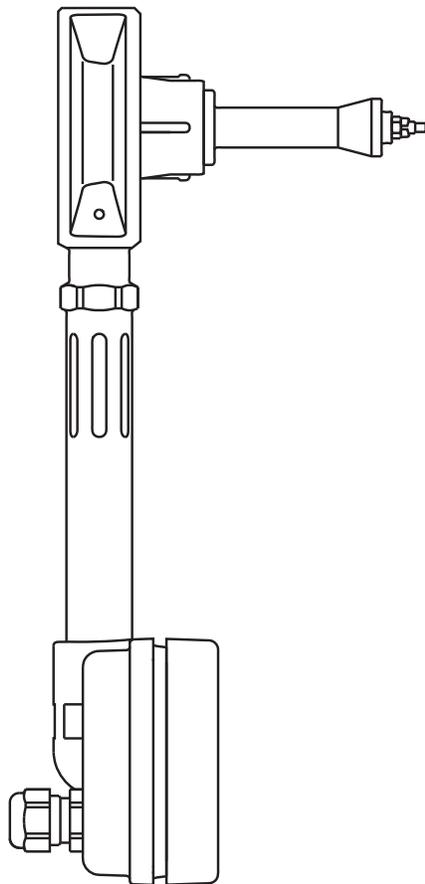
**Example:** 1 off Spirax Sarco 4" TVA flowmeter for installation between ASME (ANSI) B 16.5 Class 150 flanges for use on saturated steam at 145 psig - Maximum flow 12,304 lb/hr.

**Note:** For details of the optional remote display see the relevant Spirax Sarco M750 literature.





**TVA Flowmeter  
for Saturated Steam Service**  
Installation and Maintenance Instructions



1. Safety information
2. General product information
3. Installation
4. Commissioning
5. Operation
6. Maintenance
7. Spare parts
8. Fault finding
9. Settings table

# 1. Safety information

Safe operation of this unit can only be guaranteed if it is properly installed, commissioned and maintained by a qualified person (see Section 1.11) in compliance with the operating instructions. General installation and safety instructions for pipeline and plant construction, as well as the proper use of tools and safety equipment must also be complied with.

## Manufacturer:-

Spirax Sarco Ltd  
Charlton House  
Charlton Kings  
Cheltenham  
Glos  
GL53 8ER

The product is designed and constructed to withstand the forces encountered during normal use. Use of the product for any other purpose, or failure to install the product in accordance with these Installation and Maintenance Instructions, could cause damage to the product, will invalidate the CE marking, and may cause injury or fatality to personnel.

## EMC directive

The product complies with the Electromagnetic Compatibility Directive 2004/108/EC. A technical file with a reference number of 'UK Supply TVA flowmeter' supports the Spirax Sarco claim that the product complies with the requirements of the Directive and the product can be used in Class A (heavy industrial) and Class B (domestic/commercial areas).

The following conditions should be avoided as they may create interference above the heavy industrial limits if:

- The product or its wiring is located near a radio transmitter.
- Cellular telephones and mobile radios may cause interference if used within approximately 1 metre (39") of the product or its wiring. The actual separation distance necessary will vary according to the surroundings of the installation and the power of the transmitter.

If this product is not used in the manner specified by this IMI, then the protection provided may be impaired.

## 1.1 Intended use

Referring to the Installation and Maintenance Instructions, name-plate and Technical Information Sheet, check that the product is suitable for the intended use/application. The product listed complies with the requirements of the European Pressure Equipment Directive 97/23/EC, carries the CE mark when so required. The product falls within the following Pressure Equipment Directive categories:

Product	Group 1 Gases	Group 2 Gases	Group 1 Liquids	Group 2 Liquids
TVA flowmetering system DN50 to DN100	-	1	-	-

- i) The product has been specifically designed for use on saturated steam only which is in Group 2 of the above mentioned Pressure Equipment Directive.

- ii) Check material suitability, pressure and temperature and their maximum and minimum values. If the maximum operating limits of the product are lower than those of the system in which it is being fitted, or if malfunction of the product could result in a dangerous overpressure or overtemperature occurrence, ensure a safety device is included in the system to prevent such over-limit situations.
- iii) Determine the correct installation situation and direction of fluid flow.
- iv) Spirax Sarco products are not intended to withstand external stresses that may be induced by any system to which they are fitted. It is the responsibility of the installer to consider these stresses and take adequate precautions to minimise them.
- v) Remove protection covers from all connections and protective film from all nameplates, where appropriate, before installation on steam or other high temperature applications.

## **1.2 Access**

Ensure safe access and if necessary a safe working platform (suitably guarded) before attempting to work on the product. Arrange suitable lifting gear if required.

## **1.3 Lighting**

Ensure adequate lighting, particularly where detailed or intricate work is required.

## **1.4 Hazardous liquids or gases in the pipeline**

Consider what is in the pipeline or what may have been in the pipeline at some previous time. Consider: flammable materials, substances hazardous to health, extremes of temperature.

## **1.5 Hazardous environment around the product**

Consider: explosion risk areas, lack of oxygen (e.g. tanks, pits), dangerous gases, extremes of temperature, hot surfaces, fire hazard (e.g. during welding), excessive noise, moving machinery.

## **1.6 The system**

Consider the effect on the complete system of the work proposed. Will any proposed action (e.g. closing isolation valves, electrical isolation) put any other part of the system or any personnel at risk?

Dangers might include isolation of vents or protective devices or the rendering ineffective of controls or alarms. Ensure isolation valves are turned on and off in a gradual way to avoid system shocks.

## **1.7 Pressure systems**

Ensure that any pressure is isolated and safely vented to atmospheric pressure. Consider double isolation (double block and bleed) and the locking or labelling of closed valves. Do not assume that the system has depressurised even when the pressure gauge indicates zero.

## **1.8 Temperature**

Allow time for temperature to normalise after isolation to avoid the danger of burns and consider whether protective clothing (including safety glasses) is required.

## **1.9 Tools and consumables**

Before starting work ensure that you have suitable tools and/or consumables available. Use only genuine Spirax Sarco replacement parts.

## **1.10 Protective clothing**

Consider whether you and/or others in the vicinity require any protective clothing to protect against the hazards of, for example, chemicals, high/low temperature, radiation, noise, falling objects, and dangers to eyes and face.

## **1.11 Permits to work**

All work must be carried out or be supervised by a suitably competent person. Installation and operating personnel should be trained in the correct use of the product according to the Installation and Maintenance Instructions.

Where a formal 'permit to work' system is in force it must be complied with. Where there is no such system, it is recommended that a responsible person should know what work is going on and, where necessary, arrange to have an assistant whose primary responsibility is safety.

Post 'warning notices' if necessary.

## **1.12 Handling**

Manual handling of large and/or heavy products may present a risk of injury. Lifting, pushing, pulling, carrying or supporting a load by bodily force can cause injury particularly to the back. You are advised to assess the risks taking into account the task, the individual, the load and the working environment and use the appropriate handling method depending on the circumstances of the work being done.

## **1.13 Residual hazards**

In normal use the external surface of the product may be very hot. If used at the maximum permitted operating conditions the surface temperature of some products may reach temperatures of 250°C (482°F).

Many products are not self-draining. Take due care when dismantling or removing the product from an installation (refer to 'Maintenance instructions').

## **1.14 Freezing**

Provision must be made to protect products which are not self-draining against frost damage in environments where they may be exposed to temperatures below freezing point.

## **1.15 Disposal**

Unless otherwise stated in the Installation and Maintenance Instructions, this product is recyclable and no ecological hazard is anticipated with its disposal providing due care is taken.

## **1.16 Returning products**

Customers and stockists are reminded that under EC Health, Safety and Environment Law, when returning products to Spirax Sarco they must provide information on any hazards and the precautions to be taken due to contamination residues or mechanical damage which may present a health, safety or environmental risk. This information must be provided in writing including Health and Safety data sheets relating to any substances identified as hazardous or potentially hazardous.

This manual explains how to install, commission and maintain the Spirax Sarco TVA flowmeter for use on saturated steam.

### 2.1 Product description

The Spirax Sarco TVA flowmeter is designed to reduce the cost of flowmetering and is used as an accurate means to measure saturated steam flowrates and record total flow. The TVA flowmeter is a stand alone device and requires no other equipment, such as differential pressure transmitters, pressure sensors, etc. to calculate mass flowrates of saturated steam.

### 2.2 Equipment delivery and handling

#### Factory shipment

Prior to shipment, the Spirax Sarco TVA flowmeter is tested, calibrated and inspected to ensure proper operation, including the wired communications.

#### Receipt of shipment

Each carton should be inspected at the time of delivery for possible external damage. Any visible damage should be recorded immediately on the carrier's copy of the delivery slip. Each carton should be unpacked carefully and its contents checked for damage.

If it is found that some items have been damaged or are missing, notify Spirax Sarco immediately and provide full details. In addition, damage must be reported to the carrier with a request for their on-site inspection of the damaged item and its shipping carton.

#### Storage

If a flowmeter is to be stored prior to installation, the environmental storage conditions should be at a temperature between 0°C and 55°C (32°F and 131°F), and between 10% and 90% relative humidity (non-condensing).

### 2.3 Sizes and pipe connections

DN50, DN80 and DN100

The TVA flowmeter is of a wafer design, suitable for fitting between the following flanges:

EN 1092 PN16, PN25 and PN40

BS 10 Table H

ASME B 16.5 Class 150 and 300

Korean Standard KS 20.

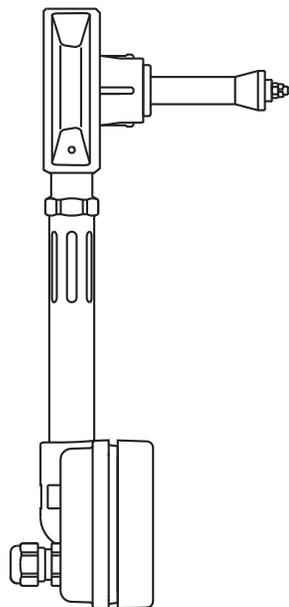
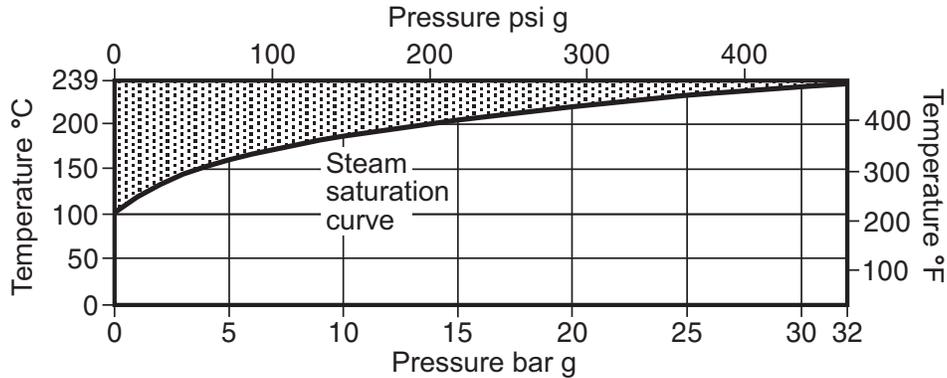


Fig. 1 TVA flowmeter

## 2.4 Pressure/temperature limits



 The product should not be used in this region due to the limitations of the software.

PMA	Maximum allowable pressure @ 239°C (462°F)	Saturated steam 32 bar g (464 psi g) otherwise as the specified flange rating	
TMA	Maximum allowable temperature	239°C	(462°F)
	Minimum allowable temperature	0°C (non-freezing)	(32°F non-freezing)
* PMO	Maximum operating pressure for saturated steam service	Horizontal flow	32 bar g (464 psi g)
		Vertical flow	7 bar g (101 psi g)
	Minimum operating pressure	0.6 bar g	(8.7 psi g)
TMO	Maximum operating temperature	239°C	(462°F)
	Minimum operating temperature	0°C (non-freezing)	(32°F non-freezing)
	Maximum electronics ambient temperature	55°C	(131°F)
	Maximum electronics humidity level	90% RH (non-condensing)	
	Maximum $\Delta$ PMX differential pressure	The pressure drop across the TVA flowmeter at the maximum rated flow is nominally 750 m bar (300 inches wg) for the DN50, and 500 m bar (200 inches wg) for the DN80 and DN100	
	Cold hydraulic test pressure of:	52 bar g	(754 psi g)

### \* Important note

**Caution:** If the electronic housing is mounted at an angle of 45° (or more) from the vertically downward position the PMO (maximum operating pressure) must be limited to 7 bar g (101 psi g).

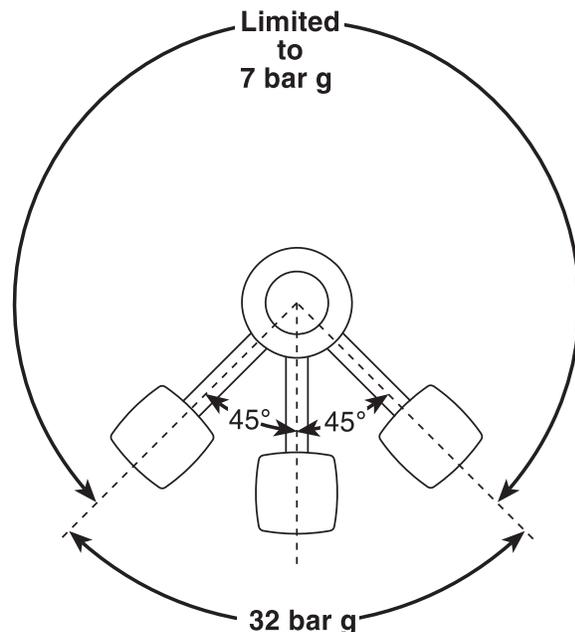


Fig. 2 Installation limiting conditions

## 2.5 Technical data

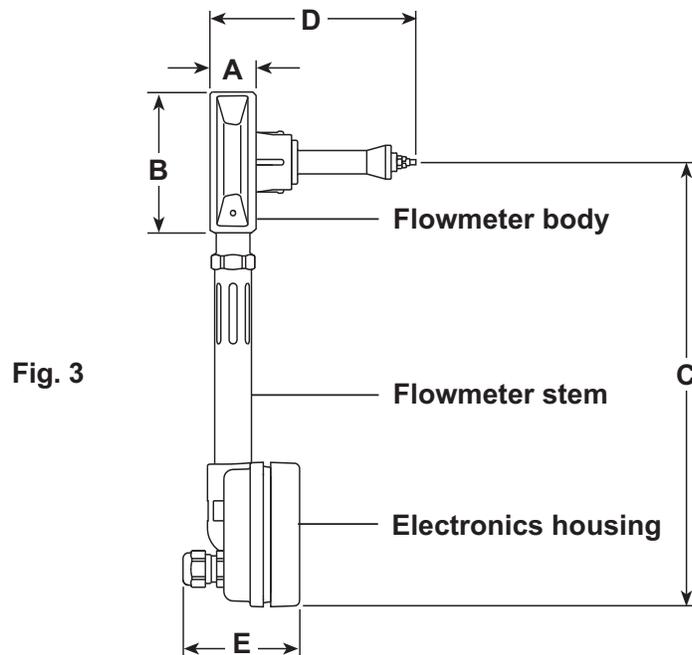
IP rating	IP65 with correct cable glands.
Power supply	Loop powered nominal 24 Vdc
Outputs	4-20 mA (proportional to mass flow) Pulsed output $V_{\max}$ 28 Vdc, $R_{\min}$ 10 k $\Omega$ , $V_{\text{on}}$ 0.7 $V_{\max}$
Communication port	EIA 232C 15 m limit - See Section 4.11
Performance	System uncertainty to ISO 17025 (95% confidence to 2 STD)
	$\pm 2\%$ of reading over the range of 10% to 100% of maximum rated flow
	$\pm 0.2\%$ FSD from 2% to 10% of maximum rated flow Turndown: up to 50:1

## 2.6 Electrical connections

Electrical connections	M20 x 1.5
------------------------	-----------

## 2.7 Materials

Flowmeter body	Stainless steel 1.4408 CF8M
Internals	431 S29/S303/S304/S316
Spring	Inconel® X750 or equivalent
Flowmeter stem	Stainless steel 431 S29
Electronics housing	Aluminium alloy LM 25



## 2.8 Dimensions/weights (approximate) in mm and kg

Size	A	B	C	D	E	Weight
DN50	35	103	322	160	65	2.67
DN80	45	138	334	160	65	4.38
DN100	60	162	344	215	65	7.28

# 3. Installation

**Note:** Before actioning any installation observe the 'Safety information' in Section 1. To meet its specified accuracy and performance it is essential that the following installation guidelines are followed carefully. For steam applications sound steam engineering practices should be followed, including the use of separators. The installation must conform to all relevant construction and electrical codes.

**CAUTION:** If the electronic housing is mounted at an angle of 45° (or more) from the vertically downward position the PMO (maximum operating pressure) must be limited to 7 bar g (101 psi g) - see Figure 4.

