INSTRUCTION MANUAL

MAGNETIC FLOWMETERS
DT43 Design Level A
Sizes 1/2 through 4 Inches

COPA-XT™ MAGNETIC FLOWMETER

PN24983

ABB Automation

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WARNING notices as used in this manual apply to hazards or unsafe practices which could result in personal injury or death.

CAUTION notices apply to hazards or unsafe practices which could result in property damage.

NOTES highlight procedures and contain information which assist the operator in understanding the information contained in this manual.

WARNING

POSSIBLE PROCESS UPSETS

Maintenance must be performed only by qualified personnel and only after securing equipment controlled by this product. Adjusting or removing this product while it is in the system may upset the process being controlled. Some process upsets may cause injury or damage.

NOTICE

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SAFETY SUMMARY

GENERAL WARNINGS

POSSIBLE PROCESS UPSETS. Maintenance must be performed only by qualified personnel and only after securing equipment controlled by this product. Adjusting or removing this product while it is in the system may upset the process being controlled. Some process upsets may cause injury or damage.

RETURN OF EQUIPMENT. All Flowmeters and/or Signal Converters being returned to ABB Automation for repair must be free of any hazardous materials (acids, alkalis, solvents, etc.). A Material Safety Data Sheet (MSDS) for all process liquids must accompany returned equipment. Contact ABB Automation for authorization prior to returning equipment.

INSTRUCTION MANUALS
Do not install, maintain or operate this equipment without reading, understanding and following the proper ABB Automation instructions and manuals, otherwise injury or damage may result.

SPECIFIC WARNINGS

All flowmeters and/or signal converters being returned to ABB Automation for repair must be free of any hazardous materials (acids, alkalis, solvents, etc). A Material Safety Data Sheet (MSDS) for all process liquids must accompany returned equipment. Contact ABB Automation for authorization prior to returning equipment. (pg. III, 3-1)

Inside edges of the Converter housing casting may be sharp! Use recommended tools, not fingers, to disconnect plugs from the connectors, otherwise injury may result! (pg. 3-3, 3-4)

SPECIFIC CAUTIONS

Some of the IC devices used in the signal converter are static sensitive and may be damaged by improper handling. When adjusting or servicing the signal converter, use of a grounded wrist strap is recommended to prevent inadvertant damage to the integral solid state circuitry. (pg. 3-1)

Use care when reconnecting the Converter coil and electrode interface connections to insure that the plugs are in proper alignment with the pins of the headers. If these connectors do not mate correctly, the Signal Converter will be inoperable and could be damaged when power is applied. (pg. 3-4)

The "magnetic programming stick" is a very strong magnet. Avoid getting the magnet near any magnetic media (such as floppy disks) since inadvertant data loss may result. (pg. 6-2)

GÉNÉRAUX AVERTISSEMENTS

PROBLÈMES POTENTIELS. La maintenance doit être réalisée par du personnel qualifié et seulement après avoir sécurisé les équipements contrôlés par ce produit. L'ajustement ou le démontage de ce produit lorsqu'il est lié au système peut entraîner des dysfonctionnements dans le procédé qu'il contrôle. Ces dysfonctionnements peuvent entraîner des blessures ou des dommages.

RETOUR D'ÉQUIPEMENT. Tout débitmètre et(ou) convertisseur retourné à ABB Automation pour réparation doit être exempt de toute trace de produit dangereux (acide, base, solvant, …). Un certificat de sécurité matériel doit être joint pour tous les liquides utilisés dans le procédé. Contacter ABB Automation pour autorisation avant renvoi du matériel.

MANUEL DE MISE EN ROUTE. Ne pas installer, maintenir ou utiliser cet équipement sans avoir lu, compris et suivi les instructions et manuels de ABB Automation, dans le cas contraire il y a risque d'entraîner blessures ou dommages.

SPÉCIFIQUES AVERTISSEMENTS

Tout débitmètre et(ou) convertisseur retourné à ABB Automation pour réparation doit être exempt de toute trace de produit dangereux (acide, base, solvant, …). Un certificat de sécurité matériel doit être joint pour tous les liquides utilisés dans le procédé. Contacter ABB Automation pour autorisation avant renvoi du matériel. (pg. III, 3-1)

Les bords des boîtiers des convertisseurs sont coupants! Utiliser les outils recommandés, pas les doigts, pour déconnecter les bornes des connecteurs, autrement vous pourriez vous blesser. (pg. 3-3, 3-4)

SPÉCIFIQUES ATTENTIONS

Certains Circuits Intégrés utilisés dans le convertisseur sont sensibles à l'électricité statique et peuvent être endommagés par une mauvaise manipulation. Pendant l'ajustement ou la maintenance d'un convertisseur, l'utilisation d'un bracelet antistatique est recommandé pour éviter la destruction par inadvertance d'un circuit intégré. (pg. 3-1)

Prenez garde en remontant les connections des bobines et des électrodes à ce que les connecteurs soient bien alignés avec les broches des supports. Si ces connecteurs ne sont pas alignés correctement, le convertisseur ne fonctionnera pas et risque d'être endommagé à la mise sous tension. (pg. 3-4)

Le crayon magnétique contient un aimant très puissant. Eviter de le poser près d'un support d'informations magnétique (disquette, carte de crédit… par exemple) car il pourrait en résulter des pertes de données sur ces supports. (pg. 6-2)

READ FIRST

WARNING

INSTRUCTION MANUALS
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RETURN OF EQUIPMENT
All Flowmeters and/or Signal Converters being returned to ABB Automation for repair must be free of any hazardous materials (acids, alkalis, solvents, etc). A Material Safety Data Sheet (MSDS) for all process liquids must accompany returned equipment. Contact ABB Automation for authorization prior to returning equipment.

Read these instructions before starting installation;
save these instructions for future reference.

Contacting ABB Automation Inc.

Should assistance be required with any ABB Instrumentation product, contact the following:

Telephone:

ABB Instrumentation Technical Support Center
1 (800) 697-9619

E-Mail:

ins.techsupport@us.abb.com

The NEMA 4X rating applies to the meter body and electronics enclosure only. The following accessories (if supplied) may not meet NEMA 4X unless specifically ordered as NEMA 4X:

- meter flanges
- meter installation hardware: studs, nuts, bolts
- enclosure mounting hardware for pipe or wall mounting
- conduit hardware

This product is painted with a high performance epoxy paint. The corrosion protection provided by this finish is only effective if the finish is unbroken. It is the users' responsibility to "touch-up" any damage that has occurred to the finish during shipping or installation of the product. Special attention must be given to: meter flange bolting, pipe mounting of electronics, conduit entries and covers that are removed to facilitate installation or repair. For continued corrosion protection throughout the product life, it is the users' responsibility to maintain the product finish. Incidental scratches and other finish damage must be repaired and promptly re-painted with approved touch-up paint. Provide the model number and size of your product to the nearest ABB Automation representative to obtain the correct touch-up paint.

1.0 INTRODUCTION

The ABB Automation DT43 magmeter is the ideal flowmeter to meter liquids with a specific minimum electrical conductivity. The flowmeter's accuracy, lack of moving parts and pressure loss and resistance to abrasion and chemical corrosion make it applicable to a variety of applications. The meter installs easily into an existing pipe line. For many years ABB Automation magmeters have been successfully installed in and are the preferred meters in the chemical, pharmaceutical, food, municipal water and waste water industries.

1.1 Operating principle

The operating principle of the electromagnetic flowmeter is based on Faraday's law of magnetic induction which states that the voltage induced across any conductor as it moves at right angles through a magnetic field is proportional to the velocity of that conductor (see Figure 1-1 below).

The voltage induced within the fluid is picked up by two diametrically opposed mounted electrodes. The induced signal voltage (**E_S**) is proportional to the magnetic flux density **(B)**, the distance between the electrodes **(D)** and the average flow velocity **(v)** of the fluid.

Since the flux density and the electrode spacing are constants, the flow signal is proportional to the average flow velocity of the fluid. Therefore, from the equation for the volumetric flow rate (q_v), the flow signal is linearly proportional to the volumetric flow rate.

1.2 Construction

This compact design (COPA) is a special arrangement of the magmeter flowmetering system. The converter is integrally-mounted directly on the primary, thereby reducing installation costs.

1.3 Model Number Breakdown

The tables on the following pages show the details of the model number composition. Refer to the ABB Automation data sheet or data tag on the equipment for the specific model number of the instrument supplied. A typical data tag is shown in Figure 1-2.

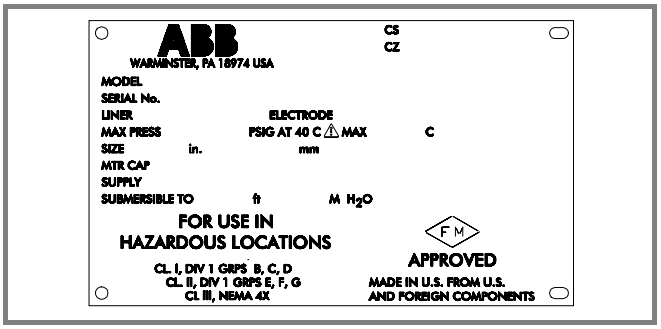
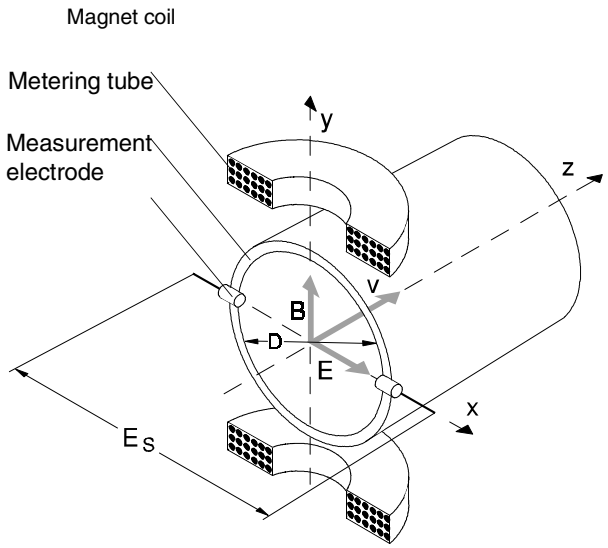


FIGURE 1-2. TYPICAL DATA TAG



E_S = induced signal voltage
B = magnetic flux density
D = electrode spacing
= (actual meter pipe diameter)
v = average flow velocity of fluid
q_v = volume flow rate

$$E_S \sim B \cdot D \cdot v$$

$$q_v = \frac{D^2 \pi}{4} \cdot v$$

$$E_S \sim q_v$$

FIGURE 1-1. BASIC MAGMETER OPERATING PRINCIPLE

1.3.1 Model DT43

Order Number DT43	–	–	—	–	–	–	–	–	–	–
Meter Construction										
Flanged	F									
Wafer (future availability)	W									
Liner Material										
Hard Rubber (2 - 4 in.)		**H**								
Soft Natural Rubber (2 - 4 in.) [future avail.]		**S**								
PTFE Teflon (1/2 - 4 in.)		**T**								
ETFE Tefzel (1/2 - 4 in.)		**E**								
Polyurethane (2 - 4 in.)		**U**								
Neoprene (2 - 4 in.)		**N**								
Meter Size										
1/2 in. (15 mm)			**15**							
1 in. (25 mm)			**25**							
1 1/2 in. (40 mm)			**40**							
2 in. (50 mm)			**50**							
3 in. (80 mm)			**80**							
4 in. (100 mm)			**1H**							
Electrode Materials										
316 Stainless Steel				**S**						
Hastelloy B				**B**						
Hastelloy C				**H**						
Titanium				**M**						
Tantalum				**T**						
Platinim/Iridium				**P**						
Zirconium				**L**						
Flange Standard/Pressure Rating										
DIN PN 10 w/cable seal entry *					C					
DIN PN 16 w/cable seal entry *					D					
DIN PN 25 w/cable seal entry *					E					
DIN PN 40 w/cable seal entry *					F					
ANSI Class 150 w/1/2" NPT conduit entry					P					
ANSI Class 300 w/1/2" NPT conduit entry					Q					
Flange Material										
Carbon Steel						**1**				
304 Stainless Steel						**3**				
Not Applicable						**9**				

* Not FM Approved

1.3.1 Model DT43 (Cont.)

Order Number	DT43	_	_	_	—	_	_	_	_	_	_

Flange Accessories

None	**A**
Protector Plates, 316 SS	**B**
Grounding Rings, 316 SS	**C**
Grounding Rings, Hastelloy-C	**D**
Protector Plates, Hastelloy-C	**E**

Certification

General Purpose	**A**
FM Class I, Div. I - Explosionproof for CL I, Div.1, Gp B,C & D; Dust-Ignitionproof CL II, Div.1, Gp E,F & G; Suitable for CL III, Div.1 NEMA 4X, Electrodes Intrinsically Safe for CL I, Div.1, Gp A,B,C & D - Outdoor Hazardous Location. Accidental Submergence, 33ft H_2O/48 Hr (10m H_2O/48 Hr)	**1**
FM Class I, Div. 2 - Intrinsically Safe Electrodes. Nonincendive for CL I,Div.2, Gp A,B,C & D: Outdoor Hazardous Locations, NEMA 4X. Dust-Ignitionproof CL II, Div 1, Gp E,F & G: Suitable for CL III, Div.1; Accidental Submergence, 33 ft H2O/48 Hr. (10m H2O/48 Hr)	**3**
FM Class I, Div. I (Intrinsically Safe Design) - Customer connections intrinsically safe for CL I, Div.1, Gp B,C & D; Electronics housing safe for CL I, Div.1, Gp B,C & D. Electrodes intrinsically safe for CL I, Div.1, Gp A,B,C & D; Outdoor Hazardous Locations, Dust-Ignitionproof CL II, Div 1, Gp E,F & G: Suitable for CL III, Div.1, NEMA 4X; Accidental Submergence, 33 ft H_2O/48 Hr. (10m H_2O/48 Hr) **[Future]**	**4**
CSA Class I, Div.2 - Nonincendive for CLI/II, Div 2, Groups ABCD; Dust-Ignitionproof CL II, Div 2, Groups EFG, CL III, Div 2; indoor/outdoor Type 4, Accidental Submergence IP68, 33 ft. for 48 hours.	**N**

Display & Magnetic Stick Operation

None	**A**
With (standard)	**D**

Communication

None (standard)	**A**
HART Protocol	**D**

2.0 ASSEMBLY AND INSTALLATION

2.1 Inspection

Before the magmeter is installed, both the primary and converter should be inspected for any damage which may have occurred during shipment. All damage claims should be reported to the shipping agent immediately and before installation of the flowmeter.

2.2 Installation requirements

The electromagnetic flowmeter must be installed in such a way that the meter pipe is always totally filled with fluid and cannot run empty during the measuring procedure. A slight slope of approximately 3% is desirable for assuring this full-pipe condition (See FIGURE 2-1).

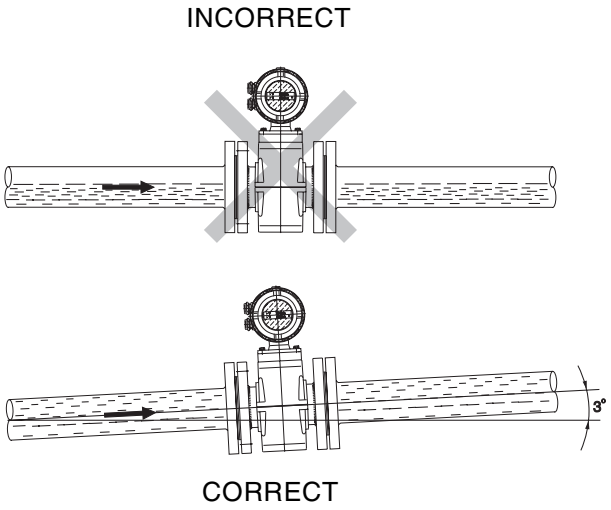


FIGURE 2-1. HORIZONTAL INSTALLATION

When installing the flowmeter in a horizontal pipeline, make sure that an imaginary line (center line) connecting the two electrodes is horizontal so that any trapped gases or air pockets cannot touch the electrodes and cause errors in the flow reading. FIGURE 2-2 shows the desired position of the imaginary connecting line of the electrodes.

By loosening the two screws on the converter base flange, the converter head can be swiveled 90° for better visibility of the instrument's controls and display. Remember to retighten the screws after adjusting the converter head position. **Do not rotate the converter head more that 90°, otherwise permanent damage may result**.

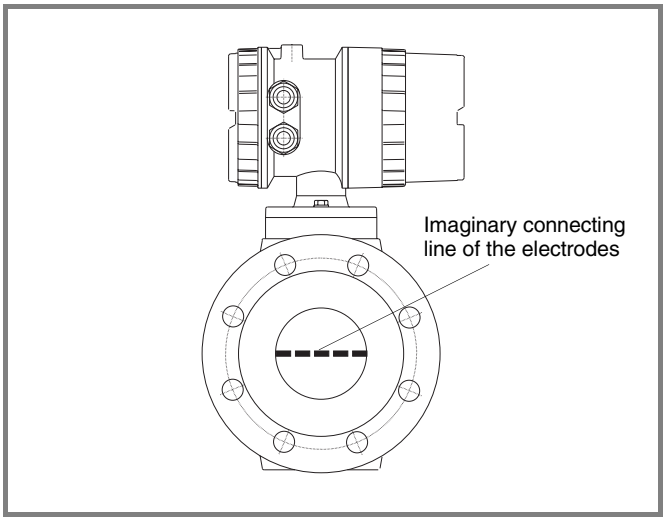


FIGURE 2-2. HORIZONTAL MOUNTING PRECAUTIONS

Installation in a vertical pipe line with fluid moving upward (FIGURE 2-3) is the ideal situation. Avoid installation in gravity-feed pipe lines because it has been found that gravity-feed installation does not guarantee a 100% filled meter pipe during measurement. Furthermore, a state of equilibrium can occur between rising gas and the downward flowing fluid.

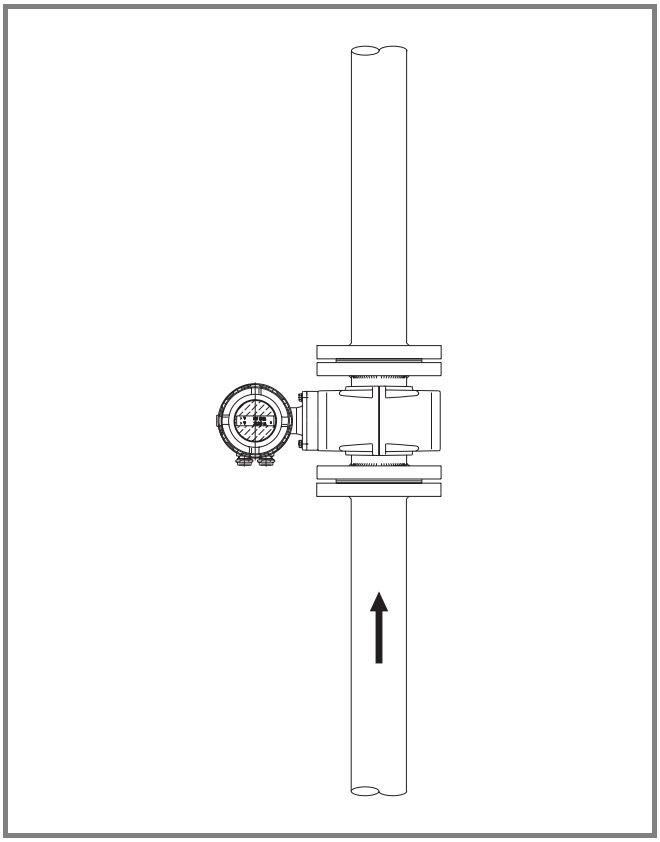


FIGURE 2-3. VERTICAL INSTALLATION

A siphon arrangement such as that shown in FIGURE 2-4 should be provided in open-ended systems. This insures that the flowmeter is completely filled with fluid during measurement.

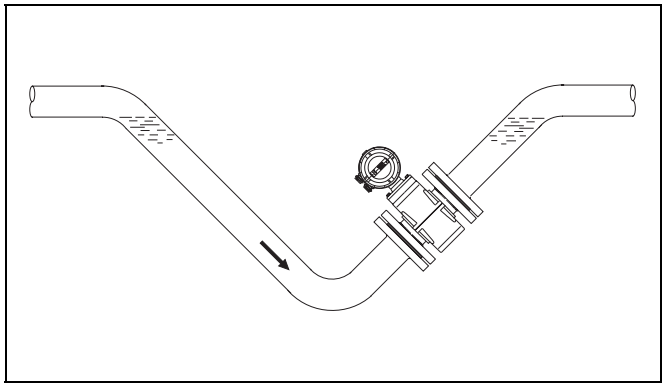


FIGURE 2-4. SIPHON ARRANGEMENT

With a free outflow pipe line (gravity feed pipe), the primary should not be installed at the highest point or in the outlet side of the pipeline. These locations may cause the meter to run empty and experience air pockets. See FIGURE 2-5 for correct and incorrect installation in this type of pipeline.