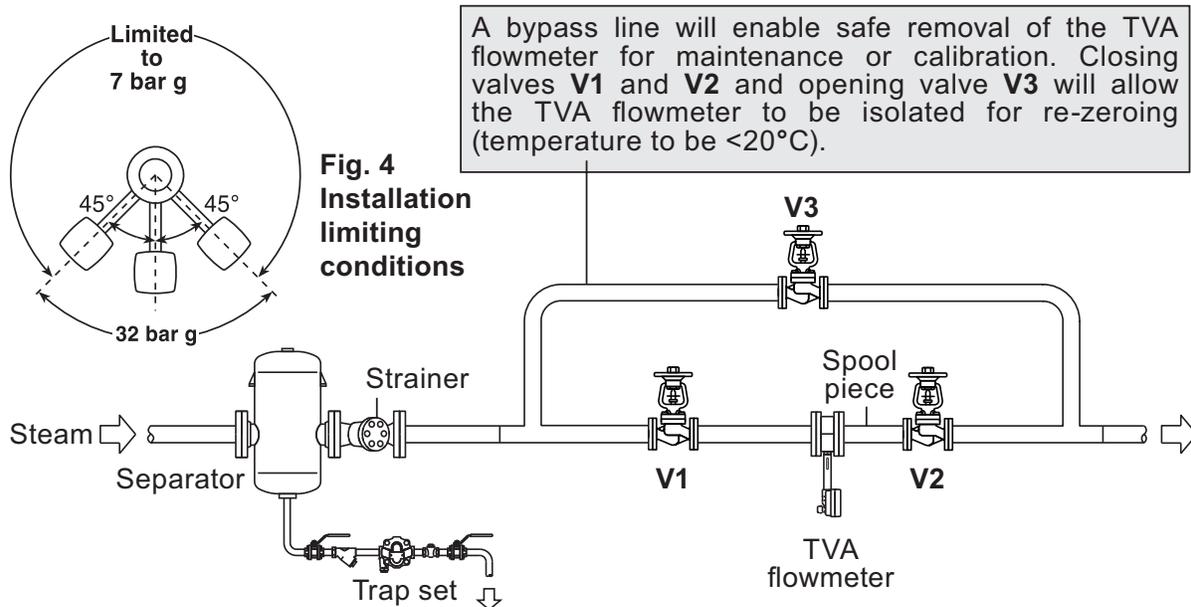


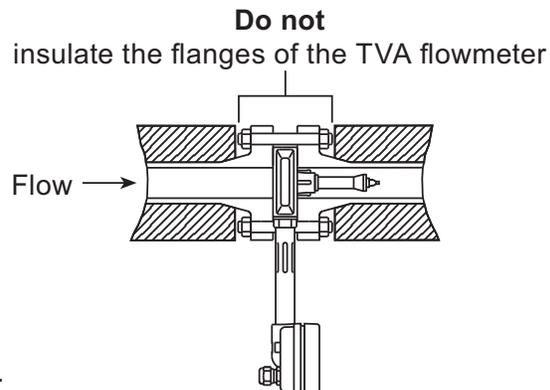
Fig. 5 Typical installation

## 3.1 Environmental conditions

The flowmeter should be located in an environment that minimises the effects of heat, vibration, shock and electrical interference. (Pressure / temperature limits are detailed in Section 2.4).

**CAUTION:** Do not lag (insulate) the TVA flowmeter or mating flanges as this may result in excessive temperatures in the electronics. Exceeding specified temperature limits will invalidate the warranty, adversely effect the performance and may damage the TVA flowmeter, see Figure 6.

Fig. 6 Pipeline insulation



### Other considerations

Be sure to allow sufficient clearance for:

- Installation of conduit/wiring.
- Removal of the electronics enclosure cover.
- Viewing of the display. **Note** electronics housing and display can be rotated.

**Warning:** Do not install the flowmeter outdoors where it can be subjected to adverse weather conditions like driving rain or where it can freeze.

### 3.2 Mechanical installation

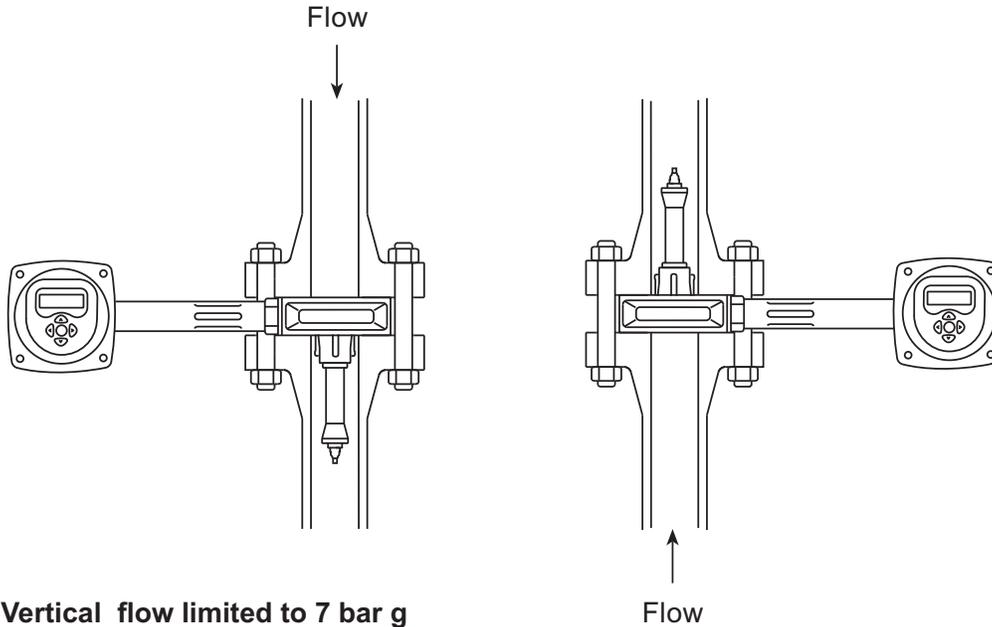
**Warning:** Do not alter the adjustment nut at the back of the TVA flowmeter shaft, as this will affect the flowmeters calibration.

#### Orientation

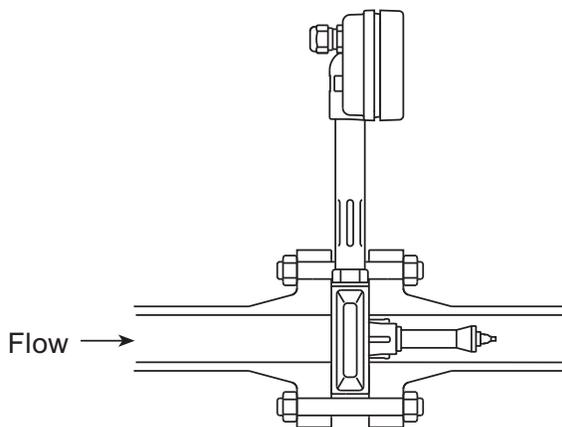
The TVA flowmeter can be installed in any orientation when the pressure is below 7 bar g (101 psi g), see Figures 7, 8 and 9.

When the pressure is above 7 bar g the TVA flowmeter must be installed in a horizontal pipe, with the electronics housing below the body, see Figure 9.

**Note:** The TVA flowmeter operates with flow in one direction only. It is not intended for use with bi-directional flow. The TVA flowmeter is clearly marked with a direction of flow arrow.

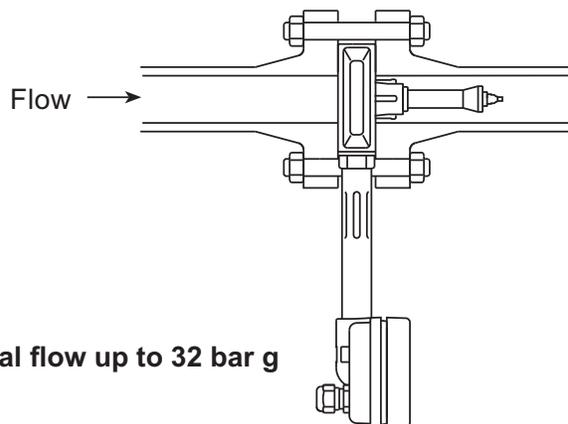


**Fig. 7 Vertical flow limited to 7 bar g**



**Fig. 8 Horizontal flow limited to 7 bar g**

**CAUTION:** If the electronic housing is mounted at an angle of 45° (or more) from the vertically downward position the PMO (maximum operating pressure) must be limited to 7 bar g (101 psi g) - see Figure 4.



**Fig. 9 Horizontal flow up to 32 bar g**

### Rotating the electronics enclosure

The electronics housing can be rotated 270° to enable sufficient clearance for installation. To rotate the electronics housing, loosen the 6 mm grub screw located on the rear of the electronics housing (see Figure 10). The electronics housing can now be rotated to the required position.

When the electronics housing has been located into the correct position retighten the grub screw to a torque of 1.3 N m (11.5 lbf in).

**Warning: Do not loosen / remove the stem from the main body of the unit.**

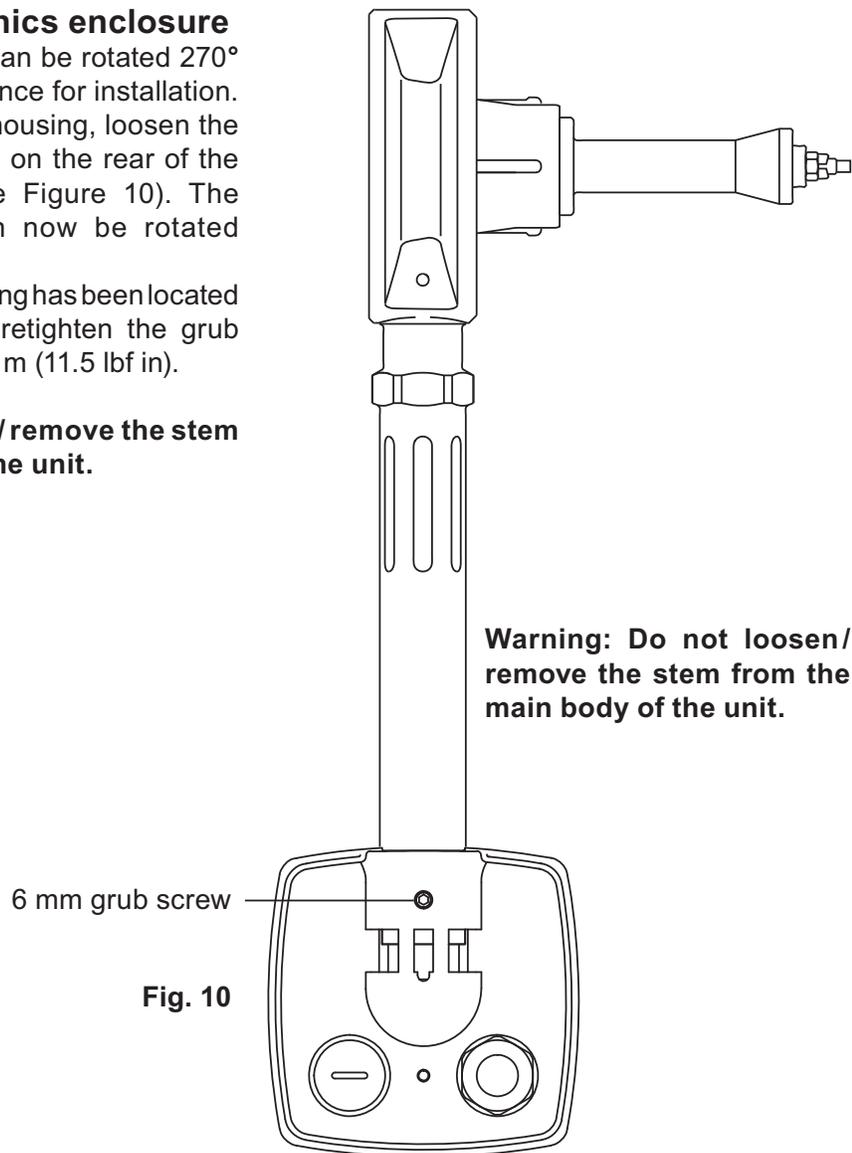


Fig. 10

### Upstream/downstream pipework

The TVA flowmeter should be installed in pipework manufactured to BS 1600, ASME B 36.10 Schedule 40 or EN 10216-2 / EN 10216-5 equivalent, which corresponds to the following pipeline internal diameters:

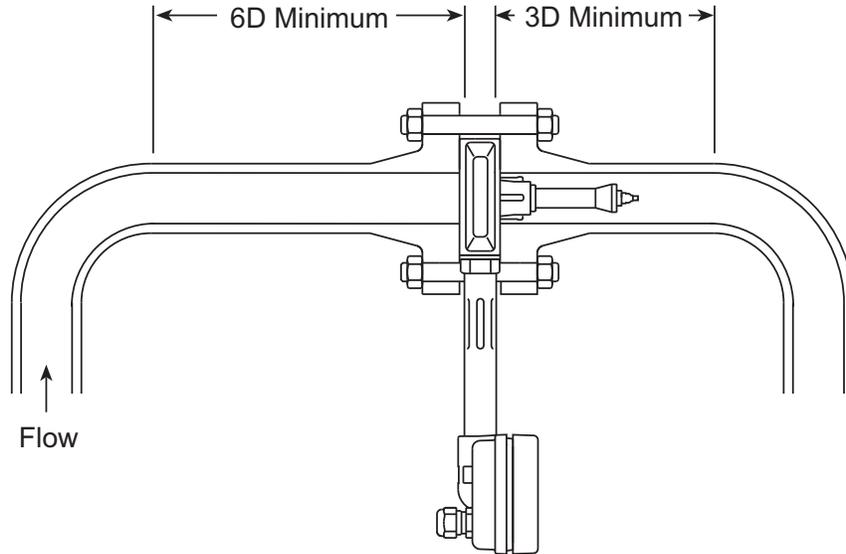
Nominal diameter	Nominal internal diameter
50 mm	52 mm
80 mm	77 mm
100 mm	102 mm

For different pipe standards/schedules, if the flowmeter is being operated at the extreme of its published maximum range, and maximum accuracy is required, downstream spool pieces manufactured from pipe to the above standard should be used.

It is important that the internal upstream and downstream diameters of pipe are smooth. Ideally seamless pipes should be used and there should be no intrusive weld beads on the internal diameter. It is recommended that slip-on flanges be used to avoid any intrusive weld beads on the internal diameter of the pipe.

**Note:** See Figures 11 to 14 for other considerations which need to be noted before determining the correct installation location.

The TVA flowmeter normally only requires a minimum of 6 pipe diameters upstream and 3 downstream of clear straight pipe. These dimensions assume a measurement from a single 90° bend (see Figure 11).

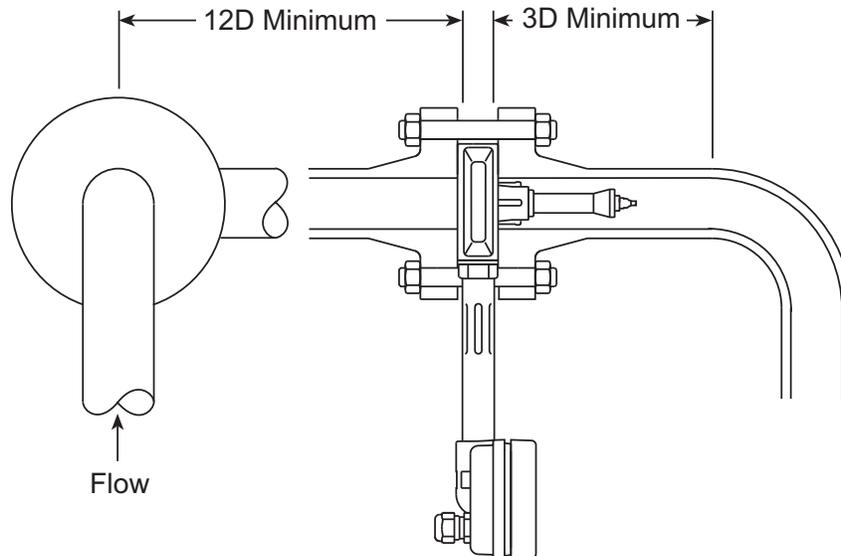


**Fig. 11** Flow

If any of the following configurations are present upstream of the TVA flowmeter:

- Two right angled bends in two planes.
- Pressure reducing valve.
- Partly open valve.

Then it is recommended that the minimum upstream clear pipework is doubled to 12 diameters (See Figure 12).



**Fig. 12** Flow

Avoid installing the TVA flowmeter downstream of an actuated valve as rapid cycling of the valve could give rise to inaccurate results or damage the flowmeter. See Figure 13. In configurations where there is more than one rapid acting pressure reducing valve close coupled, the TVA flowmeter should be installed with a minimum of 25 upstream and 3 downstream pipe diameters away from the valves. Safety valves should also be as far away as possible from the flowmeter - at least 25D.

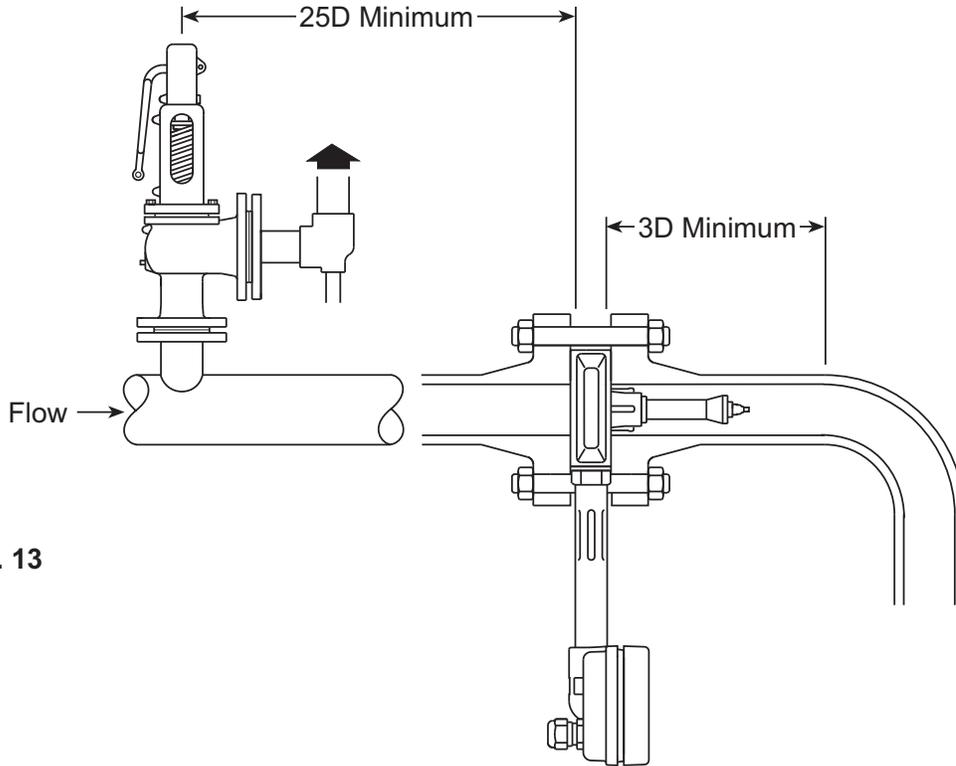


Fig. 13

To install the TVA flowmeter pipeline unit into existing pipework and for aiding possible flowmeter removal, a spool piece can be fabricated locally to the dimensions given below (see Figure 14).

Size	DN50	DN80	DN100
Dimension A	180 mm 7.1 in	240 mm 9.5 in	300 mm 11.8 in

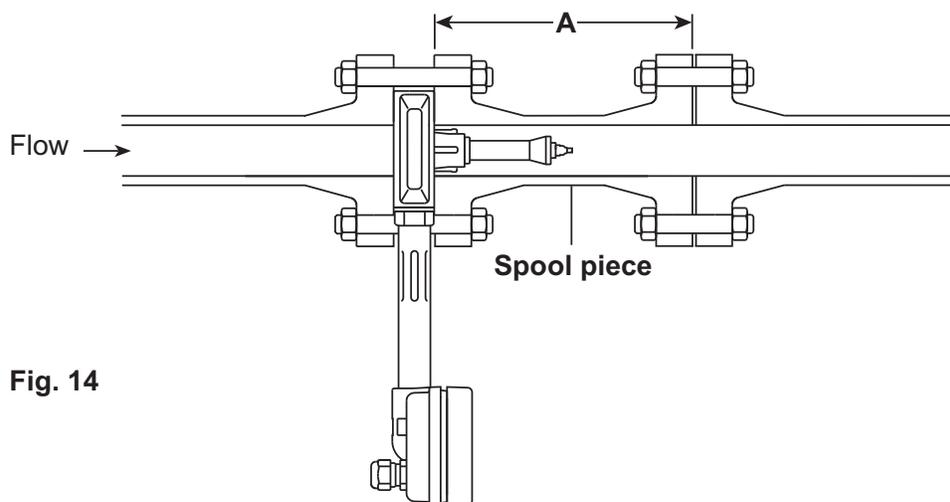
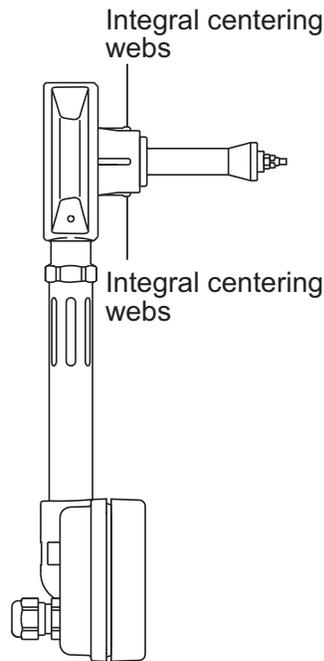


Fig. 14

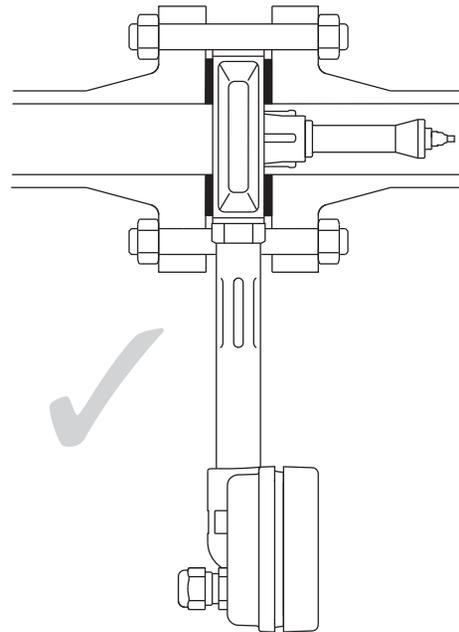
### Location in pipework

Bolt ring gaskets having the same internal diameter of the pipework are recommended. This will prevent possible inaccuracies being created by the gasket protruding into the pipe.

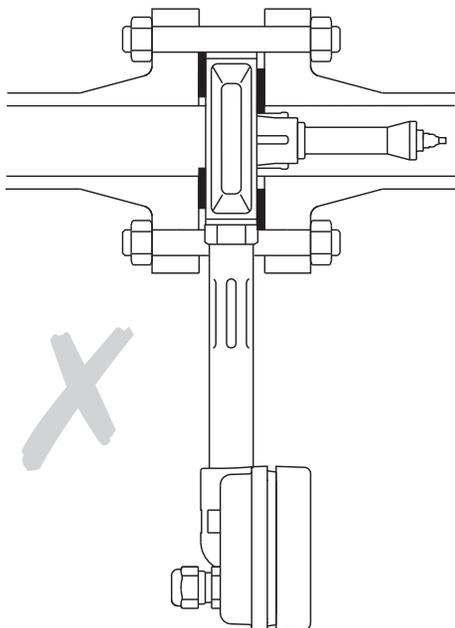
It is important that the TVA flowmeter is located centrally in the pipework as any eccentricity may cause inaccurate readings. The TVA flowmeter has integral centering webs, which locate on the internal diameter of the pipework (see Figure 15).



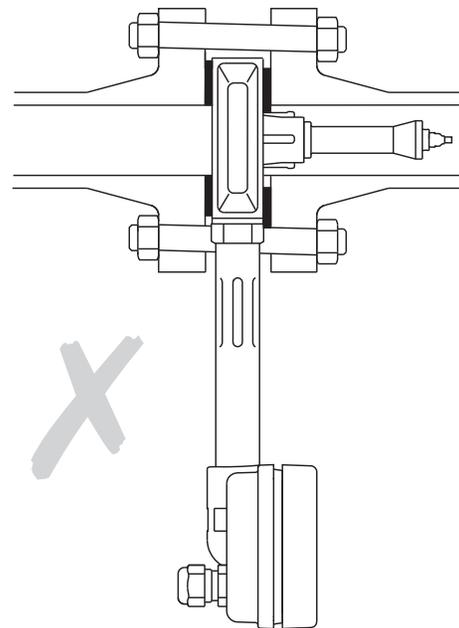
**Fig. 15 Integral centering webs**



**Fig. 16 Gaskets fitted correctly**



**Fig. 17 Gaskets fitted incorrectly**



**Fig. 18 Gaskets and pipe offline, fitting incorrectly**

### 3.3 Electrical installation

The TVA flowmeter is a loop powered device. This Section describes loop wiring and shows typical conductor terminations (The EIA 232C (RS 232) wiring is discussed in Section 4.11, page 28). It also considers the effect of connecting additional equipment (e.g. recorder, loop powered display) to the loop.

#### Wiring the TVA flowmeter

The wiring terminals can be accessed by removing the end cap of the enclosure. A typical loop wiring diagram is shown in Figure 19.

If an M750 display unit is purchased from Spirax Sarco for use with the TVA flowmeter, the M750 must be configured to the flow of the TVA flowmeter @ 20 mA. If the TVA flowmeter 4 - 20 mA output is rescaled (see Section 4.6.1), it is important that the 20 mA input valve on the M750 is also rescaled.

#### Notes:

**The flowmeter must be earthed. The TVA is supplied with a 1 metre earthing lead attached to a 4 mm threaded hole at the rear of the enclosure close to the 20 mm conduit holes. An alternative earth cable can also be attached.**

**Please ensure all paint is removed to ensure a low resistance connection is made. The earth cable should be at least 1.5 mm sq and the use of a crimp is recommended. Remove the silica gel from the enclosure after commissioning.**

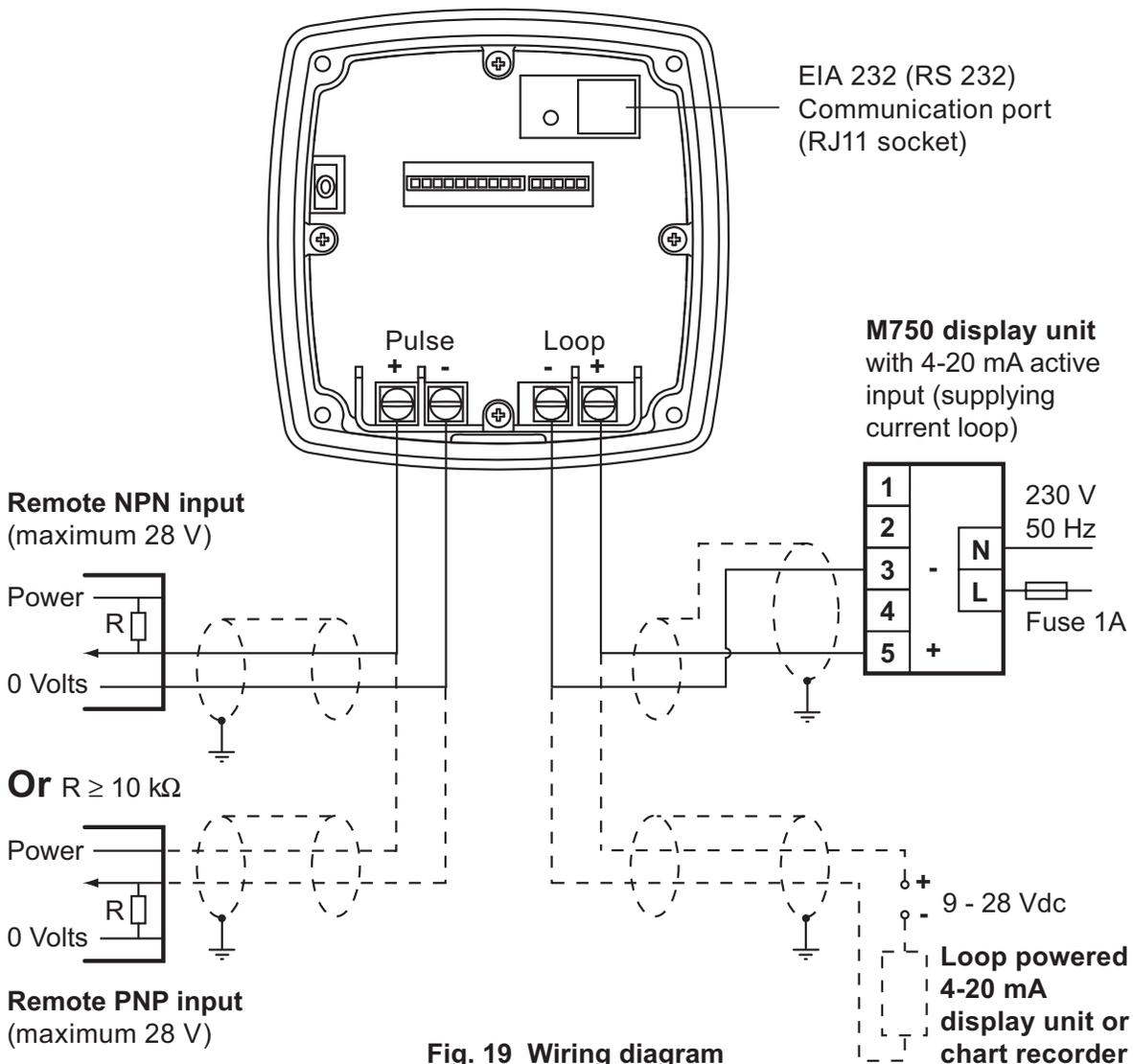


Fig. 19 Wiring diagram

## Power supply requirements

A nominal 24 Vdc is needed to power the flowmeter. However, the TVA flowmeter will operate correctly as long as the power supply is in the range shown in Figure 20. A single, stand-alone, supply may be capable of powering several transmitters. It can be mounted in a control room or in the field, but cannot be on the same loop. Follow the power supply manufacturer's recommendations with regard to mounting and environmental considerations.

The graph (Figure 20) shows the range of power supply voltages and loop resistances over which the TVA flowmeter is capable of operating. The loop resistance includes all the wiring.

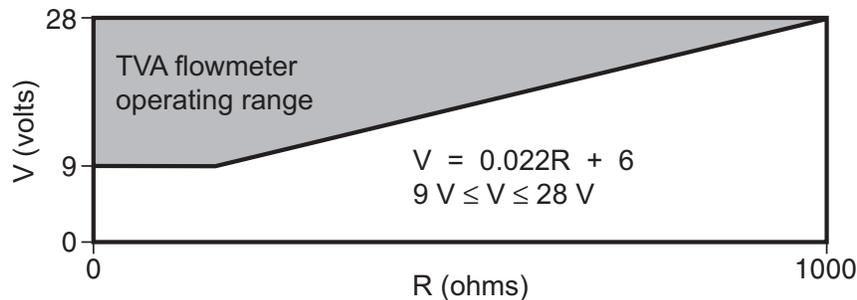


Fig. 20

## Cable length

Generally the maximum cable length between the TVA flowmeter and the power supply is 300 m (984 ft).

However the actual cable length is governed by the number of network devices, the total resistance of the network and the cable capacitance.

**Suggested cable type:** for both loop and pulse should be shielded twisted pairs, each core, seven stranded wire with cross sectional area of 0.5 mm<sup>2</sup>.

Cable glands suitable for M20 x 1.5 to EN 50262 / IP68 are recommended.

The cable gland / body torque setting is 5 N m (3.68 lbf ft).

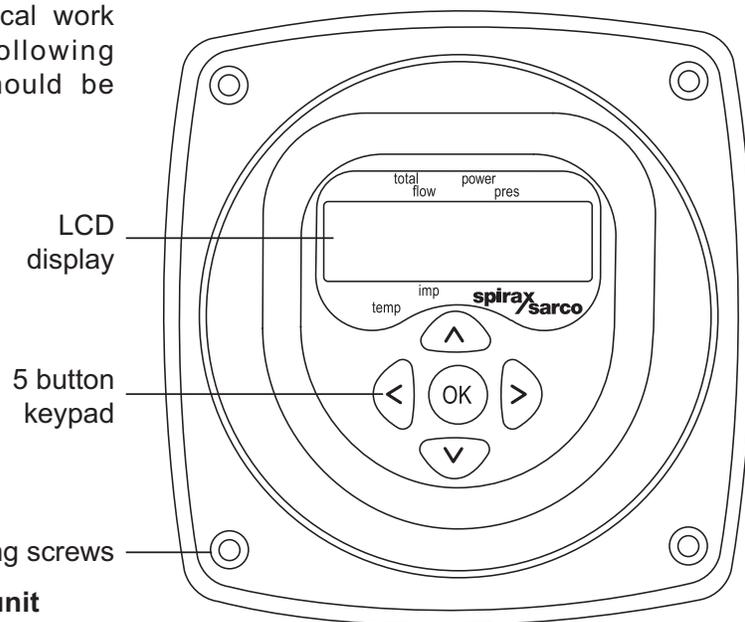
The gland nut torque setting (with cable fitted) is 5 N m (3.68 lbf ft).

# 4. Commissioning

After all mechanical and electrical work has been completed, the following commissioning instructions should be followed.

**The TVA flowmeter should be commissioned with the flow through the unit isolated.**

**Note:** The TVA flowmeter is factory set to display data in metric units. To commission the TVA to display imperial units see Section 4.4.2, page 24.



**Fig. 21 TVA flowmeter display unit**

All commissioning is carried out through the display unit installed behind the front end cap of the TVA flowmeter enclosure. The display unit consists of a small LCD display and a 5 button key pad.

As all the commissioning settings are stored in a non-volatile memory, it is possible to connect a 9 V PP3 battery to the TVA flowmeter's 4 - 20 mA loop power supply and commission the unit uninstalled. However, the TVA flowmeter should still be zeroed in-line (see Section 4.5.3) and its operation checked. The M750 display unit can be used to provide a remote display function if required, utilising the linear output.

## Rotating the display

The display can be rotated through 180° to enable ease of commissioning. To rotate the display disconnect the power supply, remove the mounting screws on the display unit, carefully remove the display unit and rotate. Carefully replace the display unit and replace mounting screws. Do not force the display unit into position. Reconnect the power supply.

**Note 1** - Electrostatic discharge (ESD) procedures should be followed while rotating the display.

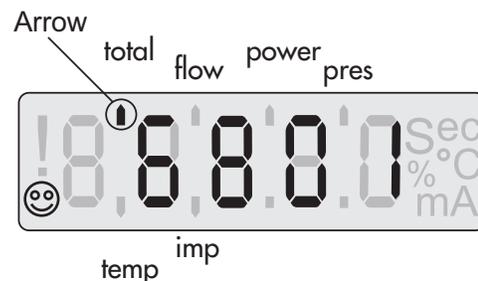
**Note 2** - **DO NOT** remove the 10 way connector from the display.

## 4.1 Run mode

Normally, the TVA flowmeter will operate in the run mode, displaying the total flow, flow, power, pressure or temperature of the fluid passing through the pipeline.

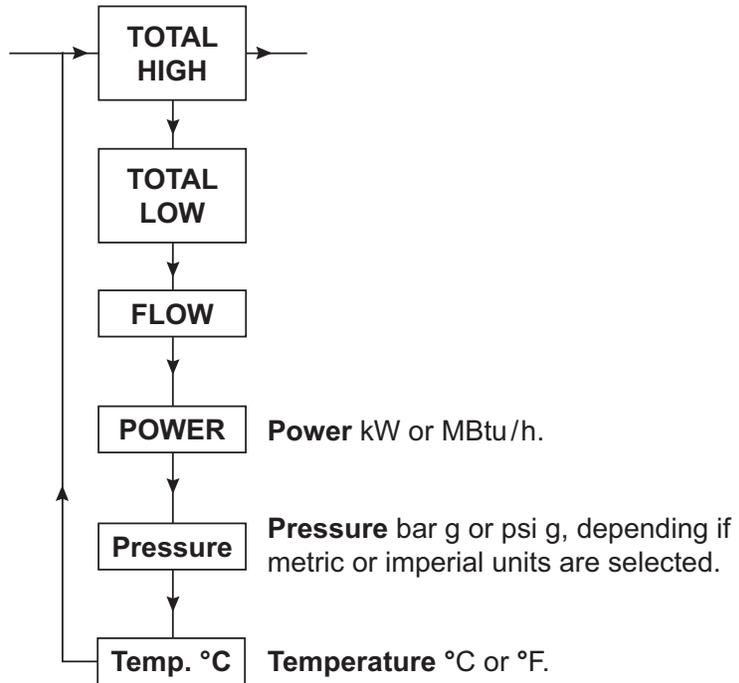
After initial power up, the TVA flowmeter will automatically enter the run mode and all commissioning menus can be accessed from this mode. (See Section 4.2, Commissioning mode, for details on how to commission).

In the run mode the fluid data is displayed on several screens which can be accessed by pressing the up or down keys. The display shows a numeric value and an arrow indicating the reading type, i.e. total flow, flow, power, pressure or temperature. All units (except °C) are implied with imperial or metric units being indicated by another arrow. The value of total flow is shown in two parts. The first five digits of the total flow will be displayed and after 10 seconds the following five digits will be displayed. To access the first five digits of total flow again it will be necessary to scroll up or down and return to the total flow display.



**Fig. 22**

### 4.1.1 Run mode data sequence



The following chart indicates the run mode data display sequence. Depending on the configuration, the flow units will be:

Units	Steam
Metric	Kg/h, KW, bar g, °C
Imperial	lb/h, MBtu/h, psi g, °F

The TVA flowmeter is factory set to display steam data in metric units and pressing the up or down keys will scroll through the following data.