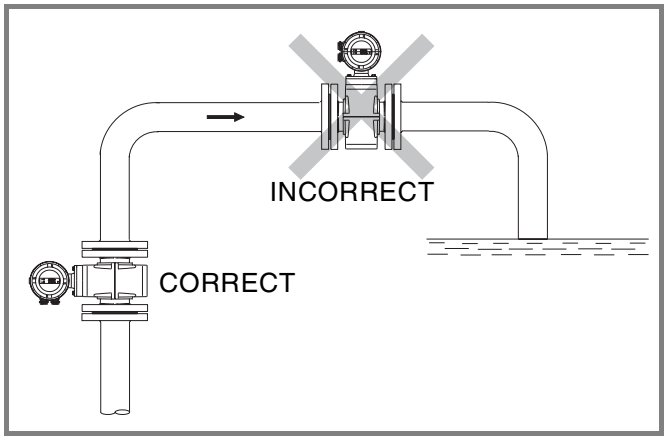


FIGURE 2-5. GRAVITY-FEED PIPELINE

The metering principle is independent of the flow profile, as long as standing eddies do not extend into the metering section. For example, the meter should not be installed immediately downstream of elbows, tangential flow entry or partially open butterfly valves. Butterfly or flap valves must be installed in such a manner that the flap does not extend into the primary.

If necessary, measures should be taken to normalize the flow profile.Practice has shown that a straight pipe run of length 3 x D installed upstream and 2 x D installed dowstream of flowmeter (where D = nominal meter ID) is sufficient to normalize the flow profile. See FIGURE 2-6.

When using the magmeter as a reference flow standard, a 10 x D straight pipe run upstream and a 5 x D straight pipe run downstream of primary must be installed.

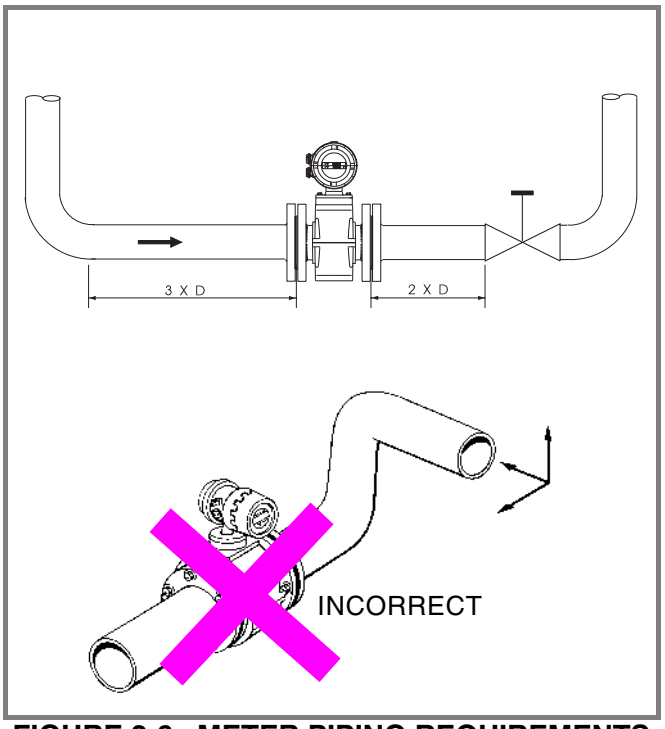


FIGURE 2-6. METER PIPING REQUIREMENTS

For highly contaminated liquids a by-pass as shown in FIGURE 2-7A is recommended. Version A allows cleaning of the flowmeter during operation.

In some cases the fluid's contamination deposits on the electrodes and causes the electrodes to become insulated from the fluid. In these situations, FIGURE 2-7B is recommended.

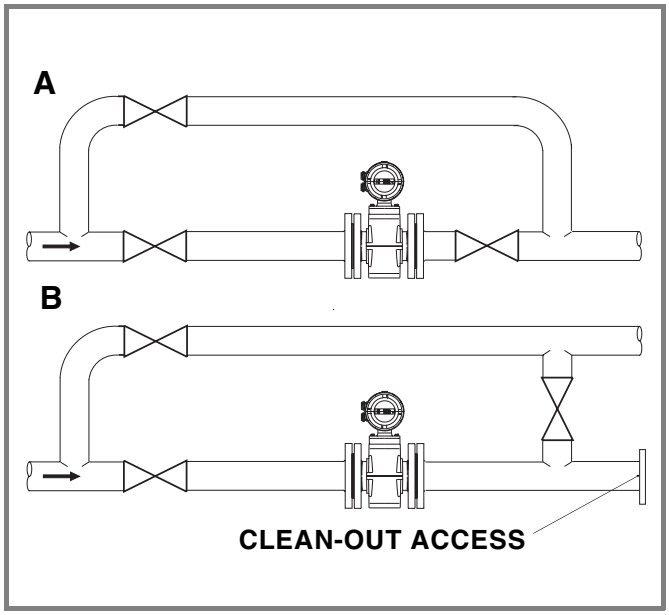


FIGURE 2-7. CONTAMINATED FLUIDS

If primaries are installed close to pumps or other devices that may cause vibration, the application of mechanical vibration dampening devices is recommended (FIGURE 2-8).

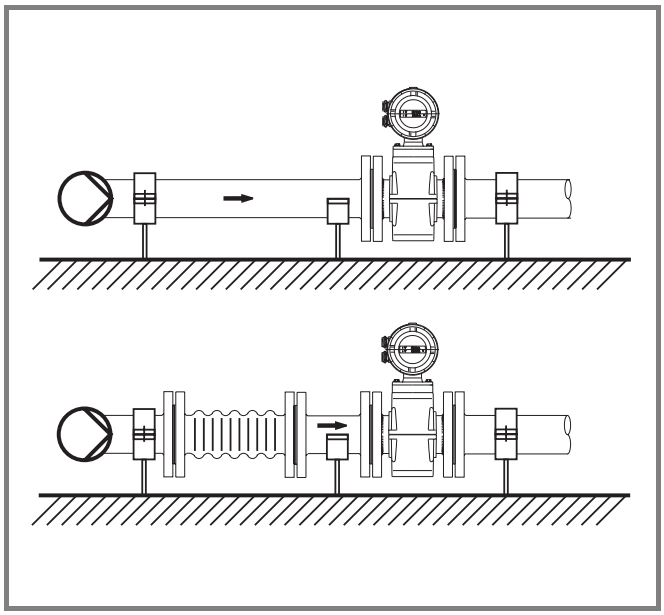


FIGURE 2-8. VIBRATION COMPENSATION

2.2.1 Installation of Primary

The electromagnetic flowmeter can be installed at any arbitrary location in the pipeline as long as the installation requirements of Section 2.2 are observed.

Select the installation site so that moisture cannot leak into the terminal or signal converter housing. Also make sure that gaskets are seated properly and to install the cover carefully after meter installation and start-up.

2.2.1.1Gaskets

Use only the gaskets supplied with the instrument. Using the proper gaskets and installing them correctly will avoid any possibility of leakage. Observe information given in Section 4-1.

NOTE

Do not use graphite gaskets. Under certain conditions they may cause an electrically conductive layer to form on the inside wall of the meter, causing meter operation to degrade.

2.2.1.2 Protective Covers

The protective covers provide protection for the liner. Keep the protective covers in place until the primary is actually ready for installation. Be careful not to damage the liner with the mating flanges to avoid potential leaks. The outline dimensions for specific meters are shown in Technical Data Section 9.0 in Figures 9-7 & 9-8 .

2.2.1.3 Torque Specifications

For 4-bolt and 8-bolt flanges, tighten the flange bolts in a "star" pattern as shown in FIGURE 2-9 to avoid localized stresses on the gaskets. Use a similar method for 12-bolt flanges. It is recommended that the bolts and nuts be lubricated and tightened using a torque wrench. The bolts and nuts should be tightened to approximately 50% of the torque value during the first pass, to approximately 80% during the second pass and to the full torque during the third pass. The maximum torque rate values shown in Tables 2-1 & 2-2 must **not** be exceeded.

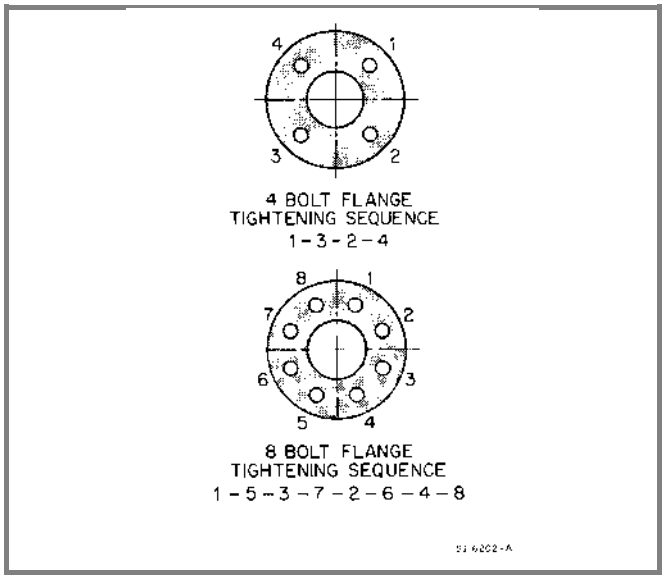


FIGURE 2-9. BOLT TIGHTENING SEQUENCE

TABLE 2-1. Torque Recommendations (ANSI FLANGES)

Size in.	Size mm	ANSI Class 150 Bolt No. & Size (in.)	ANSI Class 150 Max. Torque Rate (ft-lb)	ANSI Class 300 Bolt No. & Size (in.)	ANSI Class 300 Max. Torque Rate (ft-lb)
½	15	4 x ½-13	6	"	7
1	25	"	10	4 x ⅝-11	15
1½	40	"	15	4 x ¾-10	25
2	50	4 x ⅝-11	25	8 x ⅝-11	15
3	80	"	40	8 x ¾-10	25
4	100	8 x ⅝-11"	35	"	40

TABLE 2-2. Torque Recommendations (DIN FLANGES)

Size in.	Size mm	Bolt No. & Size	Max.Torque Rate ft-lb	Max.Torque Rate Nm	Pressure Rating bar
½	15	4 x M12	7.4	10	40
1	25	4 x M12	15.5	21	40
1½	40	4 x M16	31.7	43	40
2	50	4 x M16	41.3	56	40
3	80	8 x M16	36.2	49	40
4	100	8 x M16	34.7	47	16

TABLE 2-3 - Torque Recommendations (WAFER)

Size in.	Size mm	Bolt No. & Size	Max.Torque Rate ft-lb	Max.Torque Rate Nm	Pressure Rating psi (bar)
½	15	4 x ½-13	5.2	7	580 (40)
1	25	"	11.1	15	580 (40)
1½	40	"	24.3	33	580 (40)
2	50	4 x ⅝-11	34	46	580 (40)
3	80	"	29.5	40	580 (40)
4	100	8 x ⅝-11"	49.4	67	580 (40)

NOTE
It is recommended that the mating flanges be made of stainless steel when installing a wafer design flowmeter.

2.2.2 Installation in Larger Pipelines

The primary can be fitted in pipelines of larger diameters using double flanged pipe reducers. The resulting pressure losses can be determined from the nomograph in FIGURE 2-10. The procedure to determine the pressure loss is as follows:

1)Calculate the diameter ratio d/D.

2)Determine the flow velocity v for the meter size and the flow rate

$$v = \frac{Q \text{ (instantaneous flow)}}{\text{meter constant}}$$

The flow velocity can also be determined from the flow rate nomograph on page 10-1.

3)Read the pressure loss from the intersection of the d/D ratio and the velocity curve in Figure 2-10.

2.3 Electrical Connection

2.3.1 Grounding

Proper grounding of the electromagnetic flowmeter is important for correct functioning as well as for safety reasons.

For grounding purposes, an AWG#10 (or heavier) copper wire must be connected between one of the grounding screws (on either the flange or housing) to the protective ground. For accurate flow measurement, fluid and pipeline should be at normal ground potential. Additional grounding by way of terminals is not necessary.

NOTE
Some of the following diagrams show multiple ground connections which should not be interpreted as **separate** earth-ground connections. All meter and pipeline components may be connected together locally and then run to a common earth ground point for simplicity.

The following different type pipelines must be considered for proper grounding procedures:

a) Metal pipe

b) Metal pipe with loose flanges.

c) Plastic, concrete, or pipelines with insulating liners.

With design a) and b) fluid is in electrical contact with piping. With design c) fluid is not in electrical contact with piping system.

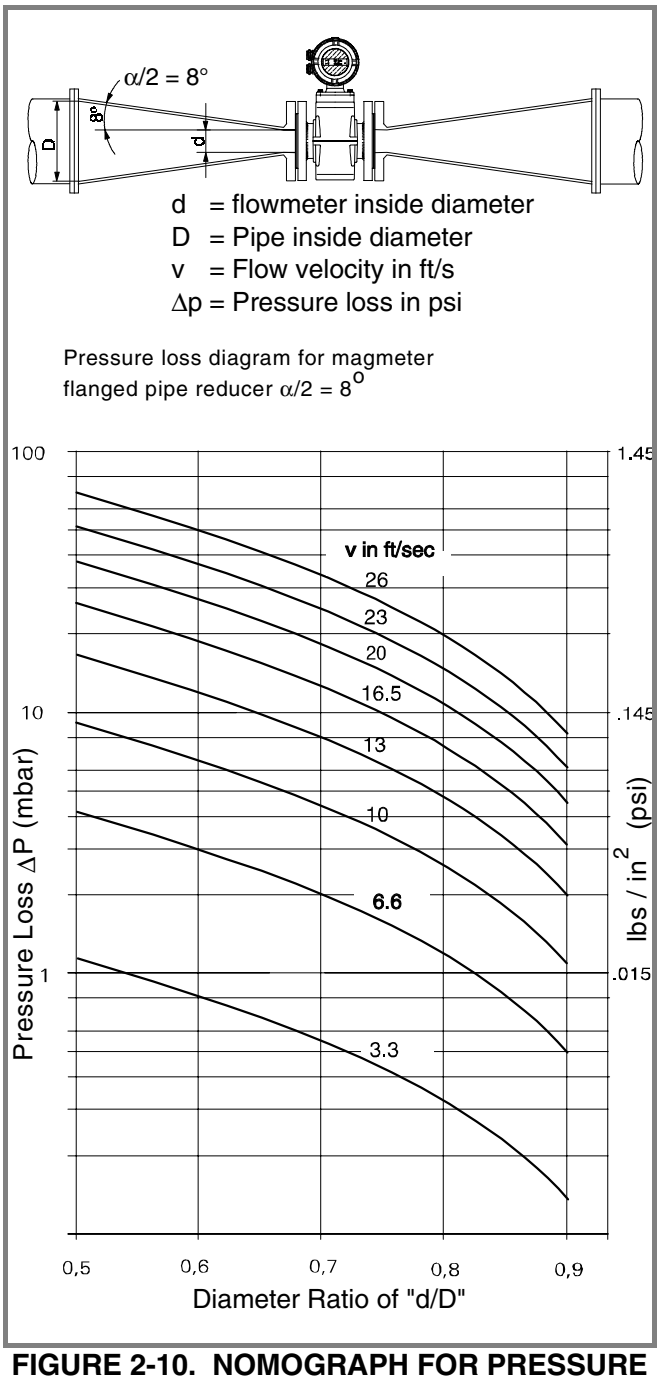


FIGURE 2-10. NOMOGRAPH FOR PRESSURE LOSS CALCULATION

2.3.1.1 Grounding Metal Pipeline

Drill and tap one blind hole (M6 or 1/4" dia.) into the peripheral surface of pipeline flanges next to the grounding wire or grounding terminal of primary. With machine screw, spring and flat washers and additional 10AWG grounding wire, connect primary with pipeline and protective ground potential.

FIGURE 2-11 shows grounding procedure for a wafer-style meter.

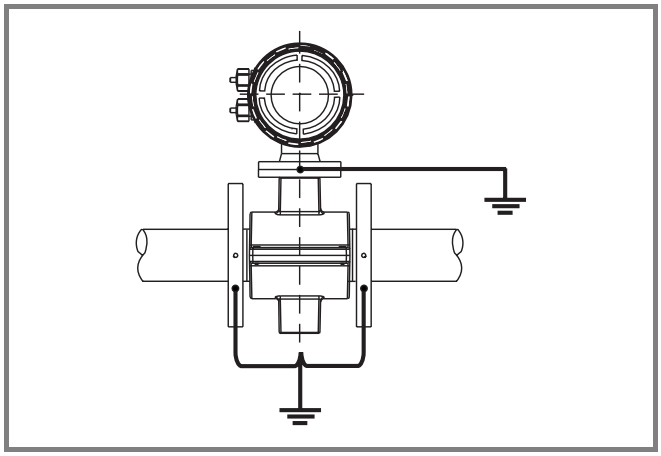


FIGURE 2-11. WAFER STYLE PRIMARY

Grounding procedure for a flanged-style meter is shown in FIGURE 2-12.

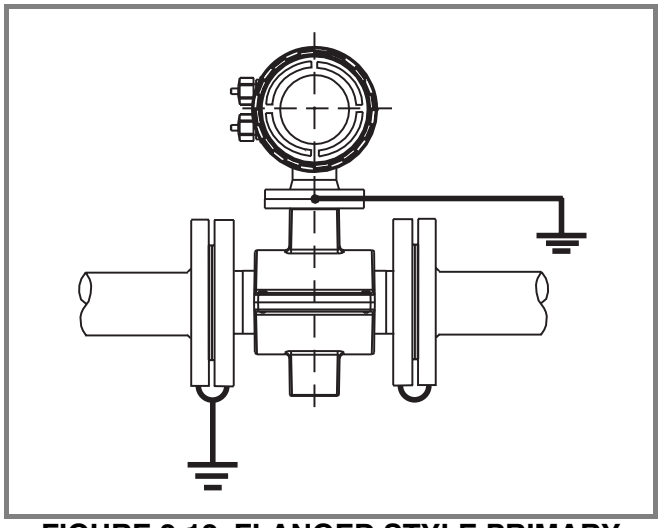


FIGURE 2-12. FLANGED STYLE PRIMARY

2.3.1.2 Grounding Metal Pipeline With Loose Flanges

Weld stud (M6 or 1/4" dia.) upstream and downstream next to the grounding wire or grounding terminal of primary to the piping system.

Using nuts, spring and flat washers and additional 10AWG grounding wire, connect primary with pipeline and protective ground potential.

FIGURE 2-13 shows grounding procedure for a wafer-style meter.

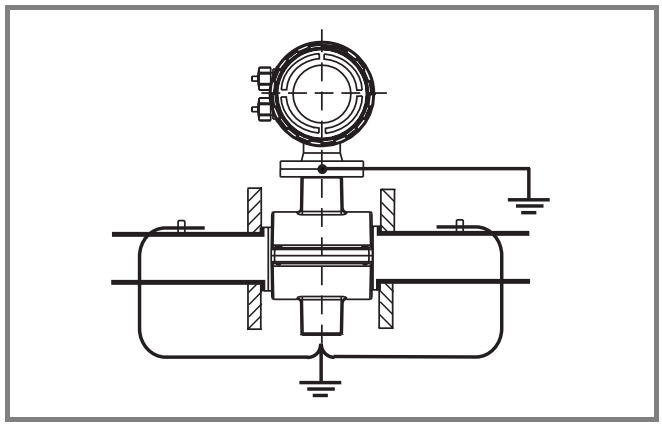


FIGURE 2-13. WAFER STYLE PRIMARY

Grounding procedure for a flanged-style meter is shown in FIGURE 2-14.

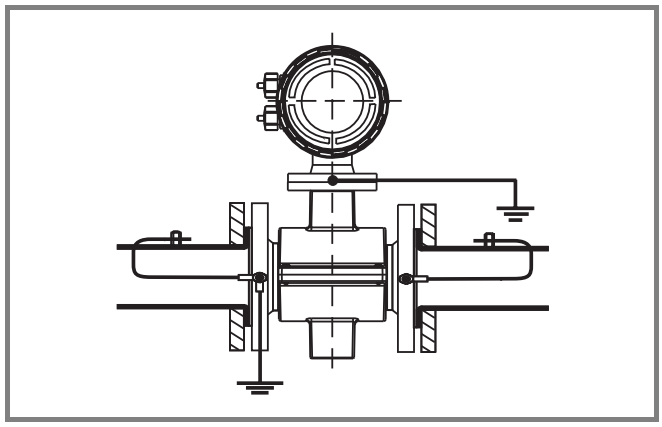


FIGURE 2-14. FLANGED STYLE PRIMARY

2.3.1.3 Grounding Plastic & Concrete Pipelines or Pipelines With Insulating Liners

Install grounding ring and primary in pipeline system. Place grounding ring upstream of primary with the lug protruding next to the grounding wire or grounding terminal of the primary.