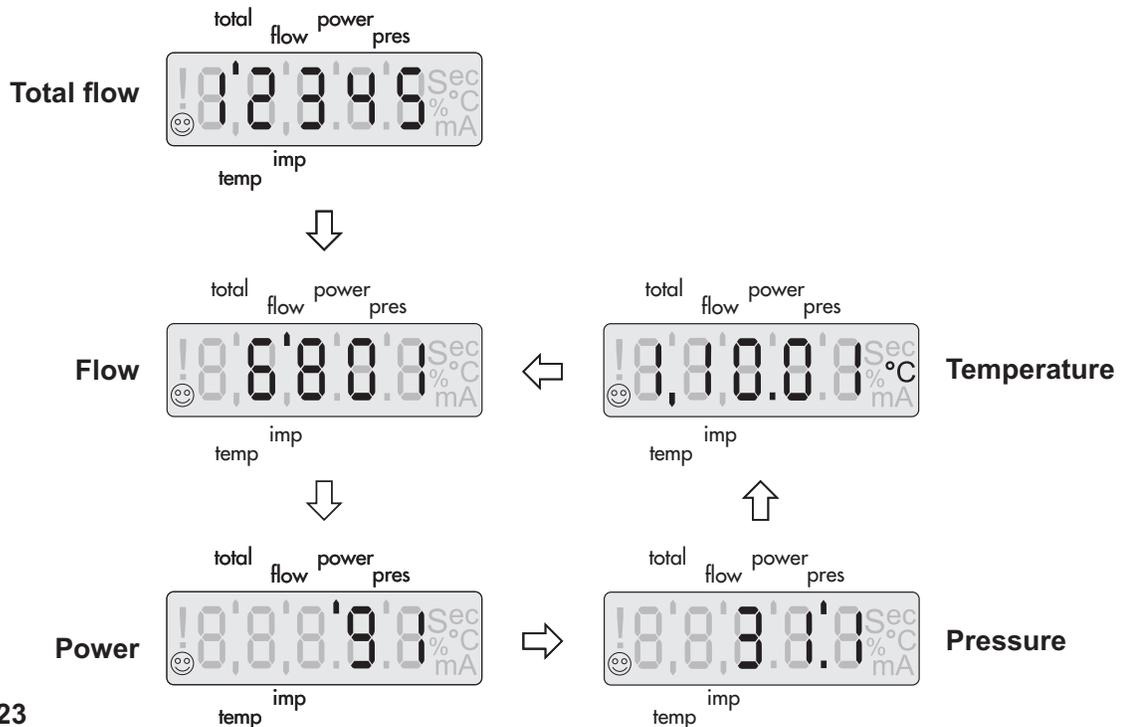


Fig. 23

### 4.1.2 Error display messages

Any errors that occur will be displayed in the run mode. The errors will alternate with the normal run mode display and will be prioritised. The errors will be latched and can only be cancelled by pressing the 'OK' button. Once the error message has been cancelled the display will show the next (if any) error.

Any continuous error will reinstate itself 2 seconds after it has been cancelled, and will be indicated by a flashing exclamation mark (!).

Certain errors will also cause the 4-20 mA alarm signal to be initiated.

The error messages are displayed over two screens and are:

**POWER  
OUT** = Power interrupted.

**NO  
SIGNL** = No signal from sensor.  
= (This can also activate  
the 4-20 mA alarm).

**SENSR  
CONST** = Signal from sensor constant.  
= (This can also activate  
the 4-20 mA alarm).

**HIGH  
FLOW** = Flow above the maximum.

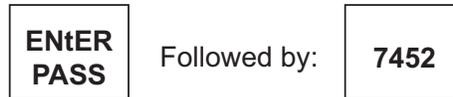
## 4.2 Commissioning mode

The commissioning mode is used to zero the flowmeter, re-range, set and test the outputs and change the pass code.

All data entry is performed via a menu and sub menu configuration with the key pad buttons used for navigation, i.e. to go deeper into the menu the right hand key is pressed, to scroll up and down the menu the up and down keys are pressed and to exit from a sub-menu the left key is pressed. Any data is entered using the OK button. The previously entered selection will flash. After a period of five minutes without any keys being pressed the TVA flowmeter will automatically default to the run mode.

For a full commissioning flow chart see Section 4.3.

To enter the commissioning mode press and hold down the 'OK' key for 3 seconds. The display then shows:



The leading digit will flash indicating that this is the position of the cursor.

The default factory set pass code is 7452. (This can be changed from within the commissioning mode). The pass code can be entered by using the up and down keys to increment the flashing value and the left and right keys to move the cursor. Pressing 'OK' will enter the pass code.

If an incorrect pass code is used the display will automatically return to the run mode.

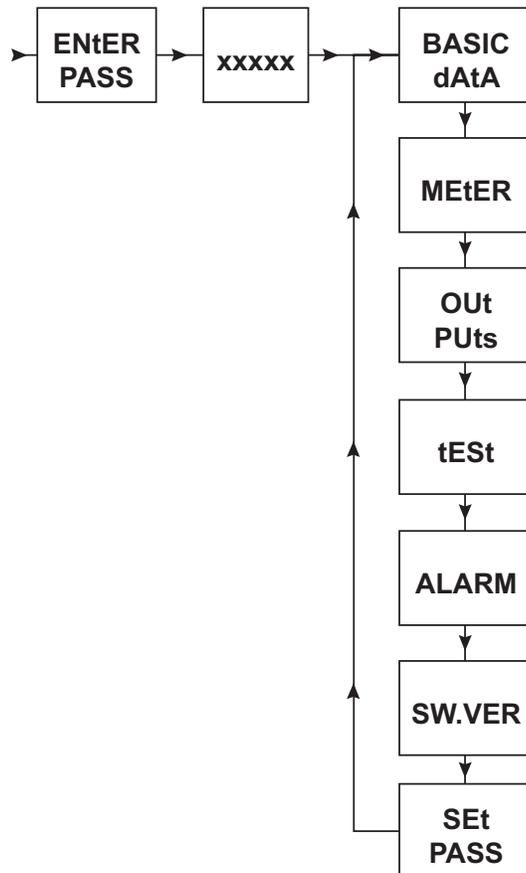
After the correct pass code is entered the display shows:



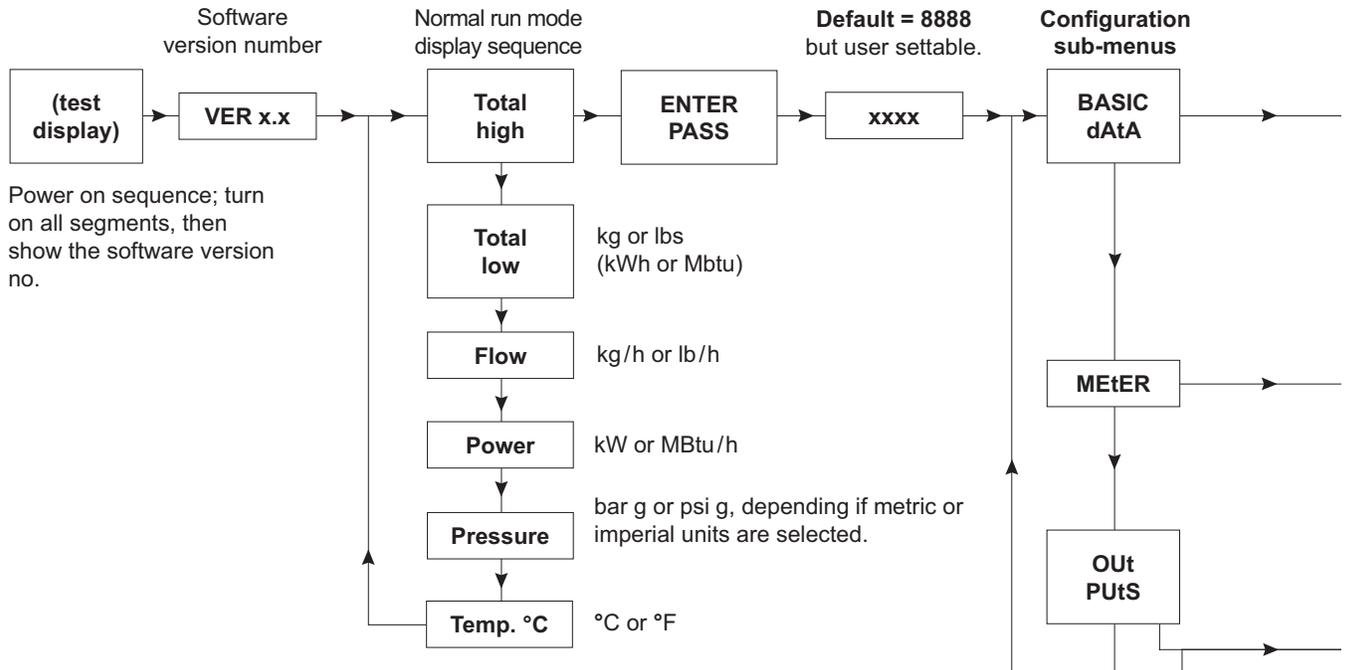
To exit from the commissioning mode at any stage, continually pressing the left key will return to the run mode.

Pressing the up and down buttons scrolls through the various first level menus.

Pressing the right arrow button enters a particular sub-menu.

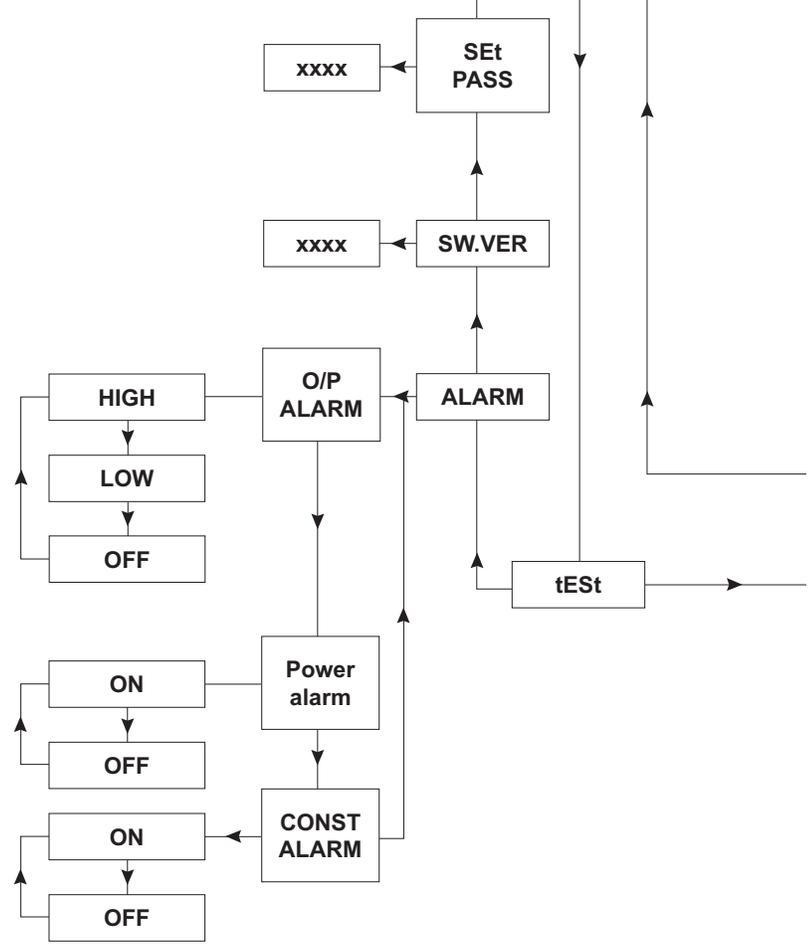


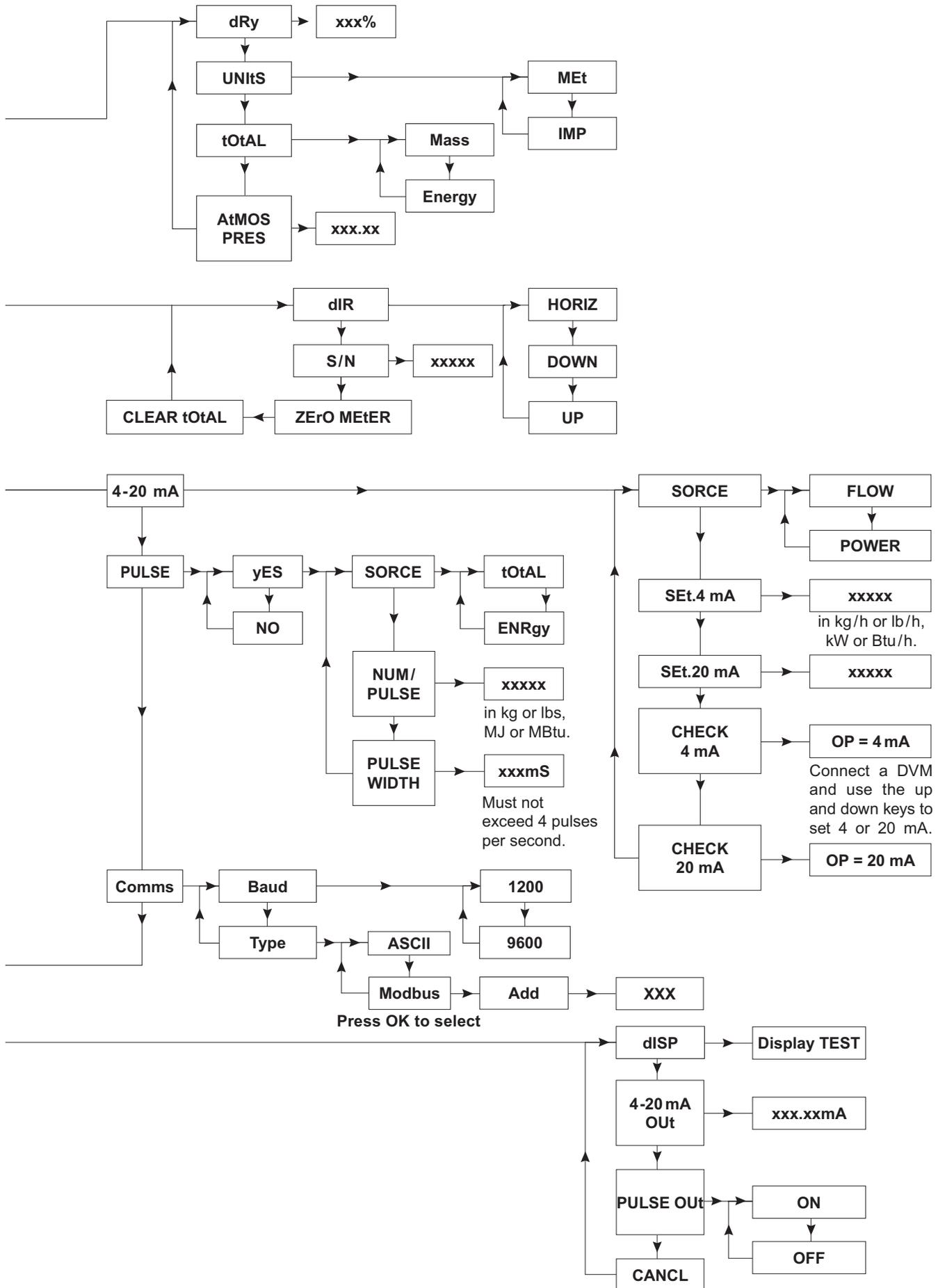
### 4.3 TVA flowmeter commissioning flow chart



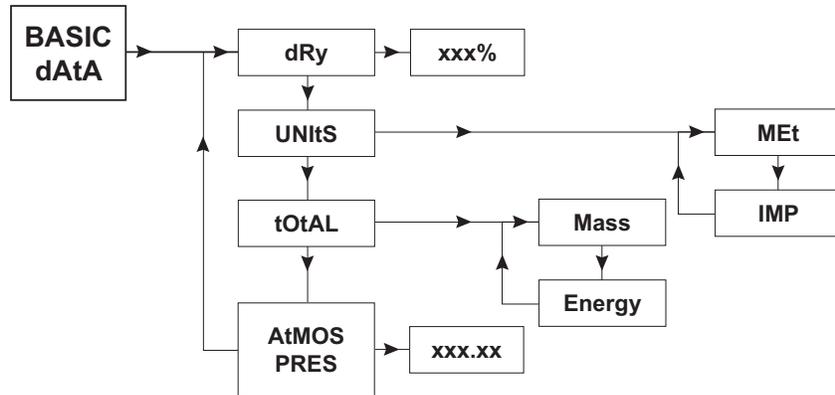
**Error Messages**  
 These alternate with the normal run mode display. They will be prioritised and will be latched when they occur. Pressing the 'OK' button will cancel the displayed alarm and allow the next one to be viewed. A continuous alarm will re-occur on the display 2 seconds after it has been cancelled.

Power interrupted	<b>POWER OUT</b>	
No signal from sensor	<b>NO SIGNAL</b>	The 4-20 mA alarm can also be activated
Signal from sensor constant	<b>SENSR CONST</b>	The 4-20 mA alarm can also be activated
Flow above maximum	<b>HIGH FLOW</b>	Shows when flow exceeds maximum





## 4.4 BASIC DATA Sub menu



### 4.4.1 dRy

Pressing the right key will display the dryness fraction. This is the dryness fraction of the saturated steam being measured. This can then be edited to suit the application. Press the 'OK' button to confirm the selection.

After the dryness fraction is entered the display will automatically step to the next sub menu and show 'UNItS'

### 4.4.2 UNItS

The units displayed and transmitted can be selected between metric (MEt), and imperial (IMP). A summary of the units is detailed in the Table below.

Units	Steam
Metric	Kg/h, KW, bar g, °C
Imperial	lb/h, MBtu/h, psi g, °F

Select either 'MEt' or 'IMP' and press the 'OK' button to confirm.

### 4.4.3 CLEAR tOtAL

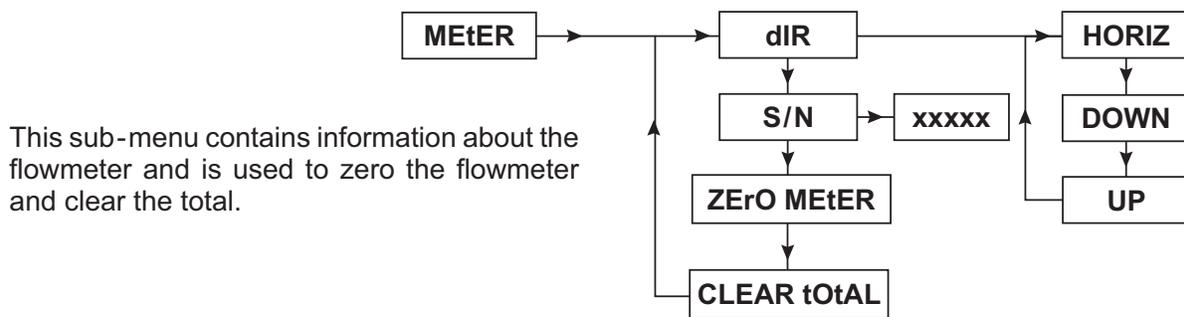
This function is used to clear the total by pressing and holding the 'OK' key for 3 seconds.  
**Note:** The total is backed-up every 8 minutes in the TVA flowmeter's non-volatile memory. If power is lost the TVA flowmeter could lose up to 8 minutes worth of totalised steam.

### 4.4.4 AtMOS PRES

This value compensates the flowrates for atmospheric pressure. It should be used if a high degree of accuracy is required or when the TVA flowmeter is installed high above sea level.  
**Note:** Values up to two decimal places can be entered.

If metric units are selected pressure units are bar absolute, for imperial units psi absolute.

## 4.5 MEtER Sub-menu



### 4.5.1 dIR

dIR is the orientation that the TVA flowmeter is installed in. The TVA flowmeter can be installed with horizontal flow up to a pressure of 32 bar g (464 psi g). For installations that require vertical flow either up or down the maximum pressure must not exceed 7 bar g (101 psi g). By selecting down or up the effect of gravity on the cone is taken into account.

**Note:** Upon entering the **dIR** sub-menu, **HORIZ** is **always** shown first. The actual direction selected is the one which is flashing.

### 4.5.2 S/N

This is the factory set serial number of the TVA flowmeter and is displayed by pressing the right key.

### 4.5.3 ZErO MEtER

This function is used to zero the TVA flowmeter manually to compensate for any electronic drift.

The procedure for zeroing the flowmeter is as follows:

- Isolate the pipeline where the flowmeter is installed and ensure that there is no flow. The line temperatures should be above 5°C (41°F) and below 30°C (86°F).
- Press and hold the 'OK' button for three seconds.

On completion the display will step back to S/N.

If 'ZErO ErrOr' is displayed, check to ensure that the line is isolated with no flow. If 'tEMP ErrOr' is displayed the line temperature is below 5°C (41°F). Allow the temperature to move above 5°C (41°F) and re-zero. **Note: The flowmeter should ideally be zeroed annually after 12 months service.**

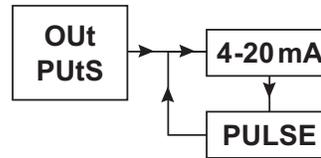
### 4.5.4 CLEAR tOtAL

This function is used to clear the total by pressing and holding the OK key for 3 seconds.

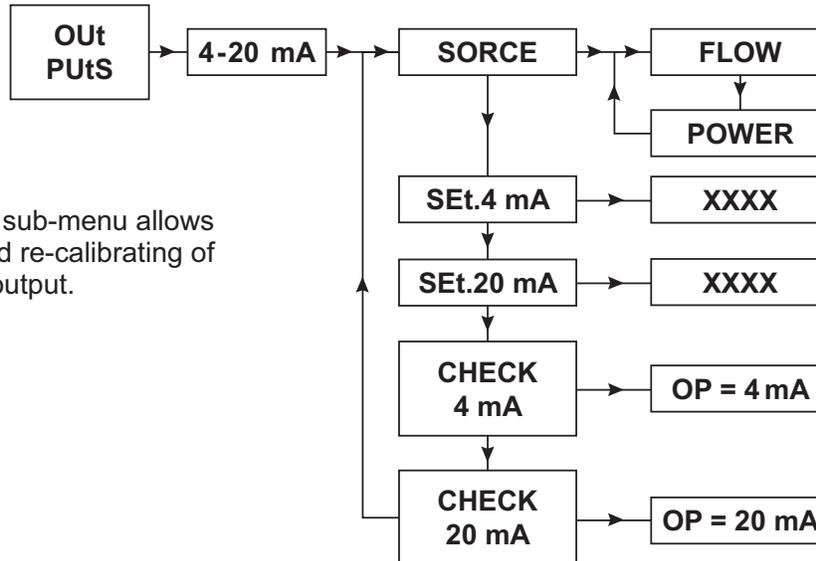
**Note:** The total is backed-up every 8 minutes in the TVA flowmeter's non-volatile memory. If power is lost the TVA flowmeter could lose up to 8 minutes worth of totalised steam.

## 4.6 OutPutS Sub-menu

This sub-menu allows both the 4-20 mA and pulsed outputs of the flowmeter to be configured.



### 4.6.1 4-20 mA Output sub-menu



The 4-20 mA sub-menu allows re-ranging and re-calibrating of the 4-20 mA output.

### 4.6.2 SORCE

This changes the source data for the 4-20 mA between flow and power.

### 4.6.3 SEt 4 mA

This sets the value for the flowrate or power, which is equivalent to 4 mA. The minimum value that can be set as 4 mA is 0 and the maximum is the 20 mA equivalent value less one.

### 4.6.4 SEt 20 mA

This sets the value for the flowrate or power, which is equivalent to 20 mA. The minimum value that can be set as 20 mA is the 4 mA equivalent value plus one and the maximum is the meters rated maximum at 32 bar g. The 20 mA value must always be a minimum of one greater than the 4 mA value.

### 4.6.5 CHECK 4 mA

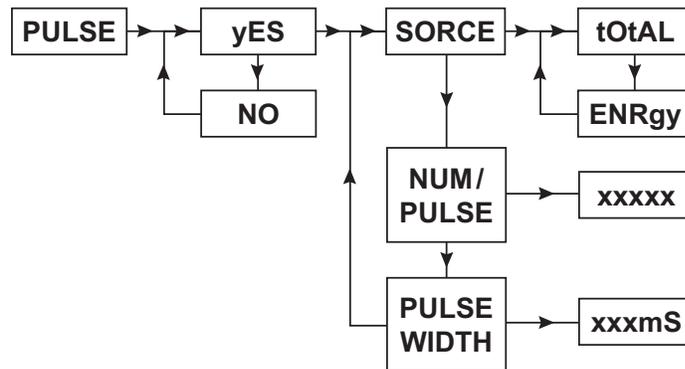
This allows the 4 mA value to be re-calibrated. A digital volt meter/multimeter should be connected in series with the 4-20 mA output. Pressing the right arrow button will display OP = 4 mA and the TVA flowmeter will output a steady 4 mA. If the multimeter does not read 4 mA the up and down arrow buttons can be pressed to alter this current until 4 mA exactly is indicated. Pressing the 'OK' button confirms the setting.

### 4.6.6 CHECK 20 mA

This allows the 20 mA value to be re-calibrated. A digital volt meter/multimeter should be connected in series with the 4-20 mA output. Pressing the right arrow button will display OP = 20 mA and the TVA flowmeter will output a steady 20 mA. If the multimeter does not read 20 mA the up and down arrow buttons can be pressed to alter this current until 20 mA exactly is indicated. Pressing the 'OK' button confirms the setting.

#### 4.6.7 Pulse Output

This sub-menu allows the pulsed output to be configured.



#### 4.6.8 PULSE

This selects whether the pulsed output is to be used or disabled.

#### 4.6.9 SORCE

This selects the source data for the pulsed output. The source data can be either unit mass per pulse (tOtAL) or unit energy per pulse (ENRgy).

#### 4.6.10 NUM/PULSE

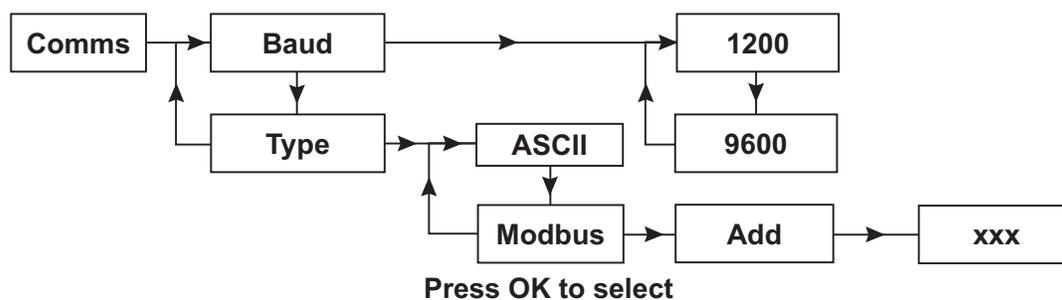
This allows the total mass, or energy, which is equivalent to one pulse to be configured. Units are dependent on the UNIt setting. Metric units will be kg for total or MJ for energy, imperial units will be lb for total or MBtu for energy.

#### 4.6.11 PULSE WIDTH

This allows the width of the pulse to be set. The width can be set in 0.01 second increments from 0.02 seconds to a maximum of 0.2 seconds.

#### 4.6.12 Comms

This allows the connection to other communications protocols.



#### 4.6.13 Baud

This allows the communication speed to be set to either 1200 or 9600. This must match the rate set within the device it is communicating to.

#### 4.6.14 Type

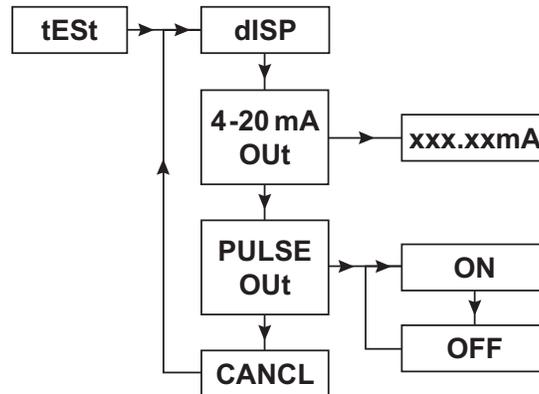
This gives the choice to select either ASCII or Modbus protocols.

#### 4.6.15 Add

If you have selected Modbus communications you must add an address. This is a three digit number between 001 - 255. Again this must match the address that the device that you are communicating to is set to.

## 4.7 tEst sub-menu

The tEst sub-menu allows access to the TVA flowmeter's diagnostic tools. From here the display, 4-20 mA and pulse outputs can be tested.



### 4.7.1 dISP

This allows the display to be tested. Pressing the right button will cause all the segments on the display to be turned on. Pressing the left button cancels the test and steps to the next stage.

### 4.7.2 4-20 mA Out

This allows the 4-20 mA output to be tested. By editing the value and pressing the 'OK' button the output can be set to the selected output. This current will continue to be transmitted for five minutes unless the cancel option is chosen.

### 4.7.3 PULSE Out

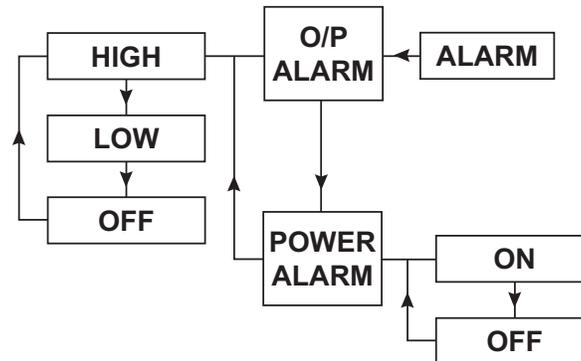
This allows the pulsed output to be tested. By selecting 'ON' or 'OFF' the desired test state of the pulsed output can be selected. Once the 'OK' button is pressed the pulsed output will remain in the selected state for five minutes or until the cancel option is chosen.

### 4.7.4 CANCEL

This allows the 4-20 mA output and pulsed output test signal selected above to be cancelled before the five minutes duration has expired.

## 4.8 ALARM sub-menu

This sub-menu gives access to setting the action that is required on the 4-20 mA output when an error is detected by the TVA flowmeter electronics. It also gives access to the power alarm function.



### 4.8.1 O/P ALARM

<b>HIGH</b>	If the self-diagnostic electronics determine that the sensor output has been constant for a period of time, or is not giving out a signal, it will set the 4-20 mA output to 22 mA.
<b>LOW</b>	If the self-diagnostic electronics determine that the sensor output has been constant for a period of time, or is not giving out a signal, it will set the 4-20 mA output to 3.8 mA.
<b>OFF</b>	This disables the 4-20 mA alarm function.

### 4.8.2 POWER ALARM

<b>OFF</b>	This disables the 4-20 mA alarm function (default).
<b>ON</b>	This enables the power alarm function.

### 4.8.3 CONST ALARM

This allows the constant flow alarm to be turned off.

The constant alarm is switched to on by the default factory setting. It detects if the flow has been constant for long periods when at pressure, which may indicate a stuck cone due to debris. If the system that the TVA is fitted to, has long periods where there is zero flow, but the line is kept at a constant pressure, it is advisable to turn the alarm off to avoid unwanted alarm messages.

## 4.9 SW.VER

This allows the software version to be viewed.

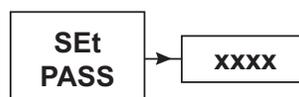


## 4.10 SET PASS

This allows the default pass code to be changed to a user defined value.

It is important that if the default pass code is changed that the new value is noted and kept safe.

The new pass code can be recorded on the Table in Section 9, page 32.



## 4.11 TVA communications

### 4.11.1 TVA UART set-up

The TVA flowmeter has an EIA 232C compatible communications link and supports two protocols: a simple Line Feed [LF] terminated ASCII protocol and a subset of Modbus/RTU. This enables users to easily interrogate the TVA flowmeter for steam data using either a dumb terminal or a P.C. loaded with a simple terminal emulation program or a standard Modbus Master / Client application. The connection length is limited to 15 metres and must be in the same building / area as the TVA flowmeter.

The TVA's communication set up should be as follows:

TVA ASCII set-up	
Baud rate	1200 or 9600
Data bits	7
Stop bits	one
Parity	none
Echo	off

TVA Modbus set-up	
Baud rate	1200 or 9600
Data bits	8
Stop bits	one
Parity	none
Echo	off

### Response time:

The TVA will start responding within 500 msec. The actual time to fully receive a response from the TVA is baud rate dependent, for example a Modbus poll of 12 registers @1200 baud rate could take  $((5 + 24) \text{ bytes} \times \sim 10 \text{ ms/byte}) + 500 \text{ ms} \approx 800 \text{ ms}$  to complete.

The polling frequency can be faster if the polling algorithm is set to poll immediately after receiving a valid response to a poll.

### 4.11.2 Using the EIA 232C communications

It is assumed that:

- The electrical wiring for the EIA 232C communications has been carried out in accordance with the EIA 232C standard. Please note the TVA EIA 232C connection requires a connector RJ11 linked to a 9 way D-type adaptor. Figure 24 illustrates the TVA flowmeter's RJ11 socket from the front.

The table below lists the RJ11 socket's pin connections. The signals are named from the PC (or data terminal) end.

RJ11 pin	9-way D-type	Signal
1		Not used
2	→ 4	DTR
3	→ 5	GND
4	→ 2	RX
5	→ 3	TX
6	→ 8	CTS



Fig. 24 RJ11 socket

- The communications protocol has been set up on the communicating device as described earlier in this Section. The following is a Table of operating codes in ASCII characters:-

### ASCII communications

Please note that all the following commands are case sensitive...

User transmits	TVA responds by transmitting
AB[LF]	Pressure in BarG [LF]
AC[LF]	Line Temperature in Celsius [LF]
AH[LF]	Energy total in kWh [LF]
AP[LF]	Power in KW [LF]
AR[LF]	Flow rate in Kg/H [LF]
AT[LF]	Total in kg [LF]

### 4.12

**After installation or maintenance ensure that the system is fully functioning. Carry out tests on any alarms or protective devices.**

## 4.13 Modbus communications

The TVA flowmeter has Modbus communications, in addition to the ASCII Modbus comms that are available through the TVA RS232 port. An RS485 to RS232 converter is required, or alternatively, an Ethernet to RS232 converter, both of which are widely available.

### Modbus comms protocol

#### Format: Request frame

Address	1 byte
Function code	1 byte
Start address	2 bytes
Quantity of registers	2 bytes
Error check (CRC)	2 bytes
Total	8 bytes

#### Format: Response frame (normal)

Address	1 byte
Function code	1 byte
Byte count	1 byte
Register data	2 x Quantity of registers, MSB first, low register address first
Error check (CRC)	2 bytes
Total	5+ (2 x Quantity of registers) bytes

#### Format: Response frame (error)

Address	1 byte
Error code	1 byte (error code = function code plus 0x80)
Exception code	1 byte (01 or 02 see below)
Error check (CRC)	2 bytes
Total	5 bytes

**Note:** Only 'Read holding registers' (function code '03') is currently supported

#### 4.13.1 ModBus request frame structure example.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
Device address	Function code	Register start address (MSB)	Register start address (LSB)	Register quantity (MSB)	Register quantity (LSB)	CRC (LSB)	CRC (MSB)
x	(3)	(0)	(0)	(0)	(12)	x	x

The above frame will poll all Modbus registers from Total low 16-bits up to and including Software Version.

Register number	Modbus address	Parameter	Received data scale	Units	Notes
40001	0	Total low 16 bits	x1	Kg	Total = (Total high x 65536) + Total low *
40002	1	Total high 16 bits	x1	Kg	
40003	2	Flow	x1	Kg/h	
40004	3	Pressure	x100	BarG	
40005	4	Temperature	x10	°C	
40006	5	Water equivalent flowrate	x10	L/hour	
40007	6	Power	x1	kW	
40008	7	Energy low 16 bits	x1	kWh	Energy = (Energy high x 65536) + Energy low *
40009	8	Energy high 16 bits	x1	kWh	
40010	9	Alarm status	-	(bit-fields)	Look table below
40011	10	SxS device ID	-	-	TVA = 0
40012	11	Software version	-	-	200 is sw ver 2.00, 201 is sw ver 2.01 etc
40021	20	Total low 16 bits	x1	Lbs	Total = (Total high x 65536) + Total low *
40022	21	Total high 16 bits	x1	Lbs	
40023	22	Flow	x1	Lbs/h	
40024	23	Pressure	x100	PSI <sub>g</sub>	
40025	24	Temperature	x10	°F	
40026	25	Water equivalent flowrate	x10	Lbs/hour	
40027	26	Power	x1	KBTU/h	
40028	27	Energy low 16 bits	x1	kBTU	Energy = (Energy high x 65536) + Energy low *
40029	28	Energy high 16 bits	x1	kBTU	

**Note** Modbus protocol requires that Modbus addresses start at offset 0, not 1. Register addresses start from 1 in description but 0 in binary. Most parameters are 16 bits and few parameters are 32 bits. Modbus registers are 16 bits, i.e. 1 device parameter needs 1x and 2x Modbus register(s) respectively. As a general note on Modbus, register types and reference register number ranges are implemented as follows:

0x = Coil = 00001 - 09999

1x = Discrete input = 10001 - 19999

3x = Input register = 30001 - 39999

4x = Holding register = 40001 - 49999

\* Multiply by the inverse 'Received Data Scale' to extract data in relevant units, i.e. divide polled 'Temperature' by 10 to get the value in °C... Tip: use real (float) type to retain 2-decimal-point accuracy.