Using screws, nuts, washers and additional 10AWG grounding wire, connect primary with grounding ring and protective grounding potential.

Grounding procedure for a wafer-style meter is shown in FIGURE 2-15.

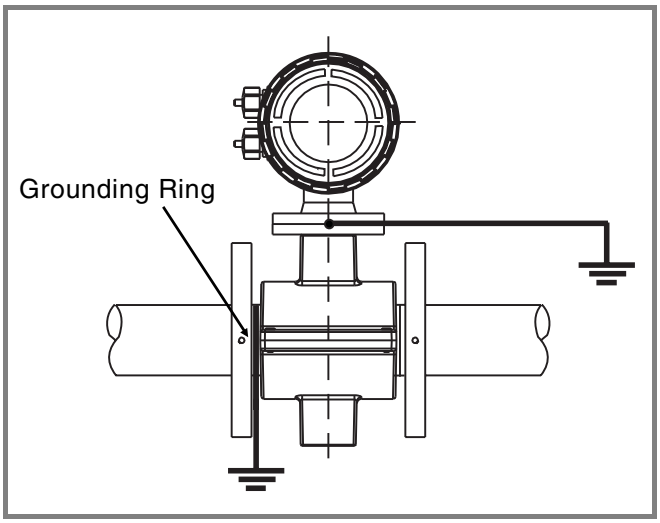


FIGURE 2-15. WAFER STYLE PRIMARY

Grounding procedure for a flanged-style meter is shown in FIGURE 2-16.

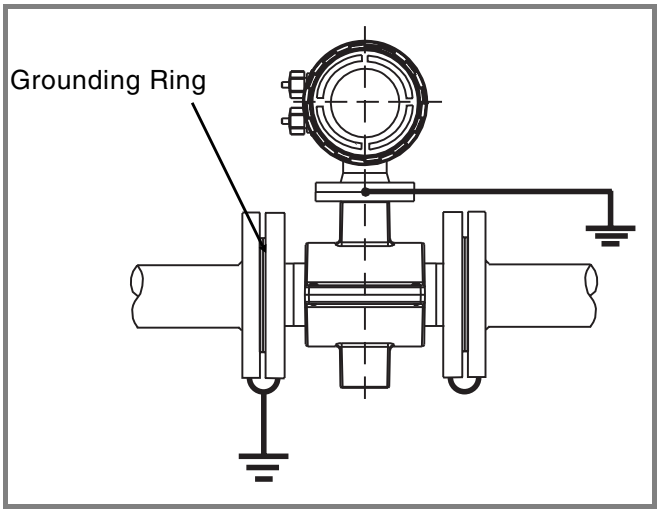


FIGURE 2-16. FLANGED STYLE PRIMARY

For fluid not in contact with the pipeline, refer to FIGURE 2-17.

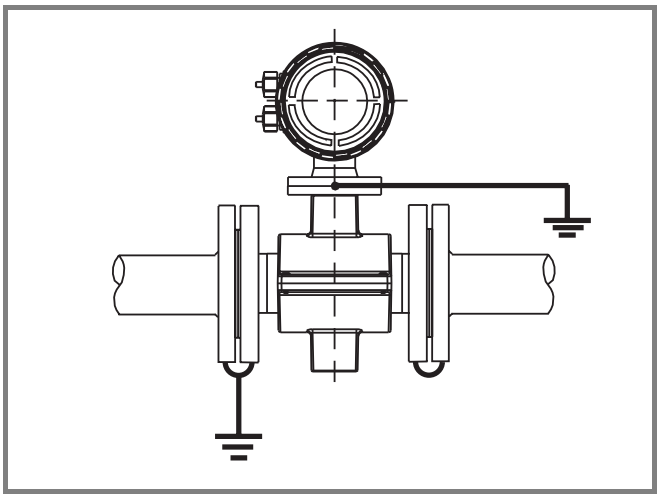


FIGURE 2-17. FLANGED STYLE PRIMARY

2.3.2 Connection to Power Supply

NOTE
In accordance with the National Electrical Code (NEC) and to preserve the NEMA-4X rating, all electrical wiring to the Converter should be run in 1/2 in. NPT conduit. Conduit is **required** when equipment is used in hazardous locations.

Make certain the power supply voltage is the correct value according to information on the nameplate of the primary (See Section 9.0 for specifications). The Model DT43 magmeter is a 2-wire system which means that the meter's power supply and the 4-20 mA output and optional digital-protocol signals are carried over the same set of wires. Refer to Section 2.3.1 for information on proper grounding of the meter.

2.3.3 Connection of Input and Output Signals

The terminals for the input and output signals are located under the terminal housing cover opposite the electronics housing containing the digital display as shown in FIGURE 2-18. The electronic housing does not have to be opened in order to connect the leads.

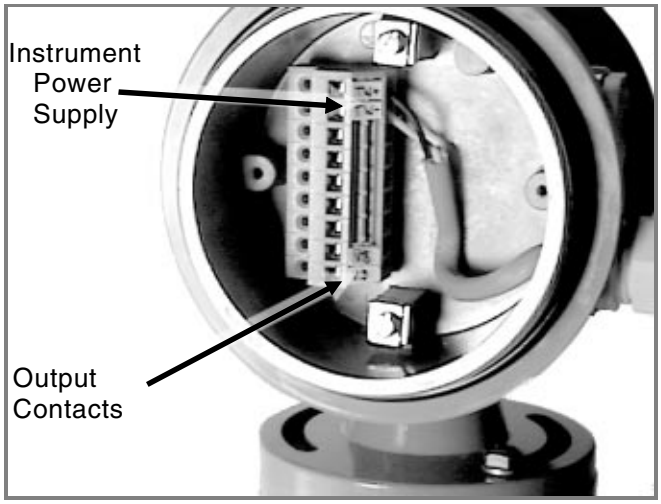


FIGURE 2-18. INTERCONNECTION BOARD

Refer to Figure 2-23 for V8 & V9 contact function.

Terminals TW+ & TW- serve as the power supply connection terminals as well as the 4-20mA output terminals while terminals V8 & V9 are available for contact or scaled-pulse output, refer to Figure 2-23 and Section 9.3.15 for additional information. Figure 2-19 shows a typical power connection diagram for the instrument. Refer to Figure 2-20 for a diagram of permissable load resistance versus power supply voltage.

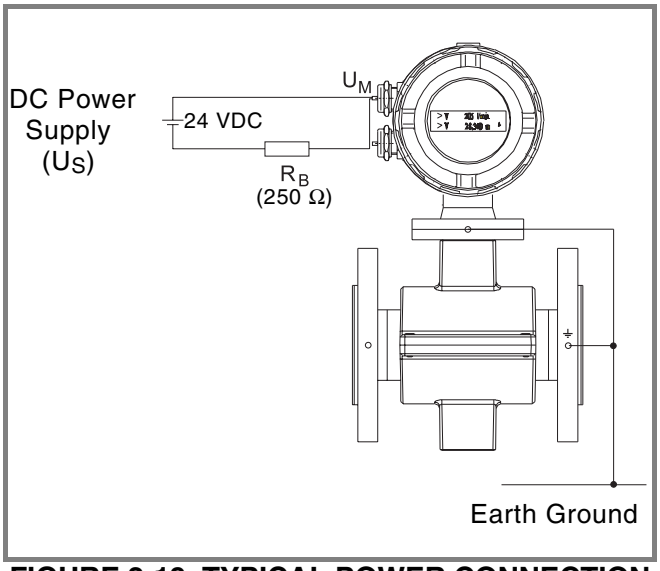


FIGURE 2-19. TYPICAL POWER CONNECTION

The allowable load resistance (R_B) will be dependent on the power supply voltage (U_S). Figure 2-20 shows the relationship between load resistance and power supply voltage.

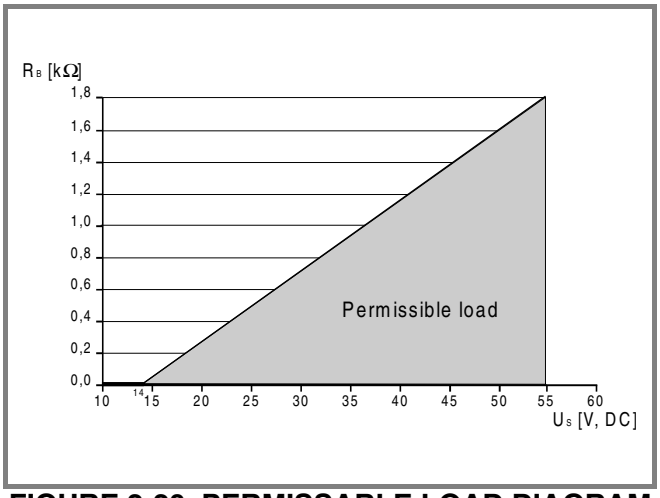


FIGURE 2-20. PERMISSABLE LOAD DIAGRAM

NOTE

For HART Protocol operation, minimum value for R_B is 250 ohms. Refer to Figure 9-5 for HART Protocol wiring.

NOTE

When installing the power cable, it is recommended that any connections to the primary be installed with a water trap as shown in FIGURE 2-21.

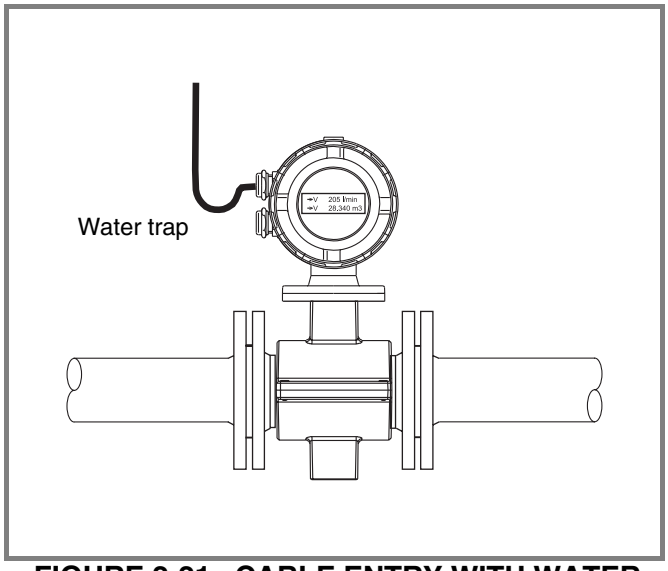


FIGURE 2-21. CABLE ENTRY WITH WATER TRAP

2.3.4 Conduit Entry Seal

The **conduit entry seal** will prevent the process liquid from entering the electrical conduit system. This seal consists of a conduit entry cable seal on the meter junction box. It is the user's responsibility to properly install the conduit entry cable seal fitting supplied with the Signal Converter interconnection cable. This will insure proper performance of this safety feature. Refer to Figure 2-22.

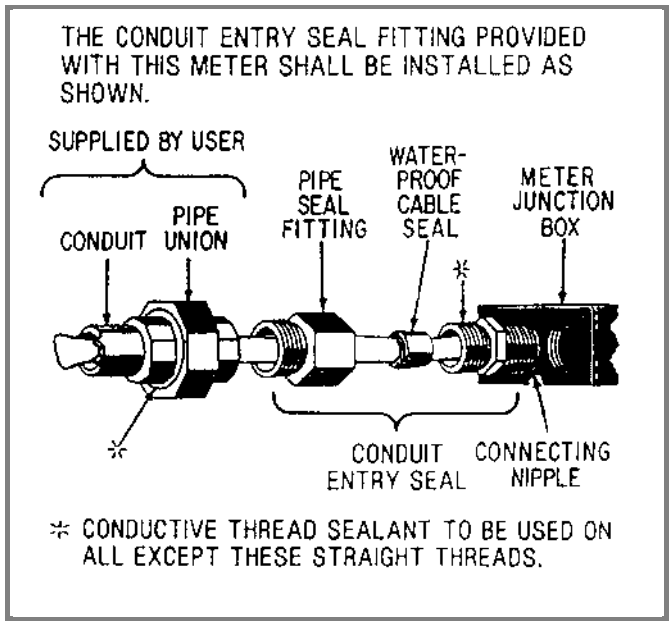
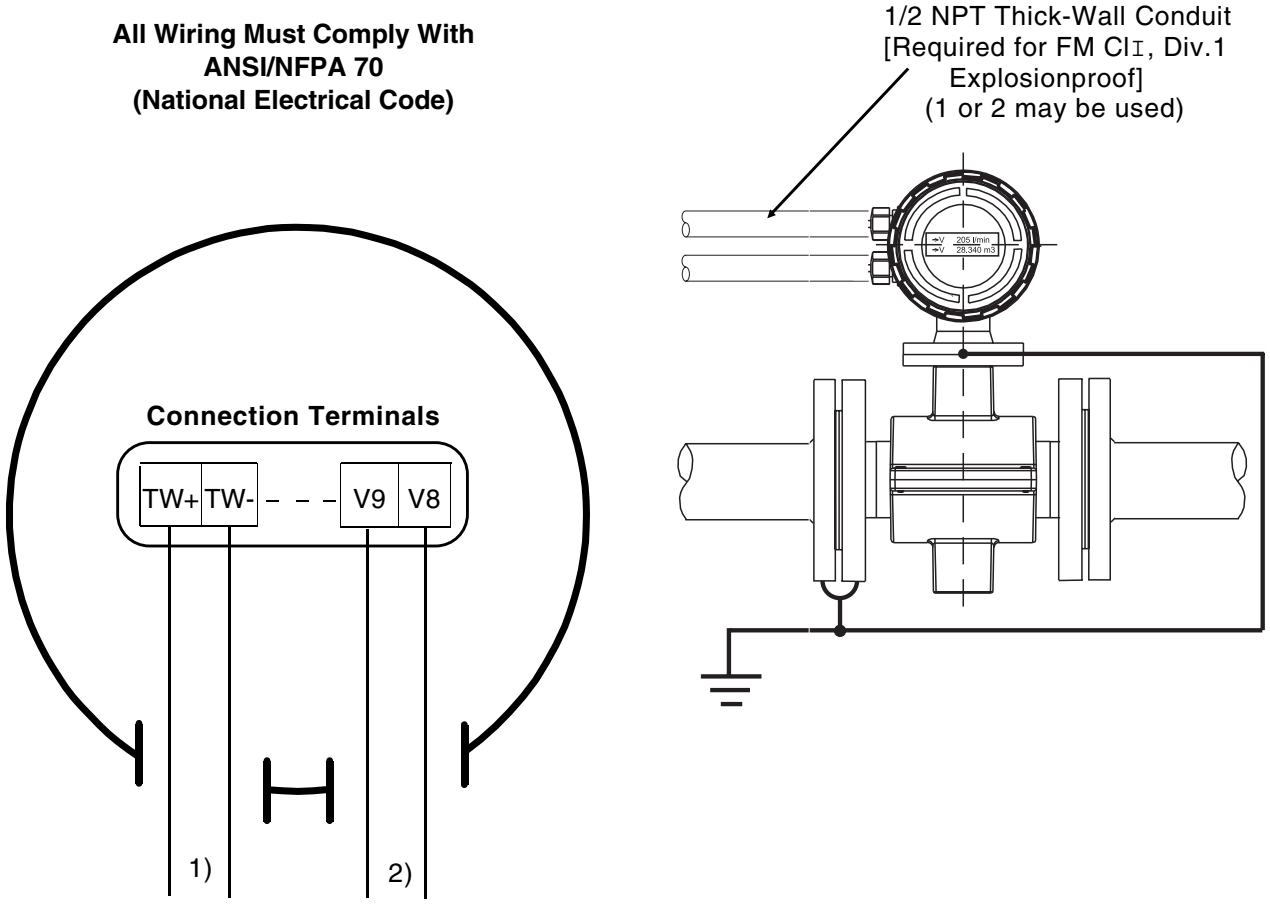


FIGURE 2-22. CONDUIT ENTRY SEAL INSTALLATION

2.3.5 Terminal Connection Diagram



1) Power supply input from transmitter power supply, TW+, TW-, 14-55 V DC

2) Output terminals V8 & V9 are open-collector opto-coupler outputs (Refer to Figure 9-4) and may be software configured as:

Contact output: Function software configurable for system monitoring or F/R flow direction signal*. Output closes on alarm.

or

Scaled pulse output: Passive - pulse width can be set from 0.1 ms to 2000 ms, Optocoupler - f_{max} 100 Hz.

Optocoupler - passive; $0\ V \leq U_{CEL} \leq 2\ V$, $16\ V \leq U_{CEH} \leq 28V$
$0\ mA \leq I_{CEH} \leq 0.2\ mA$, $2\ mA \leq I_{CEL} \leq 10\ mA$
Refer to Section 9.3.15 for detailed information.

* The factory setting is ***No Function*** for binary contact output. See Section 7.0 for additional information.

Comment: To maintain the EMC-Requirements the instrument must be connected to ground.

3) Refer to Figure 9-5 for **HART Protocol** wiring.

FIGURE 2-23. TERMINAL CONNECTION DIAGRAM

3.0 MAINTENANCE

3.1 Maintenance of Primary

The DT43 Primary is a maintenance-free device and requires very little routine service. All repairs and maintenance work should be performed by qualified Customer Service personnel. Once a year, the following items should be checked:

- Ambient conditions (ventilation, moisture)
- Sealing of flange connections
- Screw-type conduit fittings
- Cover screws
- Function of Power Supply
- Lightning Protection System
- Grounding connections

Electrode contamination of either an insulating or conductive nature may lead to different flow rate indication than expected and, consequently, the fluid flow will not be measured properly.

The primary electrodes will require cleaning if the flow rate indication on the converter's display varies while measuring a known constant volumetric flow.

WARNING
All Flowmeters and/or Signal Converters being returned to ABB Automation for repair must be free of any hazardous materials (acids, alkalis, solvents, etc). A Material Safety Data Sheet (MSDS) for all process liquids must accompany returned equipment. Contact ABB Automation for authorization prior to returning equipment.

3.2 Maintenance of Converter

3.2.1 General

Except for an occasional performance verification check, there is no required routine maintenance for the Model DT43. In the event a malfunction occurs in the primary, the meter body must be replaced. The integrally mounted Signal Converter assembly is removable for maintenance or replacement purposes.

ABB Automation offers a Repair/Exchange Program to facilitate replacement of a defective meter or converter. If the equipment is beyond the warranty limit, a fixed price will be charged under this program for replacement of defective equipment with appropriate credit issued when the repairable unit is received by ABB Automation (charges prepaid). The equipment available under this program is as follows:

- the complete Flowmeter with integrally mounted Signal Converter and installation hardware
- the Flowmeter, without the Signal Converter
- the Signal Converter assembly

CAUTION
Some of the IC devices used in the signal converter are static sensitive and may be damaged by improper handling. When adjusting or servicing the signal converter, use of a grounded wrist strap is recommended to prevent inadvertant damage to the integral solid state circuitry.

The signal converter uses complex electronic circuit components. Generally, due to the complexity of troubleshooting integrated circuit devices, maintenance beyond the assembly level is not recommended. Also, caution must be used when connecting test probes, as even a momentary accidental short circuit may damage or destroy an integrated circuit device. Therefore, only trained electronic technicians who are familiar with CMOS technology and have a background in logic and gating circuitry should be permitted to service this equipment.

In the event of a malfunction in the Signal Converter assembly, a replacement electronics assembly can be easily substituted for the defective assembly, thereby minimizing system down-time (see Section 3.2.4). Servicing by substitution of spare assemblies is generally more economical than stocking a large variety of IC chips, transistors, diodes, etc. Also, test equipment requirements and the level of technical expertise necessary are minimized. Should any doubt arise regarding the proper procedure for solving an existing problem, it is suggested that the user contact his local ABB Automation service facility for technical assistance.

NOTE
The Converter contains no customer-serviceable parts. Repairs should only be attempted by a qualified electronics technician.

When communicating with ABB Automation regarding the replacement of a complete meter (with integrally mounted Converter), the meter body, or the Signal Converter, it is important to refer to the com-

plete instrument serial number to assure that the correct replacement will be supplied. The subject information is provided on the manufacturing specification sheet supplied with the Magnetic Flowmeter as well as on the instrument data tags.

3.2.2 System Troubleshooting

During routine operation of the meter, conditions may be encountered which will generate error messages on the display. The table below lists the main error codes which may be encountered, along with any corrective action required.