### 4.13.2 Alarm status register bit-fields:

Bit	Set (1)	Cleared (0)
Bit 0 (0x0001)	Sub-saturation alarm is active	Sub-saturation alarm is idle
Bit 1 (0x0002)	Default	
Bit 2 (0x0004)	Pressure alarm is active (too high or too low)	Pressure alarm is idle
Bit 3 (0x0008)	-	-
Bit 4 (0x0010)	Hi flow alarm is active	Hi flow alarm is idle
Bit 5 (0x0020)	Sensor constant alarm is active	Sensor constant alarm is idle
Bit 6 (0x0040)	No signal from sensor alarm is active	No signal from sensor alarm is idle
Bit 7 (0x0080)	Power failed (has been turned off and on) alarm is active	Power failed alarm is idle
Bit 8 (0x0100)	Hi flow alarm has latched	-
Bit 9 (0x0200)	Sensor constant alarm has latched	-
Bit 10 (0x0400)	No signal from sensor alarm is latched	-
Bit 11 (0x0800)	Power failed alarm has latched	nothing
Bit 12 (0x1000)	-	-
Bit 13 (0x2000)	-	-
Bit 14 (0x4000)	-	-
Bit 15 (0x8000)	-	-

A maximum of 12 Modbus registers can be polled together at the same frame. It has to be noted that only a poll with a valid start address and quantity that falls within the supported register range will produce a normal frame response. If you ask for a frame with start address outside this range or a frame that the start address + quantity falls outside this range, the TVA will reply with an 'illegal data address' error message. If the function code is incorrect, it will reply with an 'illegal function' error message.

If a message is received with the wrong CRC, it will be ignored. The TVA response time is not instant (look below) so wait for it to reply before asking for more data, otherwise it will ignore new requests.

As the TVA is a loop powered instrument, it needs CTS and/or DTR to be wired into it so that it can use these to power its communications interface.

### 4.13.3 Response time:

The TVA will start responding within 500 msec. The actual time to fully receive a response from the TVA is baud rate dependent, for example a Modbus poll of 12 registers @1200 baud rate could take  $((5 + 24) \text{ bytes} \times \sim 10 \text{ ms/byte}) + 500 \text{ ms} \approx \mathbf{800 \text{ ms}}$  to complete.

The polling frequency can be faster if the polling algorithm is set to poll immediately after receiving a valid response to a poll.

## 5. Operation

The TVA flowmeter operates by measuring the strain produced on a moving cone by an instantaneous flowrate. This strain is then converted into a density compensated mass flowrate and is transmitted via a single loop powered 4 - 20 mA output and pulsed output. The unique design of the TVA flowmeter produces the high turndowns and high accuracy required in process applications.

## 6. Maintenance

The TVA flowmeter should be zeroed using the zero meter sub-menu at least once a year. This will remove any electronic long term drift that may occur. Frequency of re-calibration depends upon the service conditions experienced by the meter and the application. Re-calibration frequency can be typically between 2 and 5 years.

### Replacement of the TVA flowmeter display electronics

#### To replace the electronics:

- Disconnect the power supply.
- Remove the front housing.
- Remove the mounting screws on the display unit and carefully remove the electronics.
- Carefully unplug the ribbon cable.
- Reconnect the ribbon cable to the new electronics and carefully replace.
- Replace the mounting screws and reconnect the power supply.

**Note:** Electrostatic discharge (ESD) procedures should be followed while installing the new electronics.

**Do not force the electronics / display unit into position.**

## 7. Spare parts

Spare electronics for the TVA flowmeter are available from Spirax Sarco and consist of:

- TVA flowmeter replacement display and electronics with front housing.

It is important that the serial number of the TVA flowmeter is given at the time of ordering.

**Example:** 1 off Spirax Sarco display and electronics panel for a DN100 TVA flowmeter having the following Serial number D\_\_\_\_.

## 8. Fault finding

Many faults which occur on commissioning are found to be due to incorrect wiring or setting up, therefore it is recommended that a thorough check is carried out should there be a problem. The TVA flowmeter display has in-built diagnostic features and will indicate a number of errors on the display and via the 4-20 mA output.

The errors will alternate with the normal run mode display and will be shown according to priority. The errors will be latched and can only be cancelled by pressing the 'OK' button. Once the error message has been cancelled the display will show the next (if any) error.

Any continuous error will re-instate itself 2 seconds after it has been cancelled, and will be indicated by a flashing exclamation mark (!).

Symptom	Possible cause	Action
<b>Display is blank</b>	dc voltage is not within the range of 9-28 Vdc. Supply connected with reverse polarity. Electronics faulty.	Check power supply/current connections. See Section 3.3. Change polarity. Refer to: Spirax-Sarco Limited
<b>Display shows: NO SIGNL</b>	Insufficient supply voltage. Current loop resistance is greater than Rmax. Electronics faulty.	Check supply voltage is between 9 and 28 Vdc. Check current loop resistance and reduce if necessary. Check current output electronics (refer to Sections 4.6 and 4.7). Refer to: Spirax-Sarco Limited
<b>Display shows: POWER Out</b>	Power supply interrupted.	Ensure power supply is secure and cancel error using the OK key. Totals transmitted may not be valid.
<b>Display shows: SENSR CONST</b>	Cone jammed. Electronics Faulty.	Remove unit from pipeline and check cone movement. Check current output electronics (refer to Sections 4.6 and 4.7). Refer to: Spirax-Sarco Limited
<b>Display shows: HIGH FLOW</b>	Meter undersized.	Check sizing and replace if necessary.
<b>Constant 3.8 mA</b>	Error signal set to Low.	Check display for errors and rectify as above. Check current output electronics (refer to Sections 4.6 and 4.7).
<b>Constant 22 mA</b>	Error signal set to High.	Check display for errors and rectify as above. Check current output electronics (refer to Sections 4.6 and 4.7).

Symptom	Possible cause	Action
<b>Flow indicated responds to changes in actual flow but value indicated does not correspond to actual flowrate</b>	<p>Flowmeter not properly centred in the pipeline.</p> <p>Gaskets at the flowmeter protrude into the pipe bore.</p> <p>Irregularities on the surface of the pipe bore.</p> <p>Signal falsified due to bi-phase medium.</p> <p>Insufficient upstream/ downstream pipe lengths.</p> <p>Flow direction reversed.</p>	<p>The axis of the flowmeter bore should be aligned with that of the pipe.</p> <p>See Section 3, Figures 16, 17 and 18 for proper installation of gaskets.</p> <p>Pipe bore should be free of irregularities.</p> <p>Bi-phase media are not permitted. Use a separator for wet steam applications to remove moisture droplets from the steam.</p> <p>See Section 3 for correct lengths of upstream and downstream pipes.</p> <p>Check flow direction arrow on primary.</p>
<b>Pulse output is incorrect</b>	<p>Pulse output incorrectly set.</p> <p>Pulse width incorrectly set.</p> <p>Pulse output is overloaded.</p> <p>Pulse output electronics faulty.</p>	<p>Check programming of pulse output, Section 4.6.7.</p> <p>Check maximum pulse width of counter electronics.</p> <p>Check load ratings.</p> <p>Test pulse output. If faulty replace unit.</p>
<b>TVA produces large amount of noise (banging and clattering)</b>	<p>Upstream/downstream installation lengths incorrect.</p>	<p>Re-install following the installation guidelines (Section 3).</p>
<b>Non zero flow indicated when no actual flow is in the pipe.</b>	<p>Unit not zeroed at commissioning.</p> <p>4 mA output not calibrated.</p> <p>4 mA retransmission set to a value higher than zero.</p> <p>Interference.</p>	<p>Zero unit.</p> <p>Calibrate 4 mA output (Section 4.6.5).</p> <p>Reset 4 mA.</p> <p>Check earthing.</p>

# 9. Settings table

This Table shows all changeable options, and enables records to be made of any changes made to the pass code or other settings. It provides a convenient reference should future changes be required.

Sub-menu	Changeable settings	Factory settings	Customer settings	Further changes
<b>Basic data</b>	Dryness fraction	1.0		
	Units	Metric		
	Nominal pressure			
	Atmospheric pressure	1.01 bar a		
<b>Outputs</b>	4-20 mA			
	Source data	Flow		
	4 mA setting	0		
	20 mA setting	Flowmeter maximum @ 32 bar g		
	Pulse	ON		
	Source data	Total		
	Number of pulses	1 per kg		
	Pulse width	50 mS		
<b>Error</b>		High		
<b>Pass code</b>		7452		

# pro<sup>o</sup>sense SPT25 Series Pressure Transmitters



The ProSense SPT25 pressure transmitter series is engineered to meet many industrial, commercial, and OEM pressure measurement applications. The all stainless steel welded thin film sensing element provides very fast response time and is compatible with many different media sensing applications. With a robust design resistant to vibration, shock, and EMI/RFI, the SPT25 series provides high accuracy over a wide compensated temperature range. Pressure sensing ranges from vacuum to 5000 psig are available along with a 1/4 inch NPT male threaded process connection. Choose from linear outputs of 4-20 mA or 0-10VDC with electrical connections of either a DIN 175301-803C L-connector or 6.6 foot (2 m) integral shielded cable.

## Applications

- Process control & automation
- Pump & compressor control
- Hydraulic systems
- Pneumatic systems
- Engine monitoring
- Refrigeration equipment
- Presses
- Machine tools

## Features

- All stainless steel welded sensing element
- Fast response time
- Pressure sensing ranges from vacuum to 5000 psig
- 1/4 inch NPT male threaded process connection
- Output options: 4-20 mA or 0-10 VDC
- Integral 6.6 foot shielded cable or DIN form C electrical connections
- Made in the USA
- CE marked
- 3-year warranty



ProSense SPT25 Series Pressure Transmitters (Shielded Cable)					
Part Number	Description	Electrical Connection	Input Voltage	Wt(lb)	Price
<b>SPT25-20-V30A</b>	Pressure transmitter, 4 to 20 mA output, -14.7 vacuum to 30 psig range, 1/4" NPT male port	Integral 6.6 ft (2m) shielded cable	9 - 36 VDC	0.38	\$115.00
<b>SPT25-20-0030A</b>	Pressure transmitter, 4 to 20 mA output, 0 to 30 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-20-0060A</b>	Pressure transmitter, 4 to 20 mA output, 0 to 60 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-20-0100A</b>	Pressure transmitter, 4 to 20 mA output, 0 to 100 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-20-0150A</b>	Pressure transmitter, 4 to 20 mA output, 0 to 150 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-20-0200A</b>	Pressure transmitter, 4 to 20 mA output, 0 to 200 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-20-0300A</b>	Pressure transmitter, 4 to 20 mA output, 0 to 300 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-20-0500A</b>	Pressure transmitter, 4 to 20 mA output, 0 to 500 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-20-1000A</b>	Pressure transmitter, 4 to 20 mA output, 0 to 1000 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-20-1500A</b>	Pressure transmitter, 4 to 20 mA output, 0 to 1500 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-20-2000A</b>	Pressure transmitter, 4 to 20 mA output, 0 to 2000 psig range, 1/4" NPT male port		\$115.00		
<b>SPT25-20-3000A</b>	Pressure transmitter, 4 to 20 mA output, 0 to 3000 psig range, 1/4" NPT male port		\$115.00		
<b>SPT25-20-5000A</b>	Pressure transmitter, 4 to 20 mA output, 0 to 5000 psig range, 1/4" NPT male port		\$115.00		
<b>SPT25-10-V30A</b>	Pressure transmitter, 0 to 10 V output, -14.7 vacuum to 30 psig range, 1/4" NPT male port		14 - 36 VDC		\$115.00
<b>SPT25-10-0030A</b>	Pressure transmitter, 0 to 10 V output, 0 to 30 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-10-0060A</b>	Pressure transmitter, 0 to 10 V output, 0 to 60 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-10-0100A</b>	Pressure transmitter, 0 to 10 V output, 0 to 100 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-10-0150A</b>	Pressure transmitter, 0 to 10 V output, 0 to 150 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-10-0200A</b>	Pressure transmitter, 0 to 10 V output, 0 to 200 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-10-0300A</b>	Pressure transmitter, 0 to 10 V output, 0 to 300 psig range, 1/4" NPT male port				\$115.00
<b>SPT25-10-0500A</b>	Pressure transmitter, 0 to 10 V output, 0 to 500 psig range, 1/4" NPT male port	\$115.00			
<b>SPT25-10-1000A</b>	Pressure transmitter, 0 to 10 V output, 0 to 1000 psig range, 1/4" NPT male port	\$115.00			
<b>SPT25-10-1500A</b>	Pressure transmitter, 0 to 10 V output, 0 to 1500 psig range, 1/4" NPT male port	\$115.00			
<b>SPT25-10-2000A</b>	Pressure transmitter, 0 to 10 V output, 0 to 2000 psig range, 1/4" NPT male port	\$115.00			
<b>SPT25-10-3000A</b>	Pressure transmitter, 0 to 10 V output, 0 to 3000 psig range, 1/4" NPT male port	\$115.00			
<b>SPT25-10-5000A</b>	Pressure transmitter, 0 to 10 V output, 0 to 5000 psig range, 1/4" NPT male port	\$115.00			

# Attachment 3-1 - Equipment Specs and Maintenance Information

# proense® SPT25 Series Pressure Transmitters

Company Information

Drives

Soft Starters

Motors

Power Transmission

Motion: Servos and Steppers

Motor Controls

Sensors: Proximity

Sensors: Photoelectric

Sensors: Encoders

Sensors: Limit Switches

Sensors: Current

Sensors: Pressure

Sensors: Temperature

Sensors: Level

Sensors: Flow Switches

Pushbuttons and Lights

Stacklights

Signal Devices

Process

Relays and Timers

Pneumatics: Air Prep

Pneumatics: Directional Control Valves

Pneumatics: Cylinders

Pneumatics: Tubing

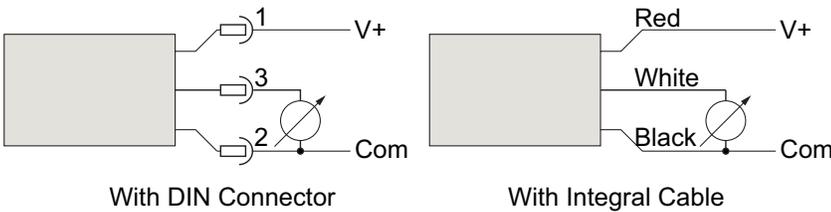
Pneumatics: Air Fittings

Appendix Book 2

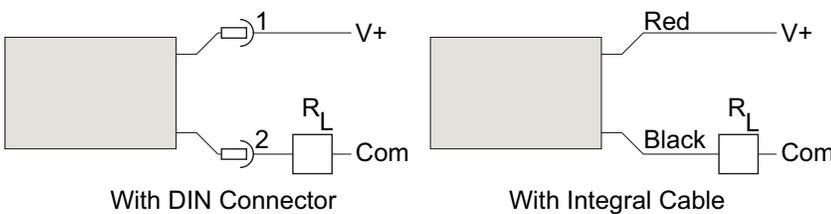
Terms and Conditions

ProSense SPT25 Series Pressure Transmitters (DIN Connector)					
Part Number	Description	Electrical Connection	Input Voltage	Wt(lb)	Price
SPT25-20-V30D	Pressure transmitter, 4 to 20 mA output, -14.7 vacuum to 30 psig range, 1/4" NPT male port	DIN 175301-803C L-connector	9 - 36 VDC	0.30	\$109.00
SPT25-20-0030D	Pressure transmitter, 4 to 20 mA output, 0 to 30 psig range, 1/4" NPT male port				\$109.00
SPT25-20-0060D	Pressure transmitter, 4 to 20 mA output, 0 to 60 psig range, 1/4" NPT male port				\$109.00
SPT25-20-0100D	Pressure transmitter, 4 to 20 mA output, 0 to 100 psig range, 1/4" NPT male port				\$109.00
SPT25-20-0150D	Pressure transmitter, 4 to 20 mA output, 0 to 150 psig range, 1/4" NPT male port				\$109.00
SPT25-20-0200D	Pressure transmitter, 4 to 20 mA output, 0 to 200 psig range, 1/4" NPT male port				\$109.00
SPT25-20-0300D	Pressure transmitter, 4 to 20 mA output, 0 to 300 psig range, 1/4" NPT male port				\$109.00
SPT25-20-0500D	Pressure transmitter, 4 to 20 mA output, 0 to 500 psig range, 1/4" NPT male port				\$109.00
SPT25-20-1000D	Pressure transmitter, 4 to 20 mA output, 0 to 1000 psig range, 1/4" NPT male port				\$109.00
SPT25-20-1500D	Pressure transmitter, 4 to 20 mA output, 0 to 1500 psig range, 1/4" NPT male port				\$109.00
SPT25-20-2000D	Pressure transmitter, 4 to 20 mA output, 0 to 2000 psig range, 1/4" NPT male port		\$78.75		
SPT25-20-3000D	Pressure transmitter, 4 to 20 mA output, 0 to 3000 psig range, 1/4" NPT male port		\$109.00		
SPT25-20-5000D	Pressure transmitter, 4 to 20 mA output, 0 to 5000 psig range, 1/4" NPT male port		\$109.00		
SPT25-10-V30D	Pressure transmitter, 0 to 10 V output, -14.7 vacuum to 30 psig range, 1/4" NPT male port		14 - 36 VDC		\$109.00
SPT25-10-0030D	Pressure transmitter, 0 to 10 V output, 0 to 30 psig range, 1/4" NPT male port				\$109.00
SPT25-10-0060D	Pressure transmitter, 0 to 10 V output, 0 to 60 psig range, 1/4" NPT male port				\$109.00
SPT25-10-0100D	Pressure transmitter, 0 to 10 V output, 0 to 100 psig range, 1/4" NPT male port				\$109.00
SPT25-10-0150D	Pressure transmitter, 0 to 10 V output, 0 to 150 psig range, 1/4" NPT male port				\$109.00
SPT25-10-0200D	Pressure transmitter, 0 to 10 V output, 0 to 200 psig range, 1/4" NPT male port				\$109.00
SPT25-10-0300D	Pressure transmitter, 0 to 10 V output, 0 to 300 psig range, 1/4" NPT male port				\$109.00
SPT25-10-0500D	Pressure transmitter, 0 to 10 V output, 0 to 500 psig range, 1/4" NPT male port	\$109.00			
SPT25-10-1000D	Pressure transmitter, 0 to 10 V output, 0 to 1000 psig range, 1/4" NPT male port	\$109.00			
SPT25-10-1500D	Pressure transmitter, 0 to 10 V output, 0 to 1500 psig range, 1/4" NPT male port	\$109.00			
SPT25-10-2000D	Pressure transmitter, 0 to 10 V output, 0 to 2000 psig range, 1/4" NPT male port	\$109.00			
SPT25-10-3000D	Pressure transmitter, 0 to 10 V output, 0 to 3000 psig range, 1/4" NPT male port	\$109.00			
SPT25-10-5000D	Pressure transmitter, 0 to 10 V output, 0 to 5000 psig range, 1/4" NPT male port	\$109.00			

## 0 to 10 VDC Output Wiring Diagram



## 4 to 20 mA Output Wiring Diagrams



### Shielded Cable Models Wire Designation

Wire Color	0 - 10 VDC Output	4 - 20 mA Output
Red	V +	V +
Black	Com	Output
White	Output	None
Bare*	Shield Drain Wire	Shield Drain Wire

\* Where shielded wiring is being used; Connect the drain wire to the guard terminal on the read out device or measuring instrument if available. In all other cases connect to the power supply negative terminal.