TABLE 3-1. ERROR MESSAGES

Error Code	Message	Corrective Action
3	Flowrate > 105%	Flowrate greater than 105% of range setting. Reduce flowrate or increase range setting.
5	EEPROM	Data in internal EEPROM is corrupted. If ERROR 5 is displayed on the display perform a "Load data from ext. EEPROM" procedure (refer to Section 7.21). If that doesn't clear the error, contact the ABB Automation Service Dept.
6	Totalizer	Totalizer values corrupted. Reset Totalizer or enter new value in the Totalizer preset (Refer to Section 7.18)
9	Excitation	Contact ABB Automation Service Dept.
A	Max. Alarm	Max. alarm limit exceeded. Reduce flowrate.
B	Min. Alarm	Min. alarm limit exceeded. Increase flowrate.
C	Primary data invalid	Error in ext. EEPROM or ext. EEPROM not installed. Contact ABB Automation Service Dept.

In the event faulty operation of the Magnetic Flowmeter is evident, the following procedure can be used as a guide to isolate the malfunctioning device to either the Flowmeter or the Signal Converter. A standard multimeter and an oscilloscope are suitable for making the test measurements.

1. If improper meter operation is suspected, proceed as follows:

a) Remove front & rear access covers from the Converter housing by turning them counter-clockwise until they separate from the housing.

b) Inspect for evidence of water entry in the connection box and Converter electronics compartment.

If there is any evidence of water entry, de-energize system at power source. Inspect conduit seals and cover gaskets for possible source of water entry. Replace the seals and/or gaskets if evidence of water entry is indicated. Allow interior of Converter housing to dry completely before restoring system power.

2. Possible causes of erroneous flow rate indication are:

- incorrect grounding
- excessive noise due to a heavy slurry process or a non-homogeneous process
- loose or intermittent wiring
- partially empty or empty meter pipe
- excess air entrained in process liquid

3.2.3 Static Test

If improper operation of the Magnetic Flowmeter is suspected, the following resistance measurements can be made to establish whether an electrical malfunction has occurred. A standard multimeter is suitable for making the resistance checks. These measurements can be made at the coil connector located on the top circuit board assembly of the converter electronics assembly.

3.2.3.1 Magnet Coil Check

There are two magnet coils in the meter that are connected in a series arrangement. The coil leads are brought up to a 2-pin connector on the top printed circuit board assembly in the Converter housing. To gain access to this board assembly, remove the Converter's front cover (display cover) by turning the cover counter-clockwise until it disengages from the housing. The coil-connection header is located on the right edge (when facing the display) of the bottom board assembly (refer to FIGURE 3-1).

Before making resistance measurements, verify that the system power service has been de-energized. Remove the electronics housing cover to obtain access to the Primary board.

WARNING
Inside edges of the Converter housing casting may be sharp! Use recommended tools, not fingers, to disconnect plugs from the connectors, otherwise injury may result!

1) Set the ohmmeter to its lowest range; e.g., R x 1.

2) Carefully disconnect the 2-terminal coil connector from the printed circuit board by using needle-nose pliers to grasp the sides of the plug and pulling the

plug upward, away from the printed circuit board, and out of the receptacle.

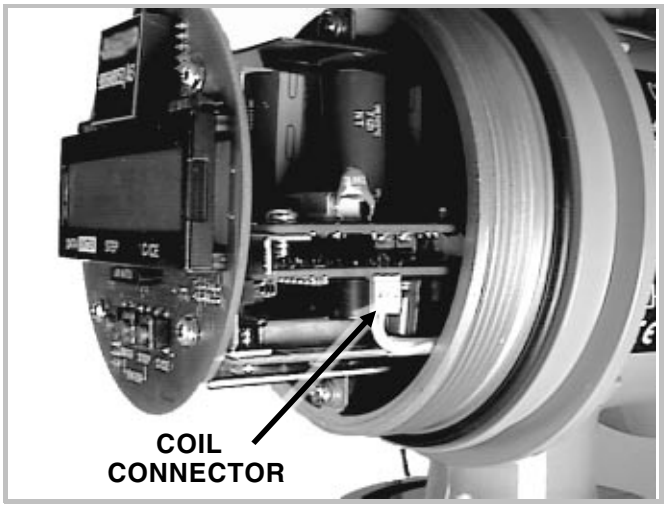


FIGURE 3-1. COIL CONNECTIONS

3) Connect the ohmmeter test leads to the plug terminals inside the plug housing (not the header terminals on the board assembly). It may be necessary to insert small wires into the plug holes to insure reliable contact of the ohmmeter leads to the terminals. The value displayed should correspond to the value (±20%) indicated in Table 3-2.

TABLE 3-2. PRIMARY COIL RESISTANCE

Meter Size		Series Coil Resistance
inch	mm	Ohms (nominal)
½	15	28.4
1	25	44.0
1½	40	44.0
2	50	39.6
3	80	34.2
4	100	38.0

If proper coil resistance is measured, it can be assumed that the magnet coils are functional. If the reading is different from the values in Table 3-1, the Magnetic Flowmeter must be replaced.

4) Set the Ohmmeter to its highest range (R x 10,000) and measure from each coil-connection plug terminal to the converter body (case ground). The resistance reading should be infinite. If this measurement is less than 100K ohms, the meter is defective and must be replaced.

If all measurements appear normal, the coil connector may be reconnected (observe the proper plug orientation, the plug is mechanically "keyed" to the receptacle). After the coil connector is reconnected to the printed circuit board, replace the Converter housing cover and return the meter to service.

3.2.3.2 Electrode Check

The electrode check is essentially a resistance measurement that can be made to establish that a short (or high resistance leakage path) does not exist between one, or both, electrodes and the meter body.

Before proceeding, verify that system power has been de-energized. To perform this test, the meter must be removed from the pipeline and the meter liner "wiped" dry.

When the meter liner has been thoroughly dried, proceed as follows:

1) Remove cover from the Converter housing electronics compartment.

2) Place ohmmeter on highest available range (for example, R x 10,000).

3) Locate the electrode connector on the top of the bottom printed circuit board assembly in the Converter electronics housing. FIGURE 3-2 shows the location of this connector. Carefully remove the connector from the printed circuit board by using needle-nose pliers to grasp the plug by its sides and pulling the plug out of the receptacle.

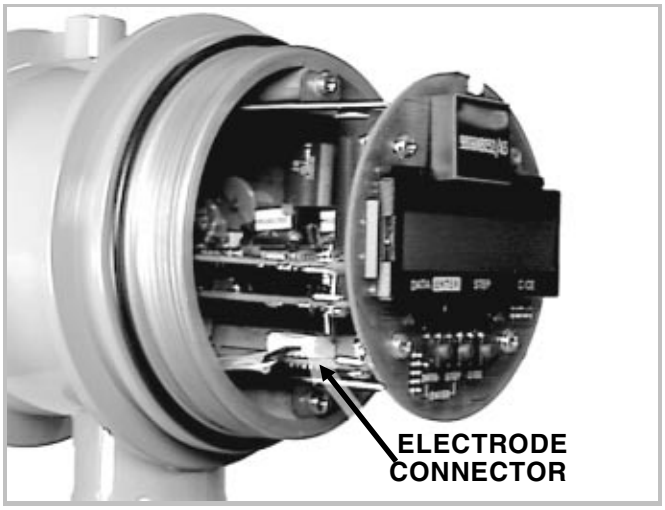


FIGURE 3-2. ELECTRODE CONNECTOR

WARNING
Inside edges of the Converter housing casting may be sharp! Use recommended tools, not fingers, to disconnect plugs from the connectors, otherwise injury may result!

4) Connect the ohmmeter "minus" lead to an unpainted part of the Converter housing (ground) and the "plus" lead to plug connector pin 2. The reading on the ohmmeter should be infinite. If any resistance is measured, the meter is defective and must be replaced.

5) Check the other electrode by connecting the ohmmeter "plus" lead to plug connector pin 3. This reading must also be infinite. If any resistance is measured, the meter is defective and must be replaced.

6) If measurement of both electrodes indicates an infinite resistance reading, the meter may then be returned to service. Reconnect the electrode connector (observe the proper plug orientation, the plug is mechanically aligned or "keyed" to the receptacle) and replace the Signal Converter cover. Return the meter to normal operation

CAUTION
Use care when reconnecting the Converter coil and electrode interface connections to insure that the plugs are in proper alignment with the pins of the headers. If these connectors do not mate correctly, the Signal Converter will be inoperable and could be damaged when power is applied.

3.2.4 Replacing Converter Electronics

In the event it becomes necessary to replace the Converter electronics assembly, the following procedure may be used:

WARNING
Inside edges of the Converter housing casting may be sharp! Use recommended tools, not fingers, to disconnect plugs from the connectors, otherwise injury may result!

1) Using needle-nose pliers, carefully remove the coil and electrode connectors from the electronics assembly (see FIGURES 3-1 & 3-2).

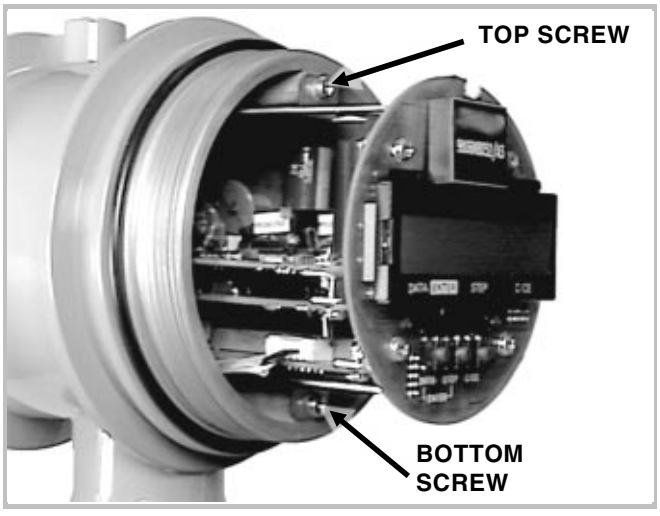


FIGURE 3-3. MOUNTING SCREWS

2) Remove the two electronics assembly mounting screws to disconnect the electronics assembly from the converter housing (refer to FIGURE 3-3). To protect against loss of the screws, the screws are "captured" and will remain in the mounting ears.

3) Carefully remove the I/O connector, shown in FIGURE 3-4, using needle-nose pliers.

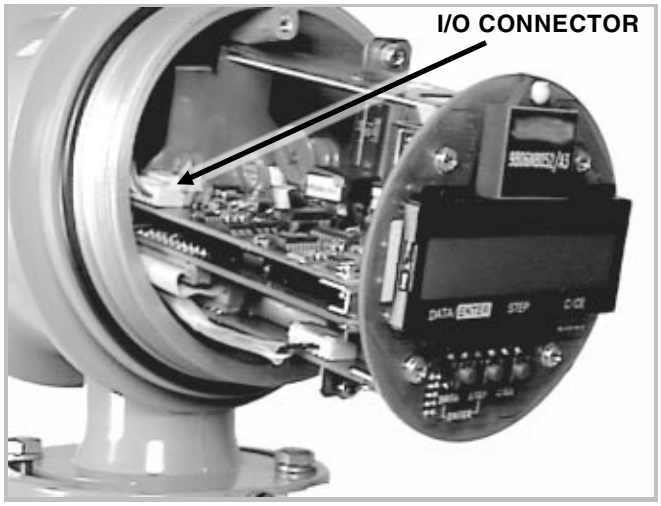


FIGURE 3-4. I/O CONNECTOR LOCATION

4) If replacing the electronics assembly, remove the EEPROM module (See FIGURE 3-5) and reinstall it on the replacement electronics assembly. Go to "Load data from external EEPROM" menu (refer to Section 7.21) and upload programmed data.

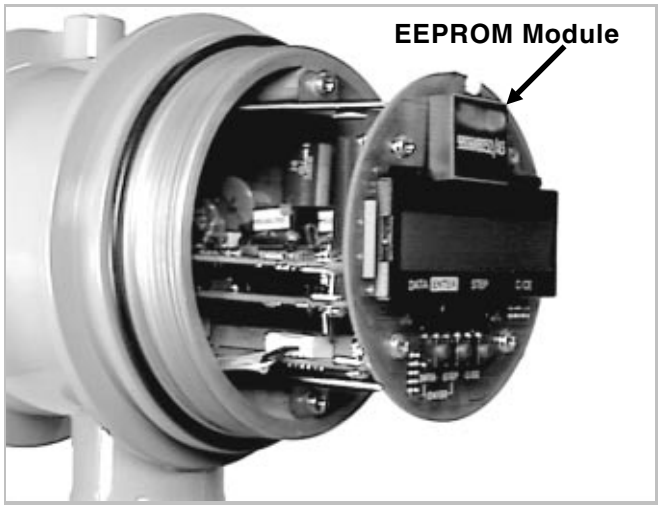


FIGURE 3-5. EEPROM MODULE

5) To reinstall the replacement electronics assembly, reverse the above procedure.

4.0 PARTS

4.1 Gaskets

Some models of the flowmeter are supplied with gaskets. Potential leakage can only be avoided by using and correctly installing the gaskets supplied by ABB Automation. For flowmeter models not supplied with gaskets, use commercially available gaskets that are appropriate for the application and are made of material consistent with the type of fluid and the process temperature (rubber, PTFE, etc.).

Two gaskets are required for each meter. If the meter has grounding rings, two additional gaskets are required for each meter.

When installing the gaskets, follow the procedures provided in Section 2.0 on page 2-3.

NOTE
If it becomes necessary to repair the lining, the electrodes or the coils , it is recommended that the meter be returned to the factory that originally supplied the meter. Before returning the meter for repair, observe the **"WARNING"** instructions in Section 3.0 on page 3-1.

NOTE
Polyurethane, neoprene & hard-rubber lined meters use neoprene gaskets. TEFLON & TEFZEL lined meters use TEFLON gaskets.

TABLE 4-1. FLANGE GASKETS FOR METER BODY

Meter Size		Flange Class	Liner Material	
Inches	mm		TEFLON / TEFZEL	NEOPRENE / HARD RUBBER/ POLYURETHANE
½	15	ANSI 150	333N123P30	----------
		ANSI 300	333N240P30	----------
1	25	ANSI 150	333N239P30	----------
		ANSI 300	333N205P30	----------
1½	40	ANSI 150	333C526U20	----------
		ANSI 300	333N314P30	----------
2	50	ANSI 150	333N415P30	333N415Q10
		ANSI 300	333N416P30	333N416Q10
3	80	ANSI 150	333N509P30	333N509Q10
		ANSI 300	333N510P30	333N510Q10
4	100	ANSI 150	333N604P30	333N604Q10
		ANSI 300	333N702P30	333N702Q10
½	15	DIN PN 10-40	333C609U01	----------
1	25	DIN PN 10-40	333C609U02	----------
1-½	40	DIN PN 10-40	333C609U03	----------
2	50	DIN PN 10-40	333C608U05	333C609U01
3	80	DIN PN 10-40	333C608U06	333C609U02
4	100	DIN PN 10/16	333C608U07	333C609U03
		DIN PN 25/40	333C608U08	333C609U04

4.2 Wiring Entry Seal Parts Kit

ANSI Flanges (Conduit Seal) - **P/N 699B390U02** (Provides seals for both entry ports)

DIN Flanges (Cable Seal) - **P/N D150A004U01** (Provides seals for one entry port only - 2 kits required)
P/N 1D150Z1053 (Dust Cover - 2 required)

4.3 Grounding Rings

TABLE 4-2. GROUNDING RINGS - SIZES 1/2 THROUGH 4 INCHES

Meter Size		Material =	Flange Rating ANSI Class 150		Flange Rating ANSI Class 300	
			316 sst	HAST "C"	316 sst	
Inches	mm	BM No.	Suffix		BM No.	Suffix
½	15	800D508	U01	U09	800D708	U02
1	25	800D508	U02	U10	800D708	U03
1½	40	800D508	U03	U11	----------	---
2	50	800D508	U04	U12	800D708	U04
3	80	800D508	U05	U13	800D708	U05
4	100	800D508	U06	U14	800D708	U06

Order number consists of two grounding rings and mounting screws. When ordering, add suffix to the BM number.

4.4 Protector Plates

TABLE 4-3. PROTECTOR PLATES FOR TEFLON & TEFZEL LINED METERS - SIZES 1/2 THROUGH 4 INCHES

Protector Plate Material	Meter Size Inches = (mm) =	Flange Rating						
		ANSI Class 150						ANSI Class 300
		½ (15)	1 (25)	1½ (40)	2 (50)	3 (80)	4 (100)	4 (100)
316 sst	Suffix =	02	03	04	05	06	07	40
HAST "C"	Suffix =	16	17	18	19	20	21	47

Order number consists of two protector plates and mounting screws. **Since the protector plates also function as grounding rings in this application, grounding rings are not required**. When ordering, specify **614B452U**__ and appropriate suffix from the table above.

4.5 Hardware

Screw, Base to Meter Body - **P/N 22J112AU20** (Qty. 2)
Washer, Base to Meter Body - **P/N 85A027CU20** (Qty. 2)
Cover O-Ring - **P/N 101A820U01** (Qty. 2)

4.6 Magnetic Programming Stick

Magnetic Stick - **P/N D614K001U01**

5.0 START UP

5.1 Preliminary Check List

Follow these start up instructions after completing the assembly and installation of the primary and converter:

- Check that the flow direction of the fluid agrees with the flow-direction arrow on the primary housing.
- Check that the flowmeter is properly grounded. Refer to Section 2.3.1.
- Check that the interconnections agree with the interconnection diagram shown in Figure 2-23.
- Check that the power supply agrees with the specifications on the nameplate.
- Check that the Primary Serial Number (located on the instrument Data Tag) matches the serial number marked on the EEPROM module (located on the Converter display PCB assembly - refer to Figure 3-1).
- Check that the ambient conditions meet the conditions listed in Section 9.0 - Technical Data.

5.2 Turn Power On

The non-backlit LCD display should become active and show information similar to that shown in Section 6.0.

- After the supply power is turned on, the data in the external EEPROM are compared to the values stored internally. If the values are not identical an automatic upload of the data is initiated. The converter displays the message “Primary data loaded”. The meter is now ready for operation
- Some parameters must be entered for proper system operation:

  - The range is automatically set to 10 m/s. Enter the desired maximum forward and reverse flow values in the appropriate units.

  - Hydraulically ideal range end values are approximately 5-10 ft/sec (or 2-3 m/s).

  - The current output is automatically set to 4-20 mA.

  - Set the number of pulses per unit, the pulse width and the Totalizer Submenu for the Passive Pulse Output.

- Check the system zero (Refer to Zero Check, Section 5.3).
- Once the "start-up" procedure has been completed, save the settings that have been entered by performing the "Store Data in Ext. EEPROM" menu procedure (refer to Sections 6.4 & 7.22). In the event that the Converter must be replaced, the EEPROM containing the programming data is removed from the old Converter and installed in the new one (refer to Section 5.4)

5.3 Zero Check

The system zero must be set at the Converter. For this parameter, all flow activity through the flowmeter must be totally stopped. Make certain that the meter pipe of the primary is totally full of fluid. The zero can be set either manually or automatically at the Converter by accessing the "**System Zero Adj.**" menu parameter. Select the menu parameter with the ENTER key and use the arrow keys to select either automatic or manual. Accept the selected parameter by pressing the ENTER key. During the automatic zero adjustment the 2nd line of the display on the converter counts from 400 to zero, after which the system zero adjustment cycle is ended. The automatic adjustment cycle takes approximately 20 seconds to complete. Refer to page 6-5.

5.4 Converter Exchange

All the parameter settings are stored in an external EEPROM installed on the display plate as shown in FIGURE 5-1. If replacing the electronics, remove the EEPROM from the original electronics and insert it into the replacement electronics. On power-up, all data should be accepted and need not be entered again. To insure this, perform a data "upload" using the "Load data from external EEPROM" menu (refer to Sections 6.4 & 7.21).

NOTE
After all parameters have been set and entered they should be saved in the external EEPROM, refer to the "Store data in external EEPROM" menu command in Section 6.4 for more details.

If any menu parameter is ever changed from a previous value, it is always good practice to "download" the new data using the "store data in external EEPROM" menu to insure that the new data is retained in the event of a power loss.

5.5 Rotating the Display

For installations where the meter is installed in a vertical section of piping, it may be desirable to rotate the display 90^{o} to make it more readable. The following procedure may be used if display rotation is desired.

First unscrew the display housing cover by removing the four Phillips head screws shown in FIGURE 5-1.

After removing the screws, the display can be pulled off. Rotate the display to the desired orientation and carefully reinstall it by re-inserting and tightening the four mounting screws. Check that the gaskets are properly seated to insure compliance with Protection Class IP 67.

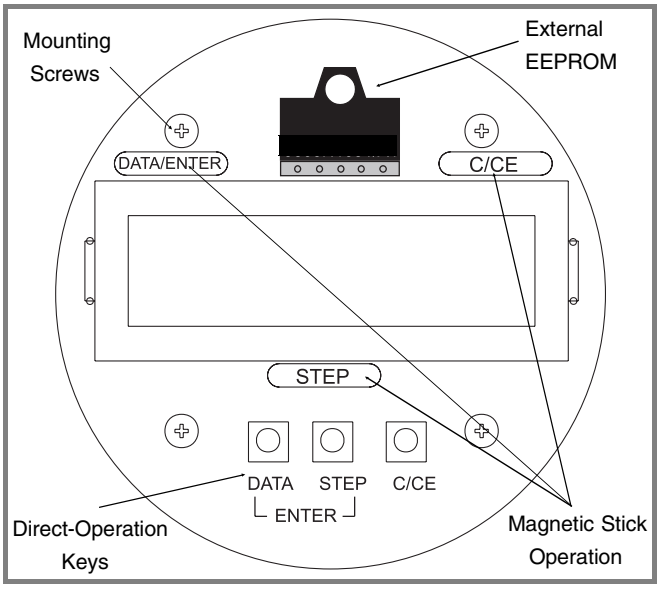


FIGURE 5-1. CONVERTER DISPLAY & EEPROM

6.0 OPERATION: DATA ENTRY AND CONFIGURATION

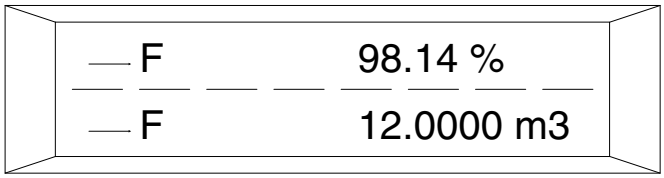
6.1 Display Indications

Initially, after the power is first turned on, the converter model number is shown in the first line of the display and the revision level in the second line. Subsequently the actual process information is displayed.

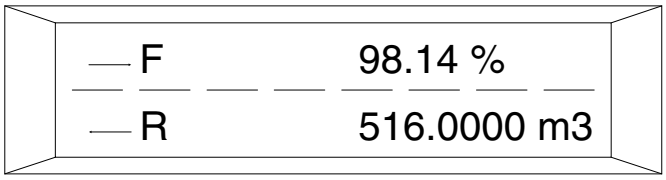
The instantaneous flow rate direction (→F for forward flow or ←R for reverse flow) is displayed on the first line together with the flow value in percent or in direct reading units. The totalizer value for the existing flow direction, up to 7 digits, is displayed in the second line with its corresponding units.

The totalizer values displayed are always those actually measured in their appropriate units, regardless of the pulse factor selected. This display is designated as process information throughout the remainder of this manual.

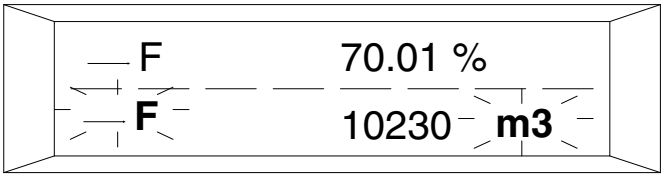
The totalizer value in the other flow direction can be displayed by pressing the STEP or DATA pushbuttons.



1st line Instantaneous forward flow rate
2nd line Forward flow totalizer value



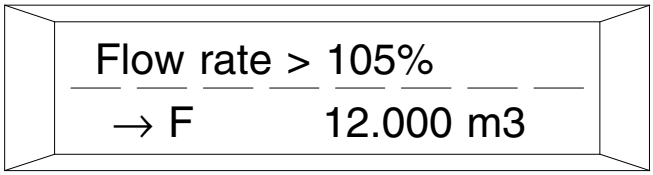
1st line Instantaneous forward flow rate
2nd line Reverse flow totalizer value



1st line Instantaneous forward flow rate
2nd line Totalizer overflow. > F and m^3 are blinking.

A totalizer overflow occurs whenever the totalizer value exceeds 9,999,999. When a value in either of the flow directions exceeds 9,999,999, the flow direction symbol (→F or ←R) and the units displayed in the 2nd line (e.g. m^3) blink. The software can store up to 250 totalizer overflows. The overflow indication can be turned off by pressing ENTER independently for each flow direction (refer to section 7.17, page 7-11).

An error message will appear in the 1st line when an error condition is detected.



Additionally during an error condition an output from the alarm relay or optocoupler is generated and the current and frequency outputs are driven to the "Iout at Alarm" parameter selection (except for Error 6).

Display of the error message will alternate with the corresponding error code on the top line of the display. Only the error message with the highest priority is displayed in text, but codes of all encountered error conditions are displayed in the Error Log.

6.2 Data Entry

Data is entered either by pressing the STEP↑, DATA↓ and C/CE pushbuttons or by using a magnetic "programming stick" to activate magnetic sensors.

The cover must be removed from the housing to gain access to the STEP↑, DATA↓ and C/CE pushbuttons on the converter but need not be removed when programming using the "magnetic stick".

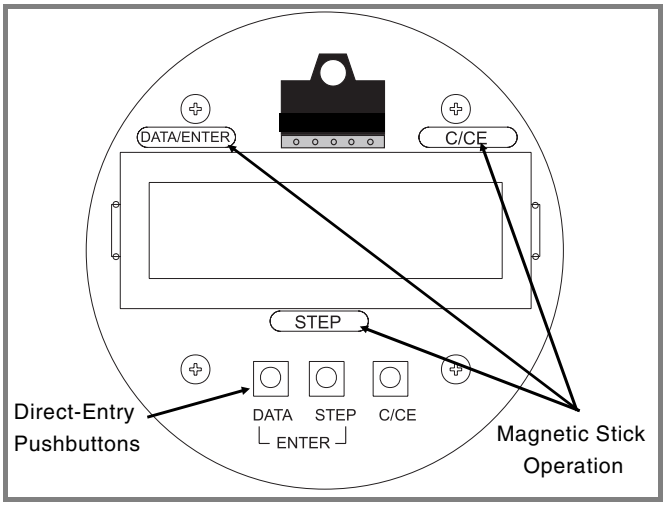


FIGURE 6-1. CONVERTER DISPLAY & PUSHBUTTONS

CAUTION
The "magnetic programming stick" is a very strong magnet. Avoid getting the magnet near any magnetic media (such as floppy disks) since inadvertant data loss may result.

The converter remains active during data entry, i. e. the current and pulse outputs are a function of the actual instantaneous flow values. The functions of the pushbuttons are described below:

C/CE	The C/CE pushbutton is used to toggle between the process mode and the menu.
STEP	The STEP pushbutton is one of two arrow buttons. **Pressing STEP pages through the menu in the forward direction.**
DATA	The DATA pushbutton is the other arrow button. **Pressing DATA pages through the menu in a reverse direction.**
ENTER	ENTER is used to gain access to the parameter to be changed and to store the new data selected or set in the parameter. The ENTER function is only in effect for 10 seconds. If no entry is made during this 10 second period, ENTER must be pressed again. **Manual mode:** the ENTER function is best performed by pressing and holding the DATA pushbutton for longer than 3 seconds or until the display flashes in acknowledgement The Program Protection can be turned on and off by pressing ENTER. **Magnetic mode:** When using the optional "magnetic stick" for operation, the ENTER function is performed by holding the magnetic stick over the DATA/ENTER sensor for longer than 3 seconds. Acknowledgement is indicated by the display flashing.

There are two methods of data entry:

- Direct number entry
- Input from a table menu.

The previous value will be displayed on the converter after 20 seconds if no data is entered. After an additional 10 second delay, the display reverts to indicating the process information.

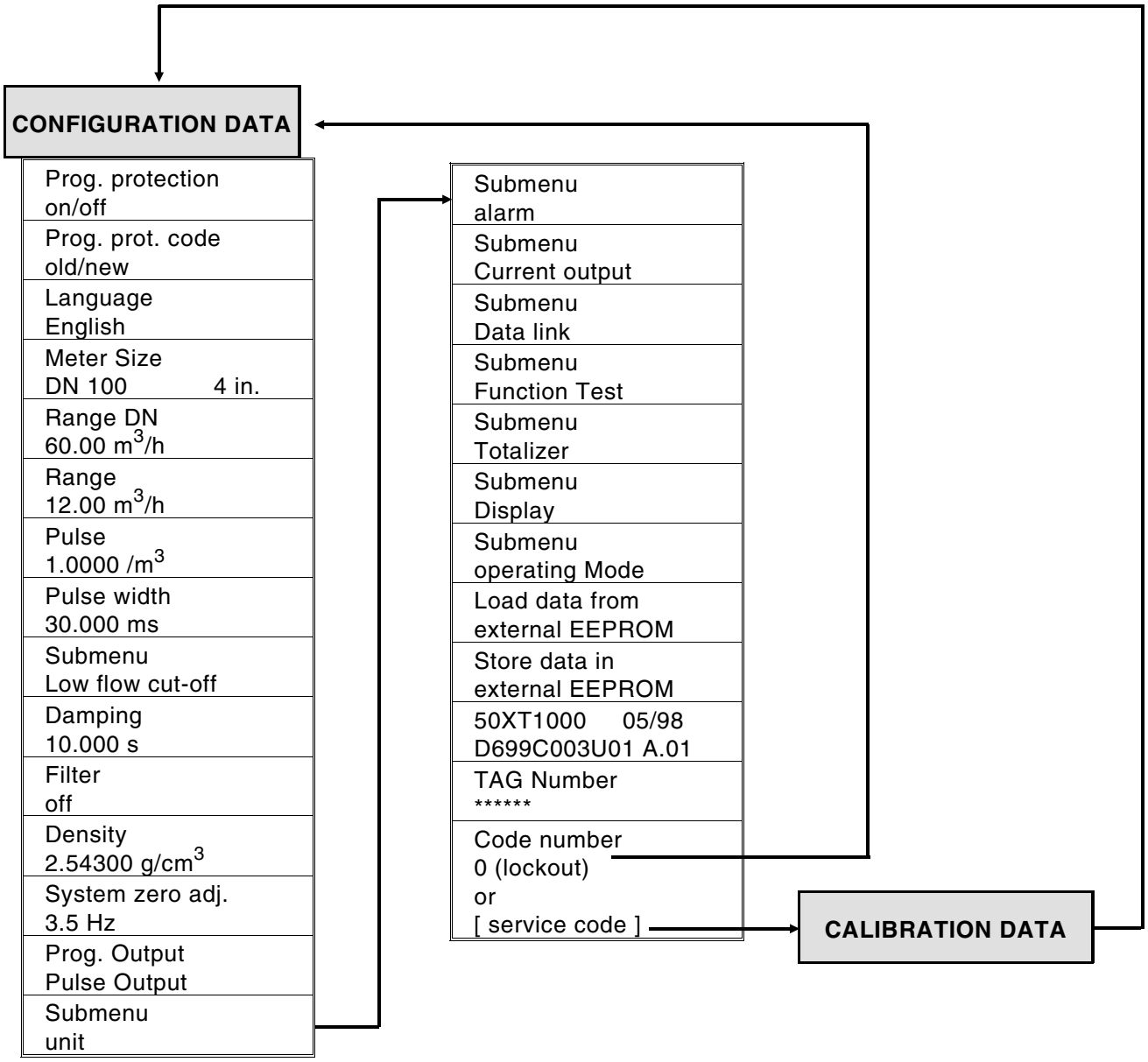
Note:
During data entry the input values are checked for acceptability. If data is not acceptable, it is rejected and a message is generated indicating that the new data has not been accepted.

6.3 Menu Sequence

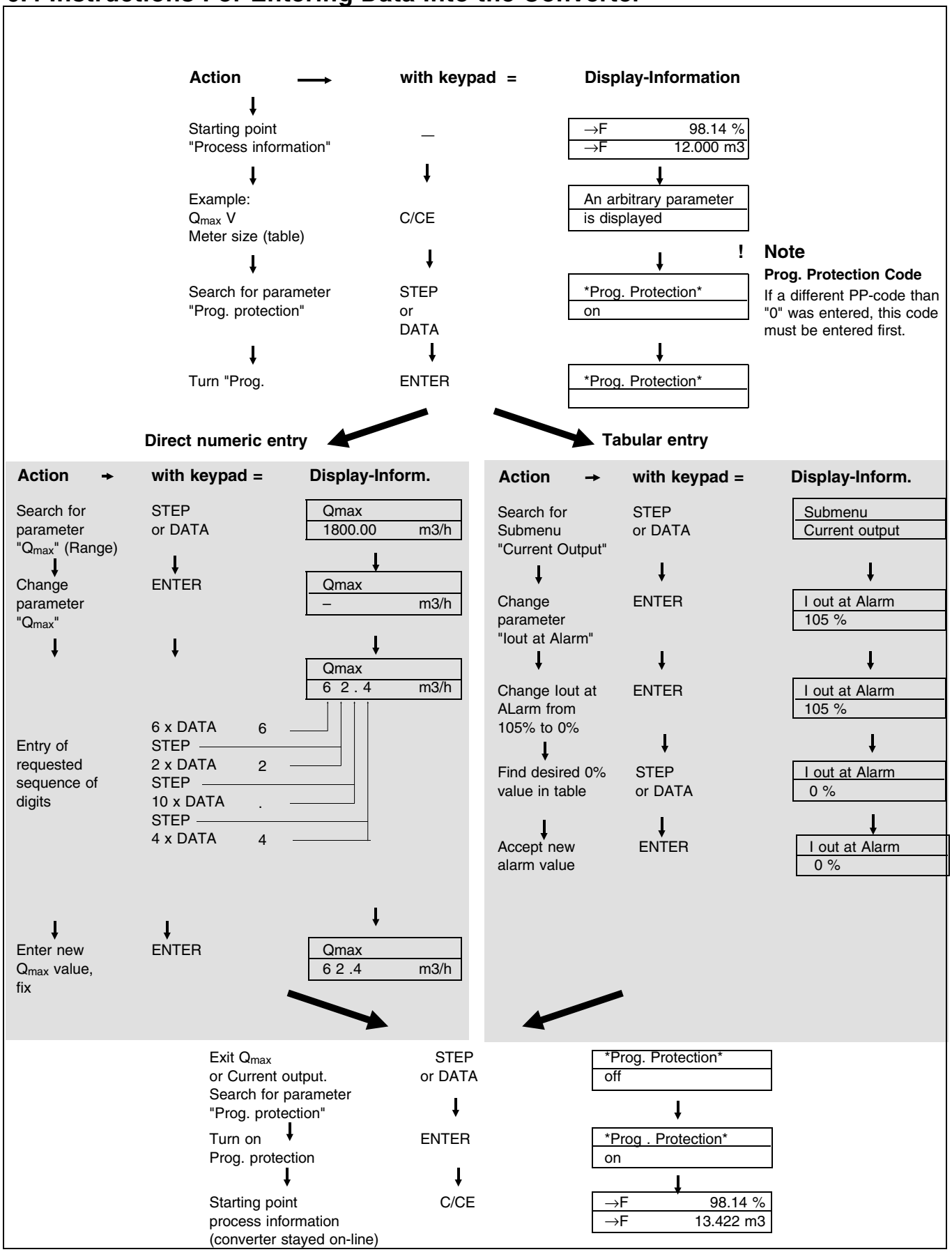
The listing below gives a general overview of the standard top-level display menu sequence when running firmware version A.01

The listing in Section 6.5 shows the standard display menu sequence and submenus using the ↑**Step** button to move through the menu items. The first message displayed the first time the **C/CE** button is pressed after the converter is powered up is "**Prog. Protection ON**". Thereafter, pressing the **C/CE** button while the converter is in monitoring mode will display the parameter that was last exited. Program Protection may be turned "**off**" by pressing the **ENTER** function when the Prog. Protection menu is displayed. When the last menu item is reached, the firmware "wraps around" and scrolls to the first item on the menu once again.

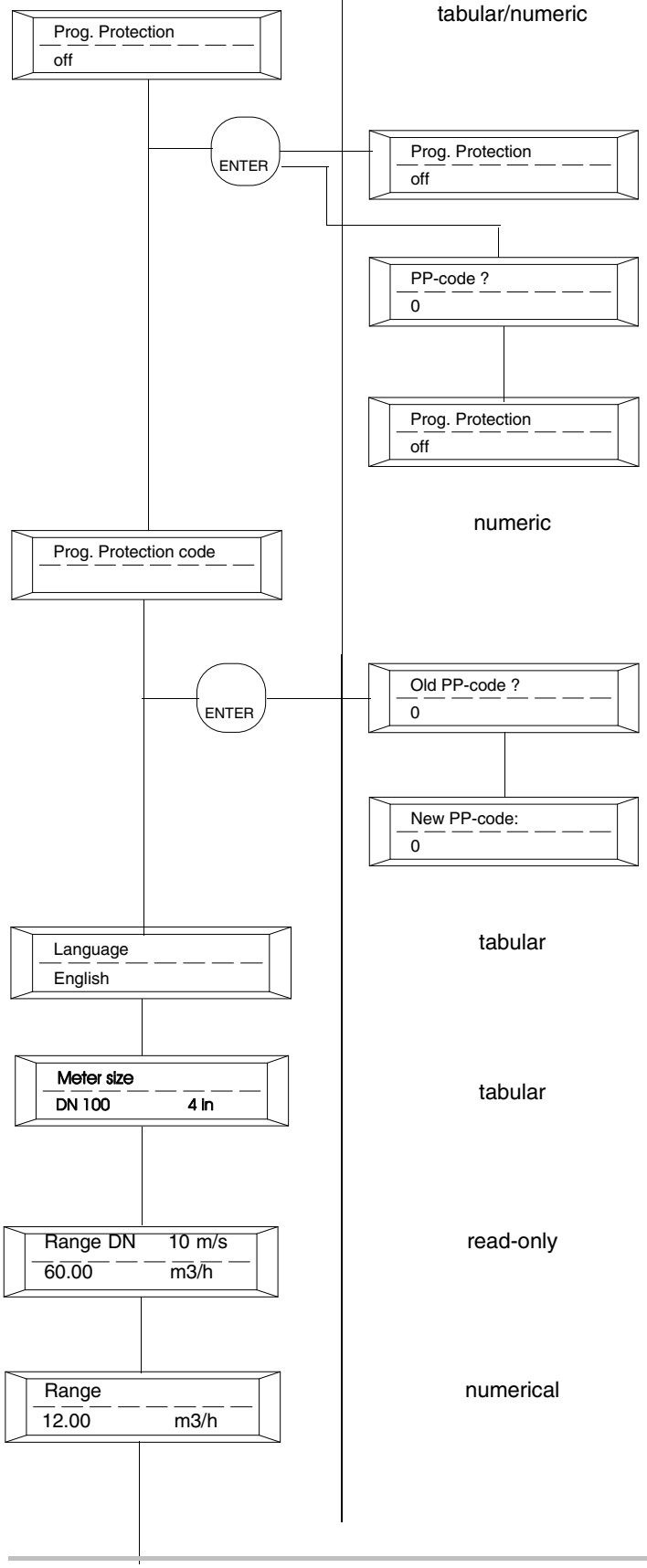
The menu items in the first column are upper-level configuration mode functions. Submenu selections (shown indented in the second column) only appear if the associated upper level is selected by pressing the **ENTER** function. The allowable selections of sub-menu items which are selected by tabular means are shown in detail in Section 7.0