### DIN Form C Models Pin Designation

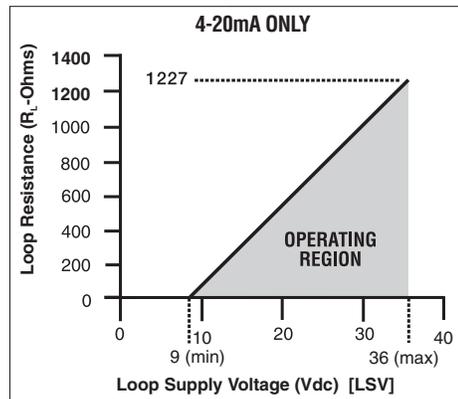
Pin No.	0 - 10 VDC Output	4 - 20 mA Output
1	V+	V+
2	Com	Output
3	Output	None
4	Case Ground	Case Ground

# proSense® SPT25 Series Pressure Transmitters

ProSense SPT25 Series General Specifications	
<b>Housing Material</b>	20% Glass Reinforced Nylon, Fire retardant to UL94 V1 / 304 Series Stainless steel
<b>Materials (wetted parts)**</b>	304 Series Stainless steel / 17-4PH Stainless Steel
<b>Operating Temperature</b>	-40 to 257°F (-40 to 125°C)
<b>Medium Temperature</b>	-40 to 257°F (-40 to 125°C)
<b>Storage Temperature</b>	-40 to 257°F (-40 to 125°C)
<b>Protection</b>	IP 67 for cabled models IP 65 For DIN connector models
<b>Accuracy*</b>	± 0.50% of full range
<b>Temperature Coefficient</b>	0.15% of full range / 10°F (0.25% of full range / 10°C)
<b>Reference Temperature</b>	70°F ± 1°F (21°C ± 1°C)
<b>Compensated Temperature</b>	-4 to 185°F (-20 to 85°C)
<b>Insulation Resistance</b>	Greater than 100 megohms at 100 VDC
<b>Shock Resistance</b>	100 gs, 6 ms
<b>Vibration Resistance</b>	Random vibration (20 g) over temperature range (-40° to 125°C). Exceeds typical MIL. STD. requirements
<b>Drop Test</b>	Withstands 1 meter on concrete 3 axis
<b>Response Time</b>	Less than 1 msec
<b>Warm-up time</b>	Less than 500 msec
<b>Position Effect</b>	Less than ±0.01% span, typical
<b>Insulation Breakdown Voltage</b>	100 VAC
<b>Reverse Polarity &amp; Miswired Protected</b>	Yes
<b>Durability</b>	Tested to 50 million cycles
<b>Humidity</b>	0 to 100% R.H., no effect
<b>Stability</b>	Less than ±0.25% full range / year
<b>Agency Approvals</b>	CE
<i>*Note - Includes non-linearity, hysteresis &amp; non-repeatability.</i>	
<i>** Not cleaned for oxygen service</i>	

ProSense SPT25 Series Technical Specifications	
<b>Technical Specifications SPT25-20-xxxx</b>	
<b>Operating Voltage</b>	9 – 36 VDC
<b>Analog Output</b>	4 – 20 mA
<b>Maximum Load</b>	Determine Maximum Loop Resistances $\frac{V_L - 9 \text{ VDC}}{0.022 \text{ amps}} = R_L$ For example [(24 VDC – 9 VDC) / 0.022 amps] = 681Ω
<b>Technical Specifications SPT25-10-xxxx</b>	
<b>Operating Voltage</b>	14 – 36 VDC
<b>Current Consumption</b>	4 mA
<b>Minimum Load</b>	10 kΩ

Power Supply Voltage vs Loop Resistance

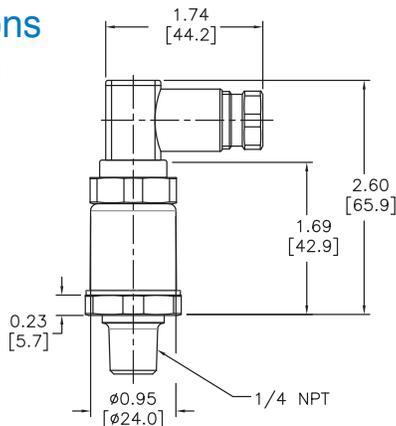


DIN Connector Specifications	
<b>Number of contacts</b>	3 + PE
<b>Cable glands</b>	PG 7
<b>Conductor size max.</b>	0.75 mm² / 18AWG
<b>Type of termination</b>	Screw
<b>Suitable cables</b>	4.5 mm to 6mm
<b>Standard DIN</b>	EN 175 301-803-C

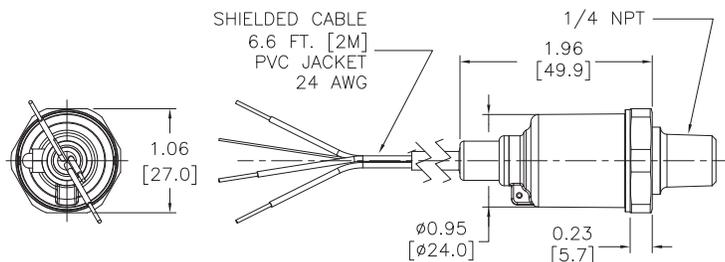
ProSense SPT25 Proof & Burst Pressures		
	<b>Proof</b>	<b>Burst</b>
<b>500 psig &amp; below</b>	200% full scale	1000% full scale
<b>1000 – 2000 psig</b>	200% full scale	500% full scale
<b>3000 psig</b>	200% full scale	500% full scale
<b>5000 psig</b>	150% full scale	500% full scale

## Dimensions

inches [mm]



DIN Connector Models



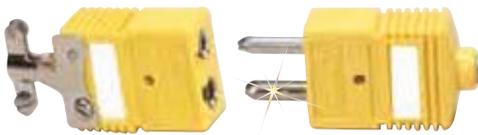
Shielded Cable Models

# Super OMEGACLAD® XL Thermocouple Probes

Attachment 3-1 Equipment Specs and Maintenance Information



## A Technological Advance in Temperature Measurement

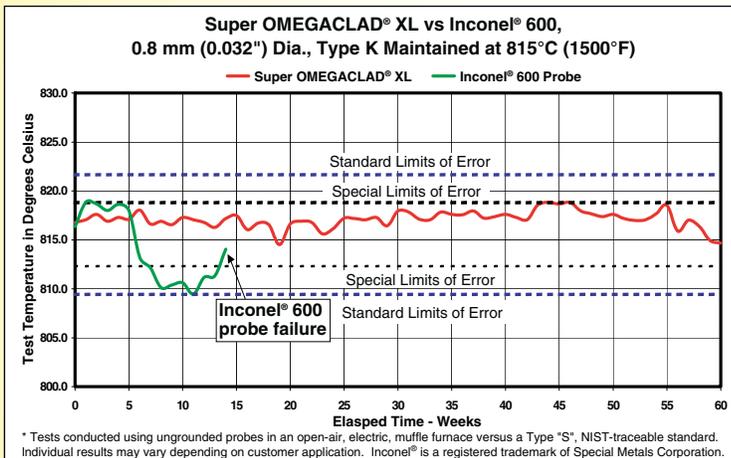


KQXL-18U-12, shown smaller than actual size.

- ✓ Thermocouple Technology from OMEGA for K and N Calibrations Only
- ✓ Super Stable Temperature Drift—Less than 2.8°C in 25 weeks
- ✓ Better Performance at a Smaller Size—0.8 mm Probe Withstands 815°C (1500°F) for 3 Years
- ✓ Probe Life Expectancy up to 10 Times Greater than Competing Devices\*
- ✓ Handles Temperatures Up to 1335°C (2400°F)



OMEGA brings you the Super OMEGACLAD® XL Thermocouple Probe family, the exclusive innovation in thermocouple technology. Manufactured using state-of-the-art processes for mineral insulated (MI) thermocouple cable and finished thermocouple probe assemblies, these temperature sensors maximize performance, even at extremely small diameters. The devices resist carburization, oxidation, and chlorination in tough environments.



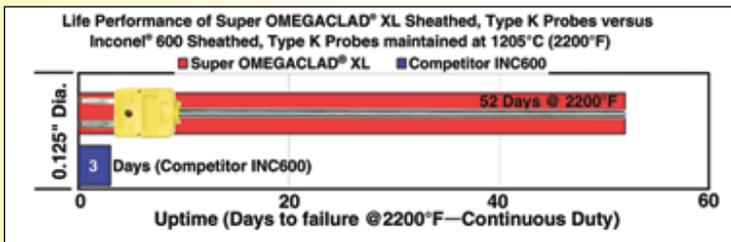
### Small Size, Big Performance!

Typical 0.8 mm (0.032") Dia. Type K probes have a maximum temperature of 700°C (1260°F). Our Super OMEGACLAD® XL 0.8 mm (0.032") Dia. probe took on 815°C (1500°F) for 3 years and even reached 1000°C (1832°F) for 2 months!

0.250"	2.25 sec**
0.125"	0.55 sec**
0.062"	0.3 sec**
0.032"	~0.25 sec**

Probes shown ~50% smaller than actual size.

\*\* Approx. response time—ungrounded in water



### 1204°C (2200°F) replace 17 of theirs in 52 days or just one of ours!

In life-cycle lab testing, the OMEGACLAD® XL sheathed, 0.125" Type K Probe operated continuously for 52 days at 1204°C (2200°F) while competitors' 0.125" Inconel® 600 sheathed, Type K probes lasted 3 days.†

† Results will vary on application and operating environment.

### Long Life, Low Maintenance!

If your application operates at the punishing temperature of nearly 1204°C (2200°F), changing out failed thermocouples costs money in excessive maintenance, slows or cuts production, and can cause inconsistent product quality.

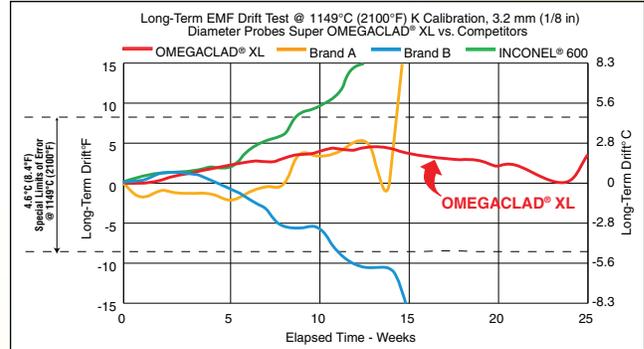
In head-to-head tests, Super OMEGACLAD® XL Thermocouple probes consistently post the best performance results. Our innovative temperature sensors last upwards of 10 times or longer when compared to competitors' Inconel® 600 sheathed probes of equal or larger diameters. Let OMEGA's leading edge products help engineer **your next innovation!**



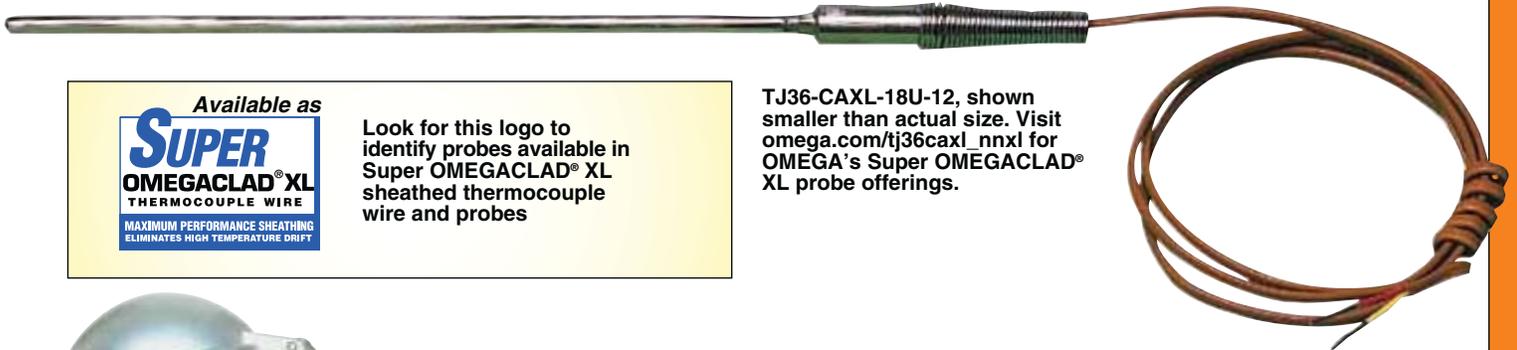
OMEGA's products making OMEGA's products. OMEGA uses Super OMEGACLAD® XL thermocouple probes in its Class 10 clean rooms to monitor critical process temperatures and achieve consistent, high-quality products.

### Low Drift, Reliable Temperatures!

Super OMEGACLAD® XL's low-drift characteristic ensures reliability of temperature readings longer than any other brand or sheath material. Within 15 weeks, Brands A, B, and C exhibited more than 8.3°C drift. At 25 weeks, OMEGACLAD® XL's drift was less than 2.8°C.\*



\* Tests conducted using ungrounded probes in an open-air, electric, muffle furnace versus a Type "S", NIST-traceable standard. Individual results may vary depending on customer application. Inconel® is a registered trademark of Special Metals Corporation.



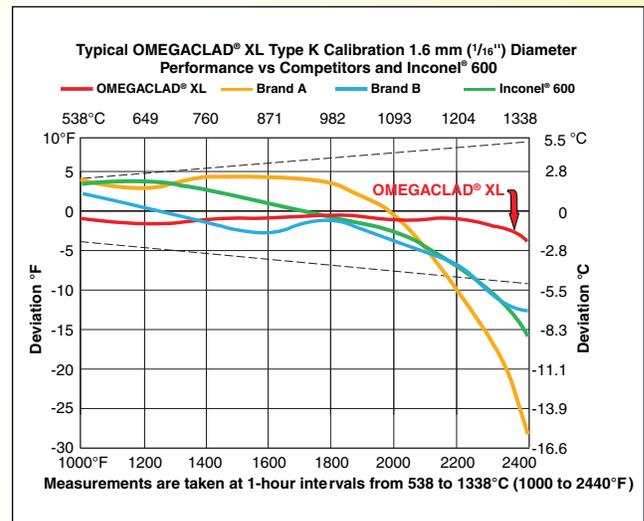
Look for this logo to identify probes available in Super OMEGACLAD® XL sheathed thermocouple wire and probes

TJ36-CAXL-18U-12, shown smaller than actual size. Visit [omega.com/tj36caxl\\_nn1](http://omega.com/tj36caxl_nn1) for OMEGA's Super OMEGACLAD® XL probe offerings.



NB1-CAXL-14U-12, shown smaller than actual size.

### Take on High Temperatures!



In tests up to 1335°C (2400°F), Super OMEGACLAD® XL outperformed both the Inconel® 600 and other competing high-temperature models.

# Super OMEGACLAD® XL Probes

Very Low Drift at High Temperatures

Super Accurate, Super Stable, Super Value—Standard Dimensions

- ✓ For Use Up to 1335°C (2440°F)
- ✓ Excellent Long-Term Stability at High Temperatures
- ✓ Larger Diameter Available (Consult Sales)



Universal connector and clamp included



## Standard Dimension—Quick-Connect Probes

To Order Visit [omega.com/kmqxl\\_nmql](http://omega.com/kmqxl_nmql) for Pricing and Details

ANSI Color Code/Alloy	Sheath Dia. inches	Model Number ANSI Color Code
<b>MOLDED STANDARD CONNECTOR</b>		
K CHROMEGLA®-ALOMEGA® XL Sheath	1/16	KQXL-116[*]-[**]
	1/8	KQXL-18[*]-[**]
	3/16	KQXL-316[*]-[**]
	1/4	KQXL-14[*]-[**]
N OMEGA-P®-OMEGA-N® XL Sheath	1/16	NQXL-116[*]-[**]
	1/8	NQXL-18[*]-[**]
	3/16	NQXL-316[*]-[**]
	1/4	NQXL-14[*]-[**]
<b>MINIATURE CONNECTOR</b>		
K CHROMEGLA®-ALOMEGA® XL Sheath	0.010	KMQXL-010[*]-[**]
	0.020	KMQXL-020[*]-[**]
	0.032	KMQXL-032[*]-[**]
	0.040	KMQXL-040[*]-[**]
	0.062	KMQXL-062[*]-[**]
	0.125	KMQXL-125[*]-[**]
N OMEGA-P®-OMEGA-N® XL Sheath	0.020	NMQXL-020[*]-[**]
	0.032	NMQXL-032[*]-[**]
	0.040	NMQXL-040[*]-[**]
	0.062	NMQXL-062[*]-[**]
	0.125	NMQXL-125[*]-[**]



Heavy-duty style

Miniature style

## Standard Dimension—Transition Junction Probes

To Order Visit [omega.com/kmqxl\\_nmql](http://omega.com/kmqxl_nmql) for Pricing and Details

ANSI Color Code/Alloy	Sheath Dia. (inches)	Model Number ANSI Color Code
<b>HEAVY DUTY TRANSITION JUNCTION PROBE</b>		
K CHROMEGLA®-ALOMEGA® XL Sheath	1/16	TJ36-CAXL-116[*]-[**]
	1/8	TJ36-CAXL-18[*]-[**]
	3/16	TJ36-CAXL-316[*]-[**]
	1/4	TJ36-CAXL-14[*]-[**]
	5/16	TJ36-CAXL-516[*]-[**]
	3/8	TJ36-CAXL-38[*]-[**]
N OMEGA-P®-OMEGA-N® XL Sheath	1/16	TJ36-NNXL-116[*]-[**]
	1/8	TJ36-NNXL-18[*]-[**]
	3/16	TJ36-NNXL-316[*]-[**]
	1/4	TJ36-NNXL-14[*]-[**]
	5/16	TJ36-NNXL-516[*]-[**]
	3/8	TJ36-NNXL-38[*]-[**]
<b>MINIATURE TRANSITION JUNCTION PROBE</b>		
K CHROMEGLA®-ALOMEGA® XL Sheath	0.010	KMTXL-010[*]-[**]
	0.020	KMTXL-020[*]-[**]
	0.032	KMTXL-032[*]-[**]
	0.040	KMTXL-040[*]-[**]
	0.062	KMTXL-062[*]-[**]
	0.125	KMTXL-125[*]-[**]
N OMEGA-P®-OMEGA-N® XL Sheath	0.020	NMTXL-020[*]-[**]
	0.032	NMTXL-032[*]-[**]
	0.040	NMTXL-040[*]-[**]
	0.062	NMTXL-062[*]-[**]
	0.125	NMTXL-125[*]-[**]

**Note:** Probes with 0.032" diameter and larger are supplied with molded transition joints. Smaller-sized probes are supplied with stainless steel transition joints. Stripped leads standard.