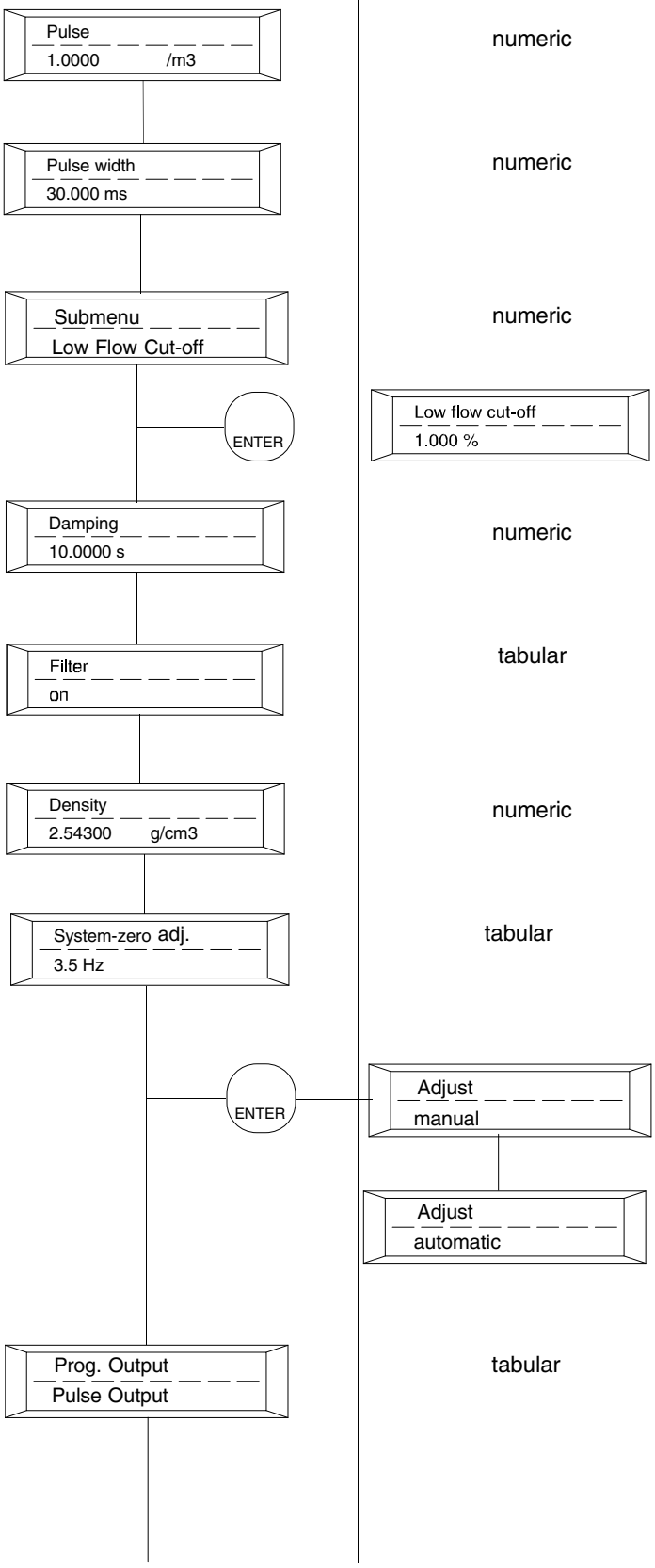
6.4 Instructions For Entering Data Into the Converter



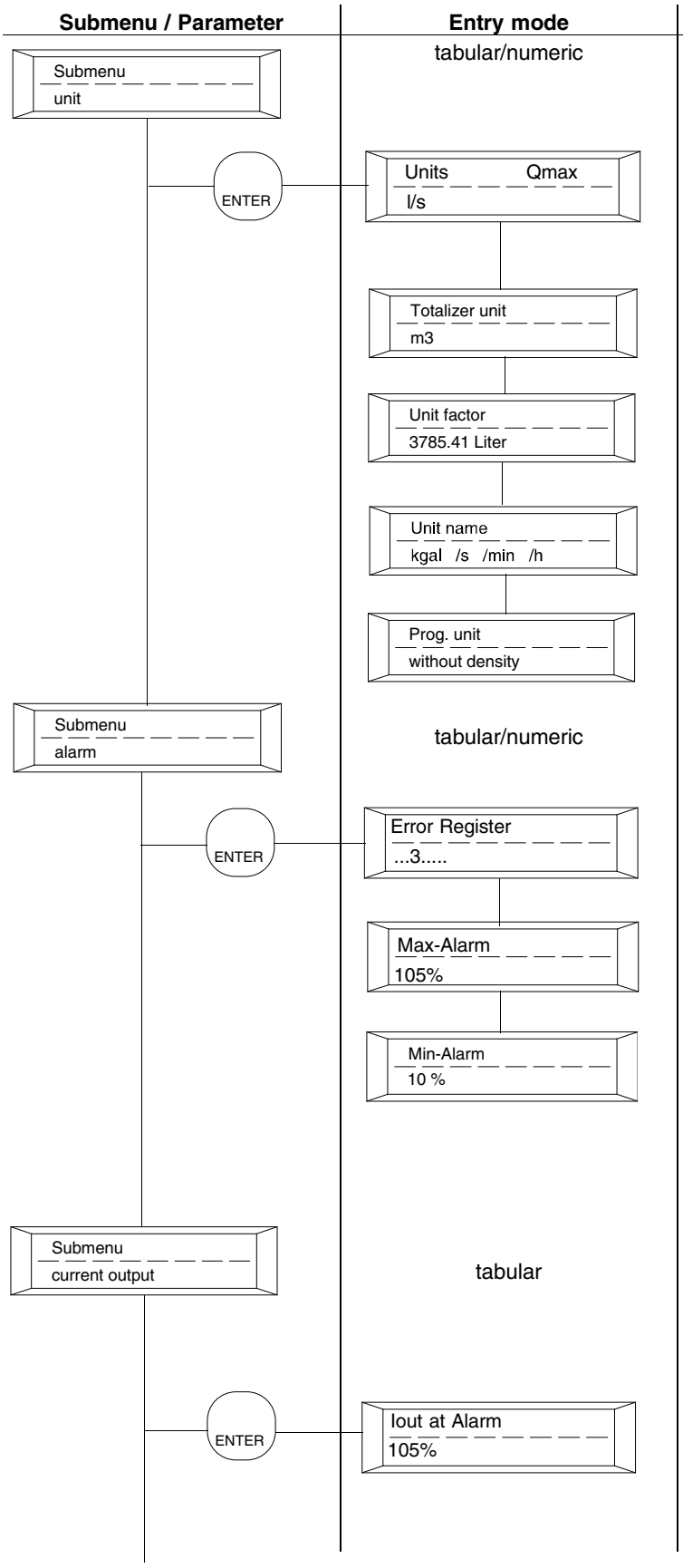
6.5 Parameter Summary and Data Entry

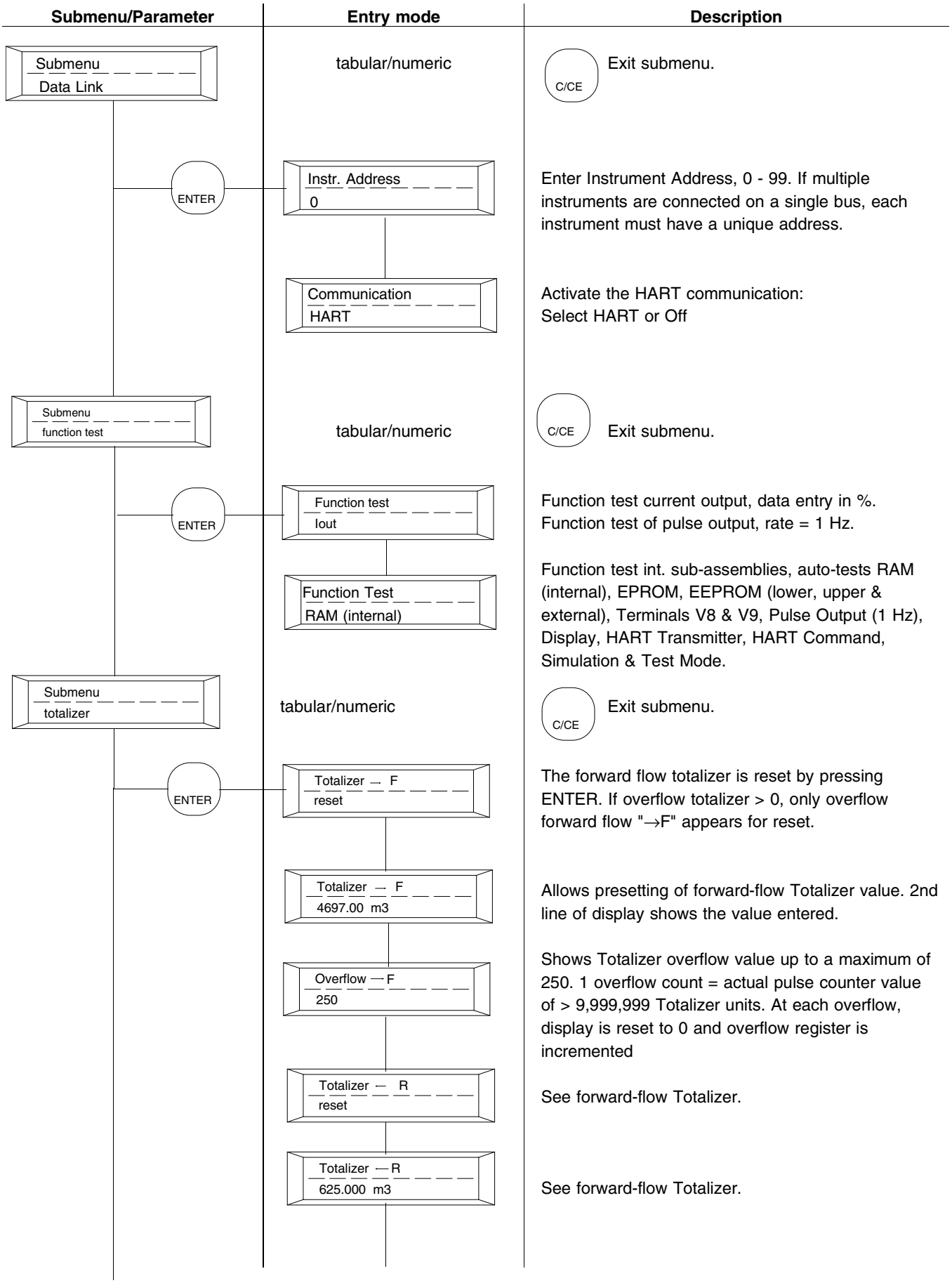


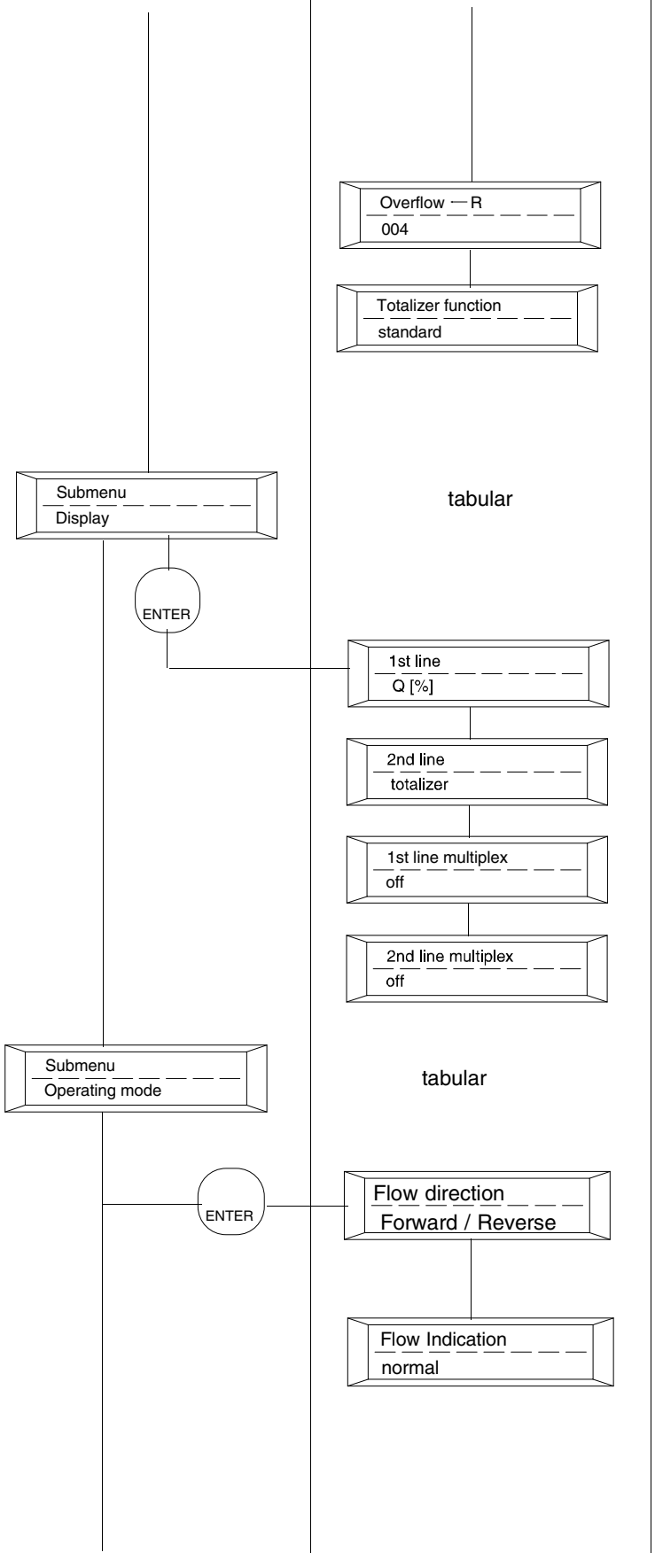
Submenu / Parameter	Entry mode	Description
Prog. Protection	tabular/numeric	Data entry is only possible by turning "Prog. Protection" off. When initially powered-up, "Prog. Protection" is "ON".
ENTER → Prog. Protection	on / off	
PP-code ?		If a different program protection code (1-255) than "0" was entered (factory entry), this code must be entered first in order to turn off the program protection.
Prog. Protection		Once Program Protection has been turned off, parameters may be changed.
Prog. Protection code	numeric	After the Program Protection has beeen turned off the Program Protectection code can be changed.
ENTER → Old PP-code ?		Enter old Program Protection code. 0 = factory entry
New PP-code:		Enter new program protection code (0-255).
Language	tabular	German / English
Meter size	tabular	DN 15 to DN 100 (1/2 in. to 4 in.)
Range DN 10 m/s	read-only	Maximum meter capacity determined by selection made in the "**Meter size**" menu. **Range** value may be from 5% to 100% of this value.
Range	numerical	Maximum range for forward & reverse flow. 0.5 m/s $\leq$ Qmax $\leq$ 10 m/s

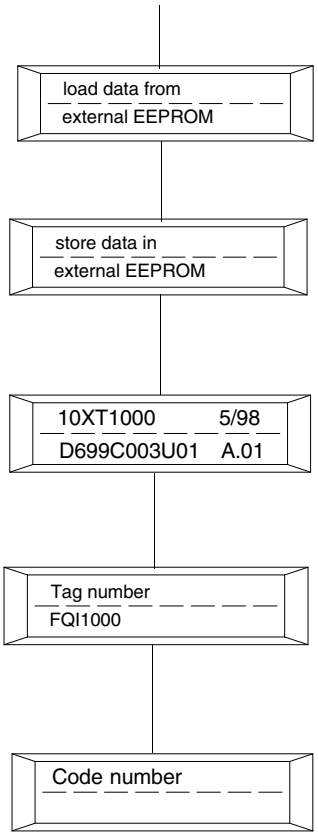


Submenu / Parameter	Entry mode	Description
Pulse 1.0000 /m3	numeric	For internal and external flow totalling, range 0.001-1000 pulses per selected unit, maximum counting frequency 100 Hz.
Pulse width 30.000 ms	numeric	For external pulse output, range 0.1 ms - 2000 ms.
Submenu Low Flow Cut-off	numeric	
ENTER → Low flow cut-off 1.000 %		Range 0 - 10 %, sets display and all outputs
Damping 10.0000 s	numeric	Range 2.0 - 100 s, response time for 0 - 99 % flow change.
Filter on	tabular	On/off. Defaults to "OFF". When noisy output signal is present turn noise reduction filter "ON" and select a damping time > 2.4 s.
Density 2.54300 g/cm3	numeric	Range 0.01 - 5 g/cm^3. Determines flow rate for display and totalizing in g, kg, t, or pound.
System-zero adj. 3.5 Hz	tabular	Zero check (required for use with older primaries). C/CE Exit submenu.
ENTER → Adjust manual		Manual value entry.
Adjust automatic		Valve must be closed. There must be no fluid flow. Press ENTER to initiate the automatic adjustment.
Prog. Output Pulse Output	tabular	Configures contact output terminals V8 & V9 to activate for Max. alarm*, Min. alarm*, Max-Min alarm*, General alarm*, F/R direction signal*, Pulse output or no function. * Contacts may be configured to open or close


Submenu / Parameter
Entry mode
Description
Submenu
unit
tabular/numeric
C/CE
Exit submenu
ENTER
Units Qmax
l/s
lbs/s, lbs/min, lbs/h, l/s, l/min, l/h, m3/s, m3/min, m3/h, m3/d, igps, igpm, igph, igpd, mgd, gpm, gph, bbl/s, bbl/min, bbl/h, bbl/d, kg/s, kg/m, kg/h, kg/d, t/min, t/h, t/d, g/s, g/min, g/h, kga/s, kga/min, kga/h.
Totalizer unit
m3
l, igal, gal, bbl, kg, t, g, lb, kga, m3.
Unit factor
3785.41 Liter
Freely configurable flow unit, referenced to liters; Value is valid for the unit kgal (factory preset).
Unit name
kgal /s /min /h
4-character designation of the selected flow unit.
Prog. unit
without density
Prog. unit for mass flow (with density) or volumetric flow (without density)
Submenu
alarm
tabular/numeric
C/CE
Exit submenu.
ENTER
Error Register
...3.....
Any errors encountered (Error 0-9, A, B, C) are stored in the Error Register. Erase error log by pressing ENTER.
Max-Alarm
105%
Limit alarm, range 0 - 105 % of set range.
Min-Alarm
10 %
Limit alarm, range 0 - 105 % of set range.
Submenu
current output
tabular
C/CE
Exit submenu.
ENTER
Iout at Alarm
105%
Select current output during an alarm condition. May be set to 0% or 105% of Qmax. Error 3 (Flowrate > 105%) will always give 105%, regardless of the selection made here.


Submenu/Parameter
Entry mode
Description
Submenu
Data Link
tabular/numeric
C/CE
Exit submenu.
ENTER
Instr. Address
0
Enter Instrument Address, 0 - 99. If multiple instruments are connected on a single bus, each instrument must have a unique address.
Communication
HART
Activate the HART communication:
Select HART or Off
Submenu
function test
tabular/numeric
C/CE
Exit submenu.
ENTER
Function test
Iout
Function test current output, data entry in %.
Function test of pulse output, rate = 1 Hz.
Function Test
RAM (internal)
Function test int. sub-assemblies, auto-tests RAM (internal), EPROM, EEPROM (lower, upper & external), Terminals V8 & V9, Pulse Output (1 Hz), Display, HART Transmitter, HART Command, Simulation & Test Mode.
Submenu
totalizer
tabular/numeric
C/CE
Exit submenu.
ENTER
Totalizer — F
reset
The forward flow totalizer is reset by pressing ENTER. If overflow totalizer > 0, only overflow forward flow "→F" appears for reset.
Totalizer — F
4697.00 m3
Allows presetting of forward-flow Totalizer value. 2nd line of display shows the value entered.
Overflow — F
250
Shows Totalizer overflow value up to a maximum of 250. 1 overflow count = actual pulse counter value of > 9,999,999 Totalizer units. At each overflow, display is reset to 0 and overflow register is incremented
Totalizer — R
reset
See forward-flow Totalizer.
Totalizer — R
625.000 m3
See forward-flow Totalizer.


Submenu/Parameter
Entry mode
Description
Overflow — R
004
See forward-overflow counter.
Totalizer function
standard
Standard = separate registration of forward and reverse flow volume by means of separate totalizers.
Differential totalizer = forward and reverse flow volume are indicated in the display by one totalizer.
Submenu
Display
tabular
C/CE
Exit submenu
ENTER
1st line
Q [%]
2nd line
totalizer
1st line multiplex
off
2nd line multiplex
off
Process indication: Different display outputs can be selected (separate for both display lines) for the process indication. For example Q [%], instantaneous flow in %, Q [engineering unit] instantaneous flow in engineering unit, Q [mA] instantaneous flow in mA [current output], F/R-flow, totalizer value of forward and reverse flow, tag number. Changeover to alternate process indication of 1st display line occors every 10 sec. if multiplex "ON" is selected.
Submenu
Operating mode
tabular
C/CE
Exit submenu
ENTER
Flow direction
Forward / Reverse
Selects flow direction to be measured. Either forward-flow only or both forward and reverse flow.
Flow Indication
normal
Normal / inverse.
Normal = flow direction same as arrows shown on display
Inverse = flow direction opposite that indicated by arrows on display.

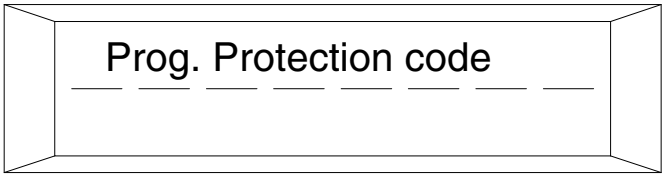
Submenu / Parameter	Entry mode	Description
	tabular tabular read-only numeric numeric	Allows restoring programmed data if converter replacement is necessary. After start-up, the actual measurement parameters can be stored in the external EEPROM located on the Display Board Assembly. Shows converter model number, firmware version number and date firmware was generated. Allows input of a Tag number with a maximum of 16 digits. Numbers and upper or lower-case numbers may be entered. Only for use by ABB Automation service personnel.

7.0 PARAMETER ENTRY

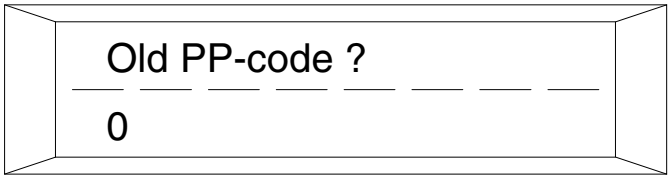
After power has been turned on, programming parameters may only be changed by turning program protection "OFF". There are two ways to turn off the program protection:

1. If program protection code (PP-code) is on "0" (factory default), the program protection is turned off by pressing ENTER key.
2. If a PP-code (1 to 255) other than "0" has been entered, this code must be entered in order to turn the program protection "OFF".

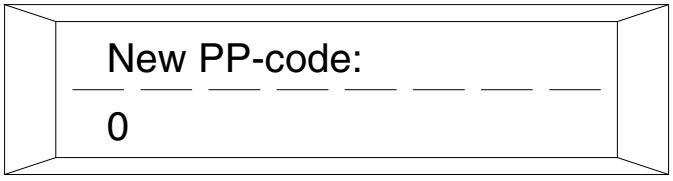
The PP-code can be changed after the program protection has been turned off.



In order to be on the safe side when changing the PP-code the old PP-code must be entered after ENTER has been actuated.



Press ENTER key after entry of old PP-code.

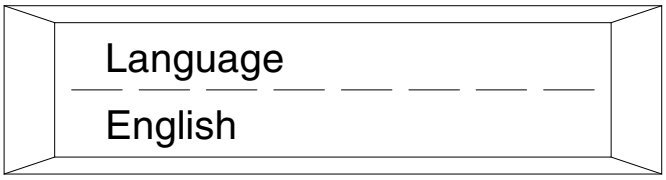


Now enter the new PP-code (0-255) and press ENTER key. The **new** PP-code is now valid to turn off the program protection.

If the PP-code is forgotten entering the Service Code will reveal the Program Protection Code. Contact ABB Automation Technical Support if assistance is required

Note:
During data entry the input values are checked for acceptability. If data is not acceptable, it is rejected and a message is generated indicating that the new data has not been accepted.

7.1 Language Tabular Entry



The text in the display may be selected to read in either English or German. The desired language can be selected with the arrow keys.

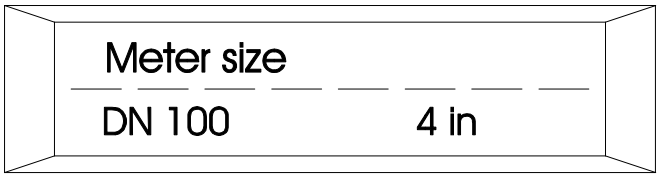
The following languages are available:

- German
- English

7.2 Meter Size Tabular Entry

The meter sizes DN10 through DN100 can be selected from the table using the arrow keys. The meter size is displayed in mm and in inches. The selection is made by using the STEP or DATA keys and accepted by pressing ENTER. When the meter is selected the values of $Q_{max\ DN}$ (see 7.3) and Q_{max} forward- and reverse flow are automatically set to the flow rate equivalent to 10 m/s. The pulse factor is set to 1.

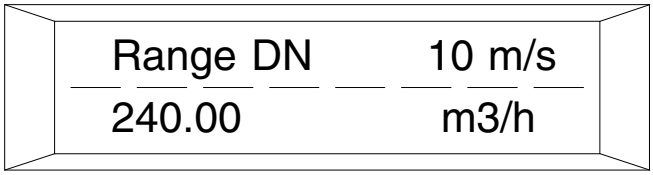
While the firmware allows setting meter sizes DN10 through DN100, actual meter sizes available are 1/2



inch (DN15) through 4 inch (DN100). Make certain that this parameter is set to the proper size for the respective meter.

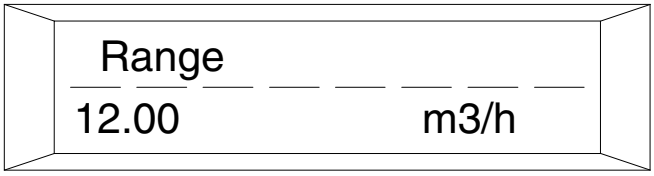
7.3 Q_{max} for the meter size at 10 m/s

$Q_{max\ DN}$ (or Range DN) is the maximum flow rate equivalent to a flow velocity of 10 m/s. The value of Range DN is set automatically when the meter size is selected.



7.4 Q_{max} Forward and Reverse flow Numeric entry

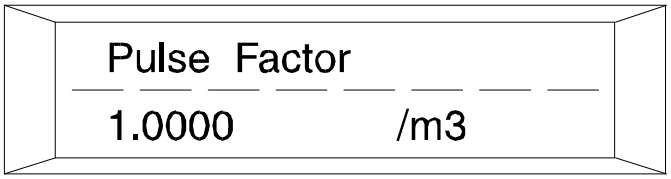
A maximum flow rate range value can be entered between the limits of 0.5 m/s and 10.0 m/s.



The selection is a numerical entry made using the STEP and DATA buttons. The unit is selected in section 7.13.

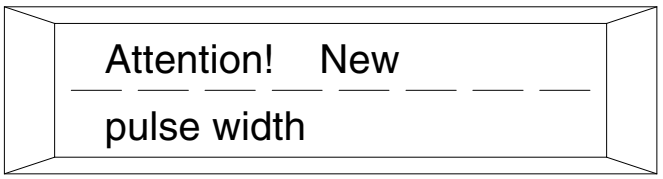
7.5 Pulse Factor - Fwd & Rev. Flow Numeric entry

The pulse factor is the number of pulses for one flow rate unit for the pulse output and the internal totalization.

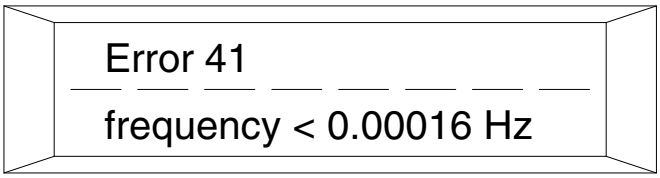


When the pulse factor is changed the totalizer value remains in the correct unit as selected per section 7.13.2 .

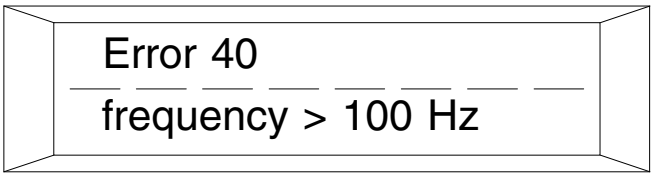
For Totalizer operation, the pulse factor can be selected between 0.001 and 1000 pulses/unit. The selected pulse factor is checked by the computer as a function of **the pulse factor** (between 0.001 and 1000 pulses/unit), **the pulse width** (between 0.1 and 2000 ms), **the totalizer unit** (e.g. ml, l, m^3) or **mass unit** (e.g. g, kg, t) with **the density correcting value**. If one of these parameters is changed, the pulse width may be automatically recalculated to be a maximum of 50% of the period of the output frequency at 100 % flow rate (duty-cycle [on/off ratio] = 50%) and following message is displayed.



If the ratio of the output frequency is too low, the following message is displayed:



If the ratio of the output frequency is too high, the following message is displayed:



7.6 Pulse Width Numeric entry

The pulse width (pulse duration) for the scaled pulse output can be selected between 0.1 and 2000 ms. For technical reasons the actual pulse width in the converter is always a multiple of 0.032 ms. The selected pulse width must be short enough to avoid pulses overlapping at the maximum output frequency (maximum flow 105 % = 105 Hz) but long enough to guarantee activation of the pulse counter being used.

Example:

Flow range = 100 l/min (Q_{max} = 100 % range end value)
Totalizer = 1 pulse/l

$$f = \frac{100\ pulses/\text{min}}{60\ s} = 1.666\ \text{Hz}$$

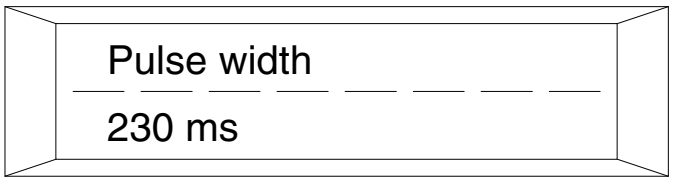
At 5% overrange:

f = 1.666 Hz · 1.05 = 1.75 Hz ($^1/_s$)

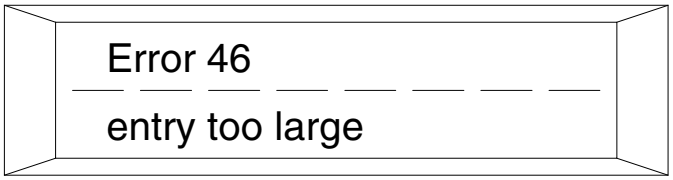
At 50% duty-cycle (on time = off time)

$$\text{Pulse width tp} = \frac{1}{1.75\ s^{-1}} \cdot 0.5 = 286\ \text{ms}$$

A value of < 286 ms can be set here. **Mechanical counters require a pulse width of ≥ 30 ms.** The following display shows a 230 ms pulse width entry.



The computer automatically checks the set pulse width. The pulse width may be 80% of the output frequency at 105% of flow rate. If this limit is exceeded, the new value will not be accepted and following error message is displayed:

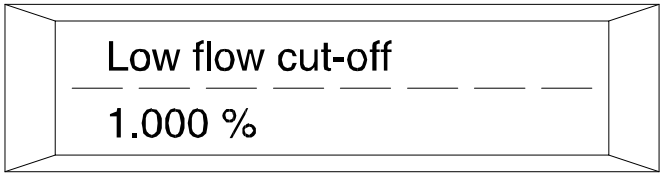


7.7 Low Flow Cut-Off Numeric Entry

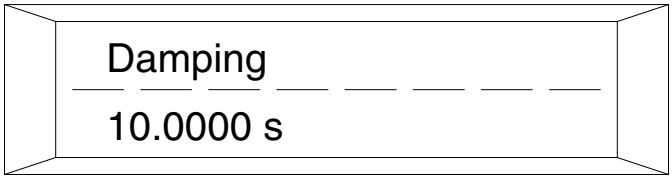
The low flow cut-off can be selected between 1% and 10% of the range end value.

Flows less than the cut-off value are not totalized. The current and pulse outputs are set to zero.

The switching threshold for the low flow cut-off has 1% hysteresis.

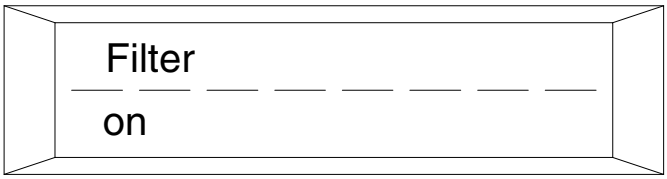


7.8 Damping Numeric Entry



The damping value can be selected between 2.0 and 100 seconds. The value represents the response time for a 0 - 99 % step flow rate change.

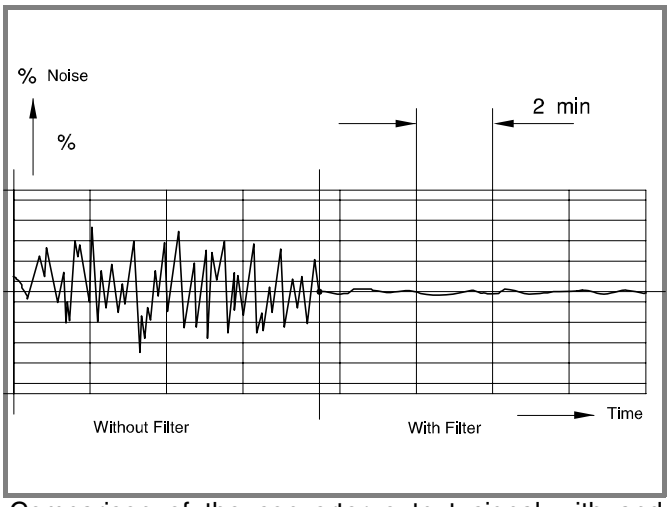
7.9 Filter (Noise Rejection) Tabular Entry



A digital filter (noise reduction algorithm) is available in the converter when pulsating flow or especially noisy signals are encountered. The digital filter improves the displayed instantaneous flow values and provides a steady current output. With the filter turned on, the damping value may be reduced. The response time of the converter will not be influenced.

With one of the arrow keys the filter is turned on and is accepted by pressing the ENTER key. The filter is only active when the selected damping time is > 2.4 s.

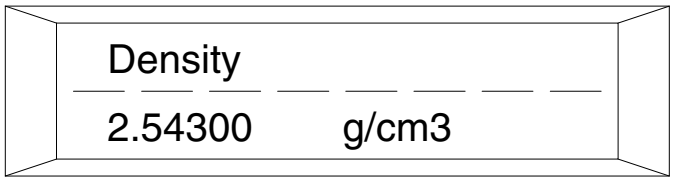
Noise Reduction Example



Comparison of the converter output signal with and without noise reduction filter.

7.10 Density Numeric entry

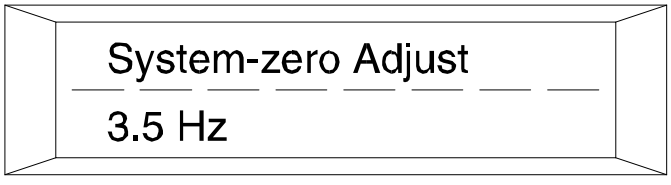
When the flow is totalized in gravimetric units g, kg, t or pound, a density value can be entered for the calculation. The translation conversion to mass flow is settable between 0.01 and 5.00000 g/cm^3. Changing the density value generates a recalculation of Range and Range DN values.



7.11 System Zero Numeric Entry

A zero check should be made after start up. In order to do this properly, there must be **absolutely no flow** through the meter. The zero adjust procedure can be initiated at the converter. Automatic or manual setting modes are possible.

Select parameter "System-zero Adj." and press the ENTER key.



The STEP and DATA keys are used to toggle between the automatic and manual modes.

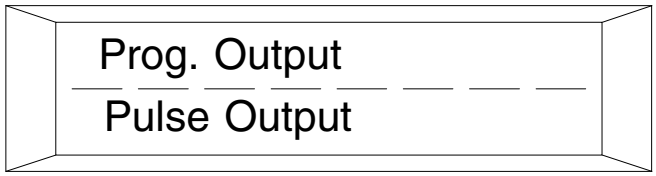
Pressing ENTER initiates the automatic zero adjustment, starting a countdown from 400 to 0 on the display. The zero value determined by the converter must be within ± 50 Hz (+/- 0.5% of Range DN). If the zero value is not within these limits no adjustment takes place. The value determined by the converter is displayed in the 2nd line of the display. Pressing the C/CE key sets the zero value to 0 Hz.

7.12 Programmable Output Tabular entry

Allows output terminals V8 & V9 to be configured to activate for one of the following functions:

- Max. Alarm*
- Min. Alarm*
- Max.-Min. Alarm*
- General Alarm*
- F/R Flow Direction Signal*
- Pulse Output
- No Function

* indicates that output circuit may be configured to be "on" or "off" upon activation.

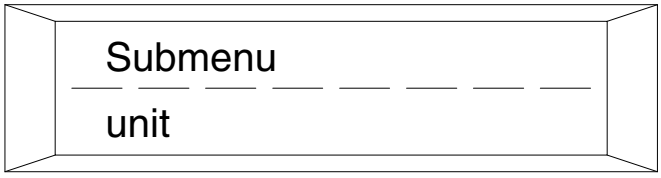


7.13 Submenu unit

This submenu allows selection of units for the following parameters:

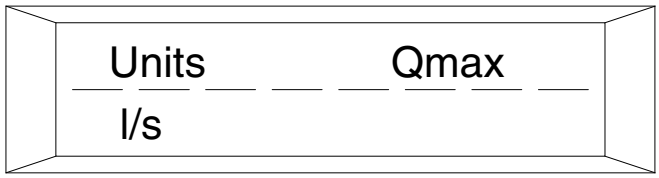
- Q_{max} Engineering unit
- Totalizer Engineering unit
- Engineering unit with unit factor freely configurable
- Unit name freely configurable
- Prog. unit with/without density

The last three parameters refer to a freely configurable unit. This function replaces the previously available fixed "kgal" unit.



7.13.1 Range Unit Tabular Entry

The listed units in the table below can be set with the STEP and DATA buttons and are accepted by pressing ENTER.



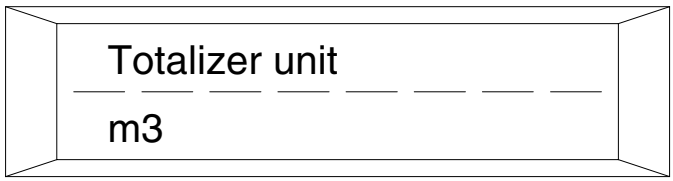
Selectable units are shown in the following table:

Unit	
Liter	l/s l/min l/h
Cubic meter	m^3/s m^3/min m^3/h m^3/d
Imperial-gallon per	igps igpm igph igpd
US - Million-gallon per day	mgd
US gallon per	gpm gph
Barrel-Brewery	bbl/s bbl/min bbl/h bbl/d
Kilogram	kg/s kg/min kg/h kg/d
Metric Ton (1000 kg)	t/min t/h t/d
Gram	g/s g/min g/h
Pound (454 g)	lbs/s lbs/min lbs/h
Kilo-gallons (1000 US gallons)	kga/s kga/min kga/h

The unit refers to $Q_{max\ DN}$, Q_{max} forward flow, Q_{max} reverse flow and the instantaneous value display if these are displayed with engineering unit.

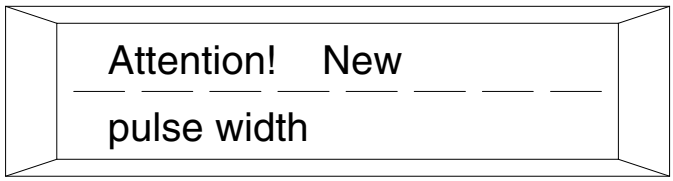
7.13.2 Totalizer Unit Tabular Entry

The units listed below are available for the flow Totalizer. They can be selected with the DATA and STEP buttons. The units can be different from those selected for the flow modes. The engineering unit is accepted by pressing ENTER.

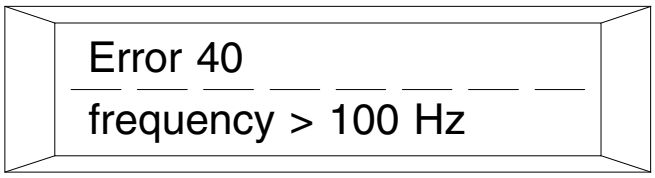


Selectable Units: lb, kg, l, m^3, igal, gal, kga, bbl, t & g.

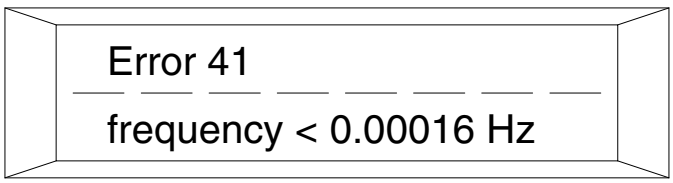
The selected engineering totalizer unit is checked by the computer as a function of **flow rate range, the pulse factor** (between 0.001 and 1000 pulses/unit), **the pulse width** (between 0.1 and 2000 ms) and with **the density correcting value** when a mass unit (e.g. g, kg, t) has been selected. If one of these parameters is changed, the pulse width may be automatically recalculated to be a maximum of 50% of the period of the output frequency at 100% flow rate (duty-cycle [on/off ratio] = 50%) and following message is displayed.



If the ratio with the output frequency is too high, following message is displayed:



If the ratio with the output frequency is too low, following message is displayed:



7.13.3 User Configurable Unit

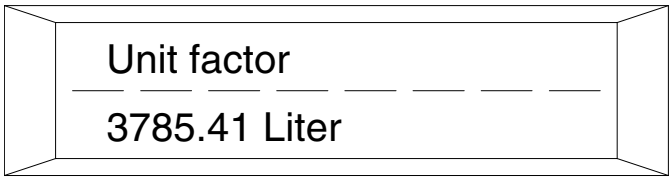
This function enables configuration of any engineering unit in the converter. The following three parameters are available for this function :

a) Units factor
b) Unit designation
c) Prog. unit - with/without density

Note:
The entry of the listed parameters a), b) and c) is only necessary in case the required engineering unit is not available in the table on page 7-5, Section 7.13.1 .