[\*]Specify junction type: "G" (Grounded), "E" (Exposed) or "U" (Ungrounded).

[\*\*]Specify length in inches: "6", "12", "18" or "24".

For a male straight M8 plug add "M8-S-M" to the model number and additional cost to the price, for a male straight M12 plug add "M12-S-M" to the model number and additional cost to the price. For a male right-angled M8 plug add "M8-R-M" to the model number and additional cost to the price, for a male right-angled M12 plug add "M12-S-M" to the model number and additional cost to the price.

**Ordering Example for Quick-Connect Probes:** KQXL-18U-12, molded quick-connect probe, Type K (CHROMEGLA®-ALOMEGA®), SUPER OMEGACLAD® XL sheath, 1/8" OD, ungrounded junction, 12".

**Ordering Example for Transition Junction Probes:** TJ36-CAXL-14G-12, heavy-duty transition junction probe, Type K (CHROMEGLA®-ALOMEGA®), SUPER OMEGACLAD® XL sheath, 1/4" OD, grounded junction, 12".

### Dual Elements



The probes shown on this page are also available in our dual element configuration. Please contact the Sales Department at 1-800-TC-OMEGA for more details.

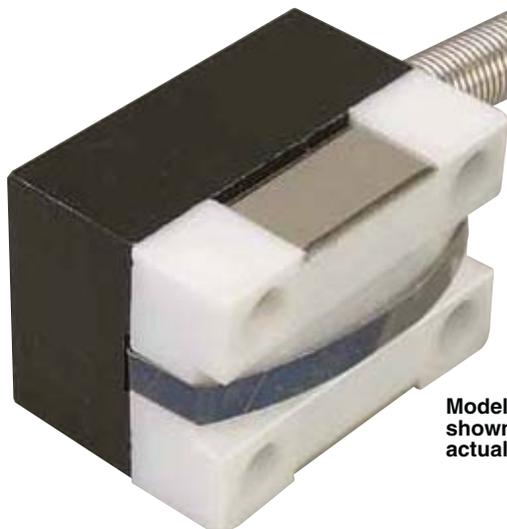
Miniature size

Both models include mating connector and cable clamp and shown smaller than actual size.

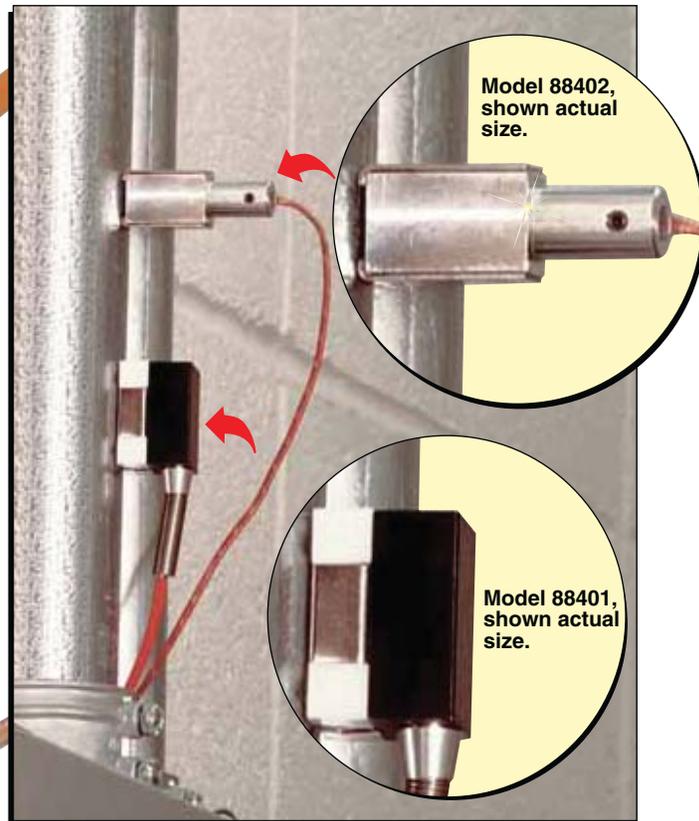
Standard size

# Magnetic Thermocouple Probes

## Model 88401



Model 88401, shown larger than actual size.

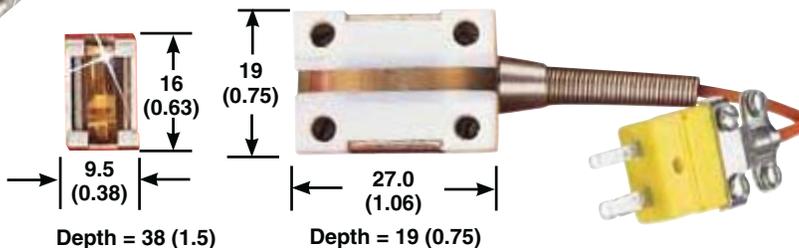


## Model 88402



Model 88402, shown larger than actual size.

Dimensions: mm (inch), shown actual size.



Magnetized probes, suitable for long term contact pressure. Requires 10 seconds to reach full surface temperature. The 88401 uses PFA insulated lead wire and is rated to a max surface temperature of 250°C (480°F). The 88402 uses “GG” fiberglass insulated lead wire and is rated to a max service temperature of 400°C (752°F). Both sensors are supplied with an SMPW connector and TAS adaptor.

### Thermocouple Types:

- K**: CHROMEQA®-ALOMEGA®
- E**: CHROMEQA®-Constantan

**To Order** Visit [omega.com/88401\\_88402](http://omega.com/88401_88402) for Pricing and Details

Model No.	Description
88401K	Magnetic K thermocouple, max temp 250°C (480°F)
88401E	Magnetic E thermocouple, max temp 250°C (480°F)
88402K	Magnetic K thermocouple, max temp 400°C (752°F)
88402E	Magnetic E thermocouple, max temp 400°C (752°F)

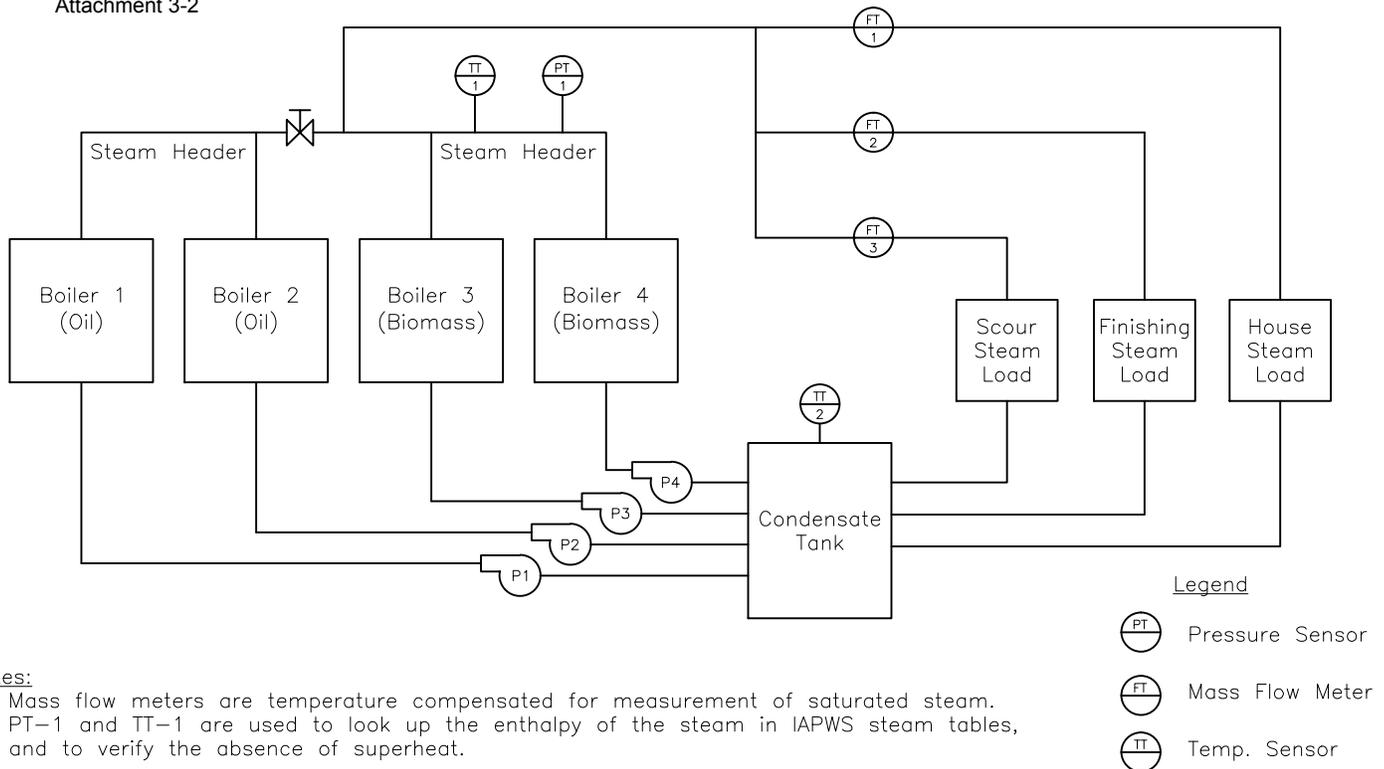
### Accessories

Model No.	Description
88401K-RE	Replacement K element or 88401K
88401E-RE	Replacement E element or 88401E

Comes complete with transition adaptor from flat pin male to round pin male, TAS.

88401 probes come with a replaceable element. Due to the design of the 88402, the element is not replaceable.

Ordering Example: 88401K, magnetic K thermocouple.

**Notes:**

1. Mass flow meters are temperature compensated for measurement of saturated steam.
2. PT-1 and TT-1 are used to look up the enthalpy of the steam in IAPWS steam tables, and to verify the absence of superheat.

**Calculation Narrative for Delivered Thermal Energy to Warwick Mills from Biomass System**

The basis for the calculation of the energy delivered to the system is the measurement of the energy in the steam from the biomass boilers. Subtracted from this value will be the energy returned to the boiler plant in the condensate tank.

Equations 1, 2, and 3 show the proposed method for calculating useful delivered energy.

$$Q = (Q_S - Q_C) * 0.98 * t \quad \text{Equation 1}$$

$$Q_S = h_S * (FS_1 + FS_2 + FS_3) \quad \text{Equation 2}$$

$$Q_C = h_C * (FS_1 + FS_2 + FS_3) \quad \text{Equation 3}$$

Where:

- **Q<sub>S</sub> (Btu/hr)** Energy in steam delivered by the biomass unit to the system, as determined by direct measurement of steam flow, temperature, and pressure.
- **Q<sub>C</sub> (Btu/hr)** Energy returned to the boiler, assuming the feedwater has the same mass flow as the steam supplied to the system, and with an energy content as determined through direct measurement of the temperature in the condensate tank.
- **FS<sub>1</sub>, FS<sub>2</sub>, FS<sub>3</sub> (lb/hr)** are the steam flows measured by flow meters FT-1, FT-2, and FT-3 respectively. These are temperature compensated based on temperature sensors internal to each meter. The values are measured each minute, averaged over each hour, and then the hour's average is used for calculation.
- **h<sub>S</sub> and h<sub>C</sub> (Btu/lb)** are determined based on temperature and pressure measurement of the saturated steam by TT-1 and PT-1, and temperature measurement of water in the condensate tank by TT-2. These values are then used to develop the enthalpy based on IAPWS steam tables.
- **t (hr)** is time in hours. Where readings are taken more frequently, the values are converted to hourly.
- The factor of 0.98 accounts for the 2% reduction in REC generation (discount factor) for parasitic load.

**Fossil Fuel Boilers**

Boilers 1 and 2 are fired on fuel oil. The operating procedure of the facility is to produce steam with exclusively biomass or oil (not both simultaneously). The plant control system continuously monitors and logs the operation of feedwater pumps P1, P2, P3, and P4. Zero RECs will be calculated at any time that feedwater pumps P1 or P2 are operating, irrespective of whether the biomass boilers are operating simultaneously. This will ensure that RECs can never be claimed for steam generated by the oil boilers.

**Accuracy**

The metering and recording equipment meets the requirements for better than ±3.0% accuracy as called for by PUC 2506.04(f)(1), and thus, no discount factor must be taken for equipment accuracy. Parasitic load is not measured, and the 2% discount factor is taken by the owner as shown in Equation 1.

SHEET NO.	REVISIONS			 Wilson Engineering Services, PC www.wilsonengineeringservices.com 902 Market St. Meadville, PA 16335	Warwick Mills New Ipswich, NH	Designed
	Date	Description	Approved			PFO 5/4/15
1						Drawn
						PFO 5/4/15
						Checked
						DAW 7/9/15
Attachment 3-2: Energy Metering Schematic						

### Part 3 Table (for ease of reference, same as previous table with Attachment 3-1)

Item	System or Component	Location	Product Name	Product Manufacturer	Model No.	Operating Range	Maximum Error
1	Steam Flow Meter	FT-1, FT-2, FT-3	Flowmeter for saturated steam	Spirax Sarco	TVA, 3"	97 - 4859 lbs/hr at 44 psig, see attached	0.2% for 2-10% of max flow 2.0% for 10-100% of max flow
2	Pressure Transducer	PT-1	Pressure Transmitter	ProSense	SPT25-20-0100D	0 to 100 psig	+/- 0.50% of full range
3	Condensate Temp. Sensor	TT-2	Type K Thermocouple Probe	Omega	KQXL-14U-6	32°F to 2,282°F	+/- 4°F or 0.4%
4	Steam Temp. Sensor	TT-1	Type K Thermocouple Probe	Omega	88402K	32°F to 752°F	+/- 4°F or 0.4%

### Attachment 3-3 (Manufacturer's Recommendations for Maintenance and Calibration)

Manufacturer's information provided as appropriate.

Item	System or Component	Recommendation	Manufacturer's Information Included
1	Steam Flow Meter	The TVA flowmeter should be zeroed using the zero meter sub-menu at least once a year. This will remove any electronic long term drift that may occur. Frequency of re-calibration depends upon the service conditions experienced by the meter and the application. Re-calibration frequency can be typically between 2 and 5 years.	Yes, in Attachment 3-1
2	Pressure Transducer	No calibration. Should be checked annually to ensure readings are accurate, and replaced if not accurate.	Yes, in Attachment 3-1 - no manufacturer calibration.
3	Condensate Temp. Sensor	No calibration. Should be checked annually to ensure readings are accurate, and replaced if not accurate.	Yes, in Attachment 3-1 - no manufacturer calibration.
4	Steam Temp. Sensor	No calibration. Should be checked annually to ensure readings are accurate, and replaced if not accurate.	Yes, in Attachment 3-1 - no manufacturer calibration.

**Wilson Engineering Services, PC**

902 Market Street  
Meadville, PA 16335  
Office: (814) 337-8223



July 9, 2015

Deborah A. Howland  
Executive Director  
New Hampshire Public Utilities Commission  
21 South Fruit Street, Suite 10  
Concord, NH 03301-2429

Re: Attachment 3-4 Warwick Mills Alternative Metering Method Description

Dear Ms. Howland,

Warwick Mills is requesting approval of an alternative metering method, pursuant to PUC 2506.06. The required metering method applicable to this facility is described in PUC 2506.04(m). The specific requirement for which an alternative method is requested is PUC 2506.04(m)(7), which requires the measurement of “boiler feedwater flow, pressure and temperature as close to the first feedwater pump inlet as possible, thereby excluding the deaerator.”

Warwick Mills proposes the following: This system does not have a deaerator, and thus boiler feedwater temperature in the condensate tank will be measured directly by temperature sensor TT-2. Boiler feedwater mass flow will be assumed to be equal to steam flow as measured by flow meters FT-1, FT-2, and FT-3. Boiler feedwater pressure is not important to the accuracy of the calculations, and will be assumed to be equal to atmospheric pressure. All other measurements are as per the rules, and all meters meet/exceed the accuracy requirements. Attachment 3-2 shows the system schematic and proposed REC calculation.

RECs are calculated by subtracting the mass flow of energy in the feedwater from the mass flow of energy in the steam headers. Assuming that the two are equal provides an accurate assessment of the useful thermal energy delivered to the demands in the facility. The rule mentions placement of the feedwater metering to exclude the “deaerator”. Since Warwick does not have a deaerator, they have determined that this alternative method is more suitable for their facility.

I have evaluated this proposed alternative metering method. The method is technically sound, the meters installed provide the meter accuracy rate of  $\pm 3.0\%$  or better, and this method will provide an accurate assessment of the useful renewable thermal energy delivered by the biomass system.

Sincerely,

A handwritten signature in blue ink, appearing to read "D.A.W.", is written over a light blue horizontal line.

Daniel A. Wilson, P.E.  
Vice President