7.13.3.1 Units Factor
Numeric entry

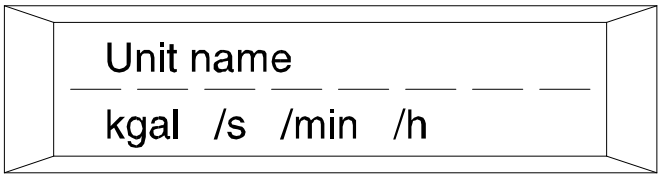
This parameter indicates the factor of the new unit with respect to one liter. The default entry is kgal=3785.41 Liter (Kga = Kilo gallons).



7.13.3.2 Unit Designation
Tabular entry

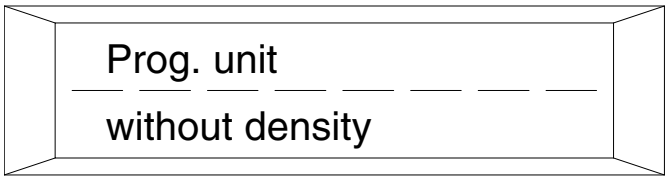
The selection is made with the STEP and DATA buttons. With DATA or the down-arrow key (↓) the alphabet is paged forward, first the lower-case letters appear and then the capital letters. The STEP or the up-arrow key (↑), controls the position and shifts the cursor to the next character position for entry. A maximum of four characters is available.

The units of time /s, /min and /h may be assigned to the engineering unit.



7.13.3.3 Programmable Unit
Tabular entry

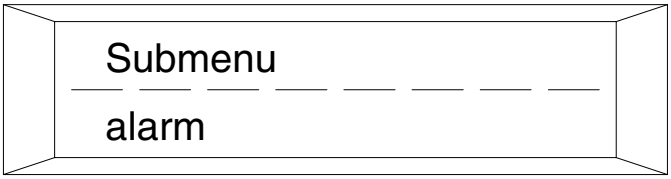
This function determines whether the newly entered engineering unit is a mass unit (with density) or a volumetric unit (without density). If density was selected, also refer to section 7.10.



7.14 Submenu Alarm
Tabular entry

After pressing ENTER the functions listed in this submenu can be selected with the STEP and DATA buttons.

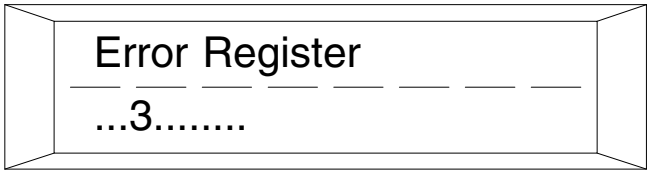
Error register (See Section 7.14.1)
MAX-Alarm (See Section 7.14.2)
MIN-Alarm (See Section 7.14.3)



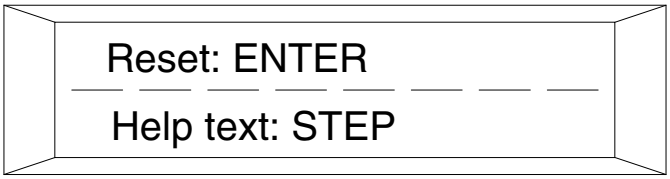
7.14.1 Error Register

Any errors that may have occurred (Errors 0 - 8, A, B & C) are stored in this register. All detected errors remain stored until the register is manually reset (by pressing ENTER or by way of data link).

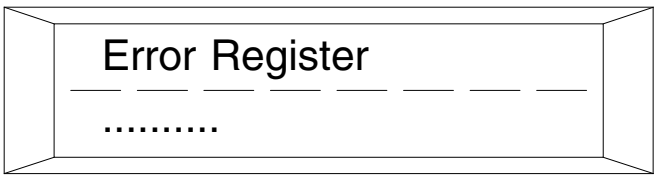
In the example shown, error 3 (flow rate > 105%) has occurred since the last reset.



After pressing ENTER, the following is displayed:



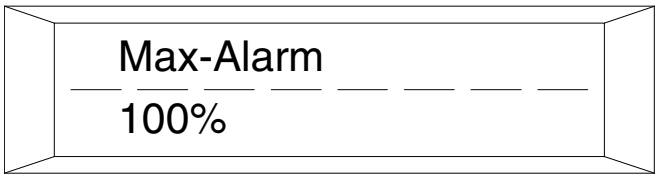
After pressing ENTER again the error register is deleted.



Pressing ENTER again will display a short description for each error.

Pressing C/CE exits the help-text information.

7.14.2 MAX-Alarm
Numerical entry



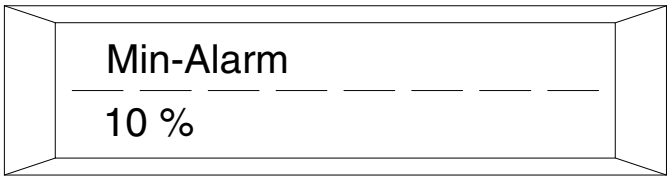
The limit of the MAX-Alarm value can be entered in 1% increments from 0% - 105% of the Q_{max} value. This value is valid for both forward and reverse flow.

When the MAX-alarm value is exceeded, output contacts V8 & V9 will change state, if so configured (Refer to Section 7.12). This condition is also indicated on the display by means of a flashing upward- pointing arrow.

For example:

MAX-Alarm limit value = 100 %
At flow > 100 % a flashing arrow (pointing upward) appears on the 1st line of the display.

7.14.3 MIN-Alarm
Numerical entry



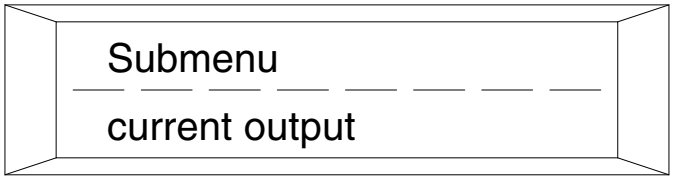
The limit of required MIN-Alarm value can be entered in increments of 1% from 0% - 105% of the Q_{max} value. This value is valid for forward and reverse flow.

> Note:
> Switching thresholds for the MAX- and MIN-Alarms are provided with 1% hysteresis.

If a MIN-alarm occurs, output contacts V8 & V9 will change state when the flow is less than the MIN-Alarm value, if so configured (Refer to Section 7.12). The alarm condition is also indicated on the display by means of a downward pointing flashing arrow.

For example:
MIN-Alarm limit value = 10 %
At flow < 10 % a blinking arrow (pointing down) after flow direction indication appears in 1st line of the display.

7.15 Submenu Current Output
Tabular entry



When an error condition is detected by the converter three things happen:

- an alarm contact output is activated
- an error message appears in the display
- the current output is set to a specified value

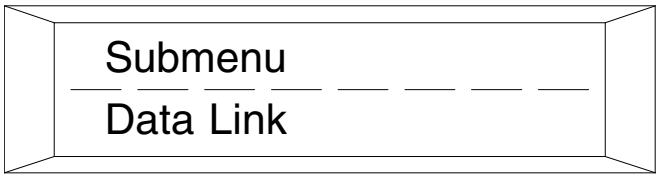
This menu allows selection of the value of the output current during an alarm condition. Selection may be one of the following values:

- 0%
- 105%

where 0% represents 4 mA and 105% is 21 mA.

Occurrance of an Error 3 (flow rate > 105%) always forces the output to 105% regardless of the value selected in this menu.

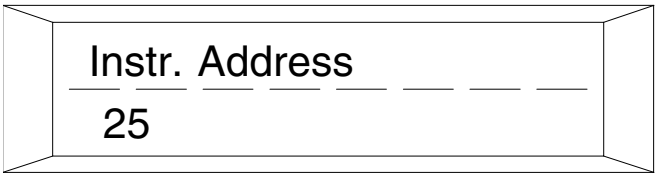
7.16 Submenu Data Link
Tabular/Numeric entry



This menu enables HART Protocol communication to be established, if available.

7.16.1 Instrument Address
Numerical entry

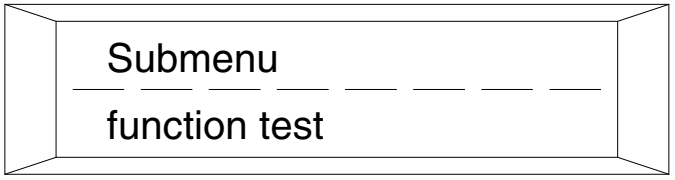
If the instrument is part of a multiple-instrument installation, it must be assigned a unique "instrument address". Any whole number between 0 and 99 may be entered.



7.16.2 HART communication Tabular entry

Enables selection of HART Protocol serial communication or none.

7.17 Submenu "Function Test" Numeric entry only I_{out} and F_{out}



The functional test submenu provides several test functions which can be used to test the instrument independent of the measured instantaneous flow rate. These test functions are the following:

- I_{out}
- RAM (Internal)
- EPROM
- EEPROM (lower, upper & external)
- Terminals V8 & V9
- Pulse Output (1 Hz)
- Display
- HART Transmitter
- HART Command
- Simulation
- Test Mode

During the functional test the converter is off-line (current and pulse output are no longer related to the flow). The individual test routines may be selected with STEP and DATA button.

The functional test is ended by pressing the C/CE button.

Select I_{Out} and press ENTER and enter the desired value in percent (%) of range. Check entered value at terminals + and – with a digital voltmeter (mA range) or with the process instruments connected to the output.

Note:
The converter does not automatically return to data logging mode. To close the function press the C/CE button.

Select **RAM** (ASIC) and press ENTER.

Select **EPROM** and press ENTER. The converter automatically tests its **EPROM** and displays its diagnosis.

Select **EEPROM** and press ENTER. The converter automatically tests its **EEPROM**(s) and displays its diagnosis .

Select **Terminals V8/V9** and press ENTER. The STEP or DATA keys can be used to toggle the contact on or off. Use a test meter to monitor the status at the terminals V8/V9.

Select **Pulse Output** and press ENTER. A 1Hz signal with a pulse width of 500 ms is transmitted over the scaled pulse output .

Select **Display** and press ENTER. The converter writes the numbers 0 to 9 and the letters A to F on the 1st and 2nd lines of the display. The operation of the dot matrix control can be visually checked.

Select **HART Transmitter** and press ENTER. The converter transmits a 2200 Hz (logic 0) signal on the current output lines. Pressing any key will change the output to test the 1200 Hz (logic 1) signal. These signals may be observed by connecting an oscilloscope across a 250 ohm load resistor connected in series with the current output lines.

Select **HART Command** and pressing ENTER. This will allow the converter to display the HART command code after a HART test transmission has been sent

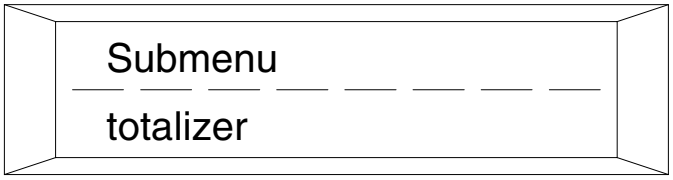
Select ****Simulation**** and press ENTER. The simulation can be turned “on" or "off” using the STEP or DATA keys. If the Simulation is turned **on**, use C/CE to return to process measurements. Any desired flowrate value can be entered using the STEP (+) and DATA (-) keys in 1% increments. The output values correspond the entered values. The message **Simulation** is displayed in the 2nd line and alternates with the integrated totalizer value. The **Simulation** parameter should be turned off after the simulation routine has been completed.

Select **Test Mode** when the converter is to be checked with a Simulator*, the parameter "Test Mode" must be turned "on".

Note
The converter does not automatically return to data logging mode. To close the function press the C/CE button

* Simulator will be available from Bailey-Fischer & Porter after March, 1999.

7.18 Submenu Totalizer Tabular entry

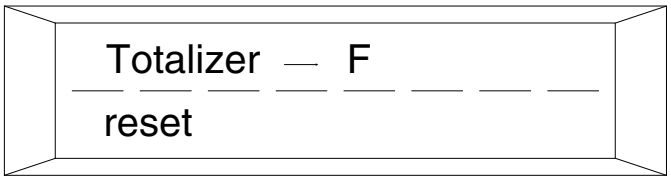


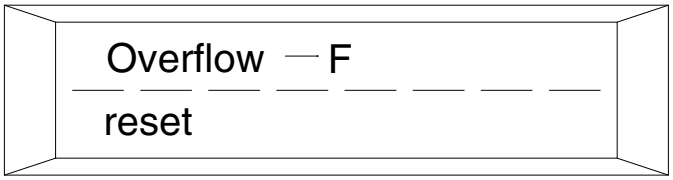
This submenu contains the following functions:

- Totalizer value forward or reverse flow and reset of overflows (Refer to Section 7.18.1)
- Totalizer functions (Refer to Section 7.18.2)

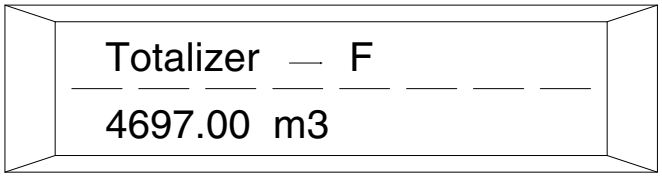
7.18.1 Totalizer Value Reset,Overflows, Presetting of Totalizer Tabular/Numeric entry

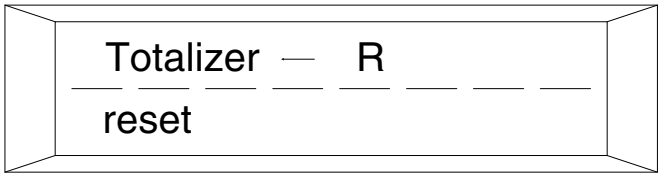
The Totalizers and overflow registers for each flow direction can be individually reset by pressing ENTER. First the overflow registers are reset (if available) and, after pressing ENTER again, the Totalizers are also reset. If the Totalizers have overflowed, the flow direction arrow and the units in the display will be flashing. The software allows up to 250 overflows of the internal Totalizer. At an overflow (Totalizer value > 10,000,000 units), the Totalizer will be reset and the overflow Totalizer will be incremented by one. If more than 250 overflows are counted, the message "Overflows > 250" appears in the display.

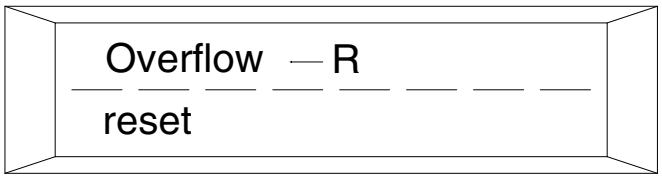




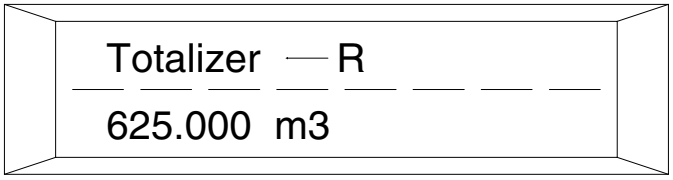
The Totalizer for "Forward flow" direction can be preset to an arbitrary value. If the converter is replaced, the new converter can be preset with the old converter's Totalizer value. Initiate the parameter (Totalizer >F/<R) with the arrow keys. The 2nd line of the display shows the present Totalizer value. After pressing ENTER, the previous Totalizer value may be entered and, by pressing ENTER again, will be accepted by the electronics.







The Totalizer for "Reverse flow" direction can also be preset, for entry see "Totalizer forward" flow direction.



Example calculation for overflow

Overflow 012

12 x	10,000,000	units
=	120,000,000	units
+	23,455	actual totalizer value
	120,023,455	units

Max. Totalizer value

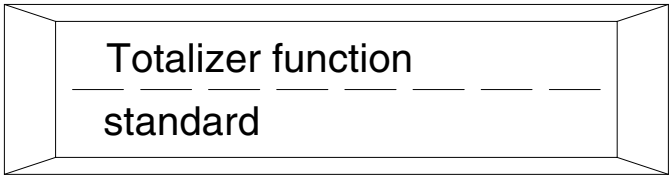
250 x	10,000,000	units
=	2,500,000,000	units

7.18.2 Totalizer Function Tabular Entry

Two operating modes are possible with the flow totalizer:

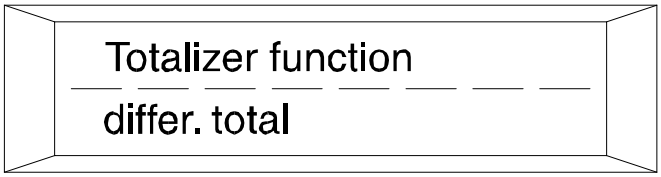
- Standard totalizer
- Differential totalizer.

7.18.2.1 Totalizer Function Standard



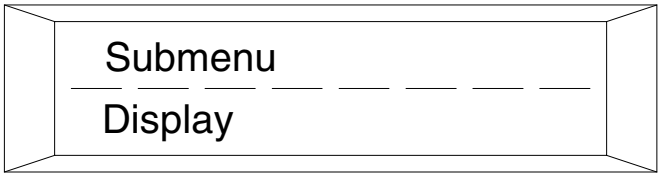
The "Totalizer Function Standard" integrates the flow rate pulse for forward or reverse flow in two different totalizers. If only the forward flow direction is selected, only the forward flow Totalizer counts. The selection is made with the STEP and DATA buttons and will be accepted with ENTER.

7.18.2.2 Totalizer Function Differential Totalizer

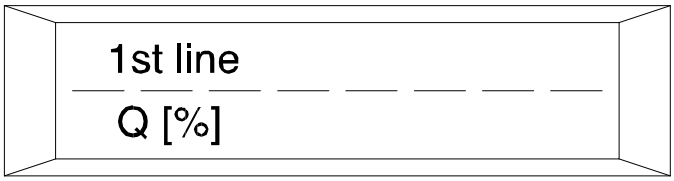


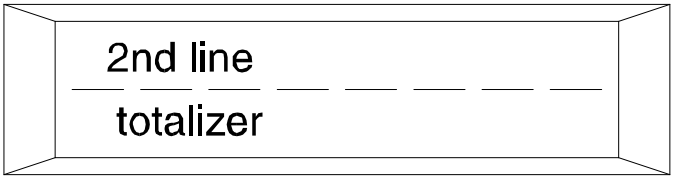
For differential totalization of both flow directions only one common internal totalizer is available. During forward flow, the Totalizer value is incremented. During reverse flow, the Totalizer value is decremented. The passive pulse output is not affected by this setting.

7.19 Submenu Display Tabular Entry



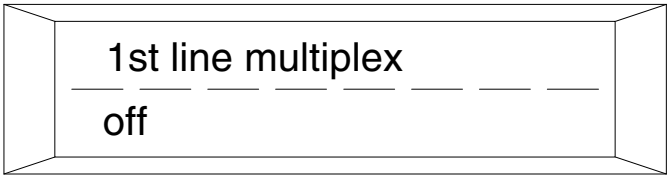
The Submenu Display parameters can be configured by selecting the appropriate parameters listed below and entering the desired information. The display may be configured so that any available information may be placed on either first or second line of the display.





In addition, a **multiplex feature** is available which can alternate any of two sets of parameters on either line of the display. This feature can be activated by turning ON the line(s) of the display desired for multiplexing and then selecting the desired parameter to be shown. The display will alternate between the display value and the multiplex value approximately every 7 seconds.

Press ENTER at the Submenu Display and press the STEP or DATA buttons until the following screen appears:



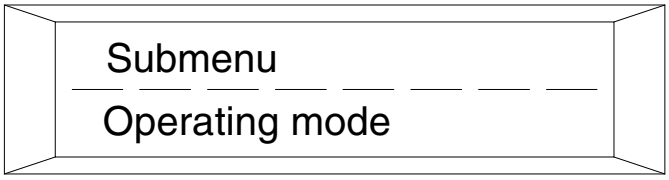
Press ENTER and the following parameters may be selected for the first line of the display by pressing the STEP or DATA buttons:

- **off**
- **Q [Bargraph]** - left to right graphic representation of flow rate as a percentage of range, with numeric percentage to the right of the bar graph
- **TAG number**
- **Totalizer -** ←**R** totalized flow for reverse direction only
- **Totalizer -** →**F** totalized flow for forward direction only
- **Totalizer** - totalized flow for the direction currently indicated on the flow rate display
- **Q [mA]** - flow rate expressed as the number of mA present at the + and – analog output terminals
- **Q [unit]** - flow rate in actual selected units
- **Q [%]** - flow rate as a percentage of range setting

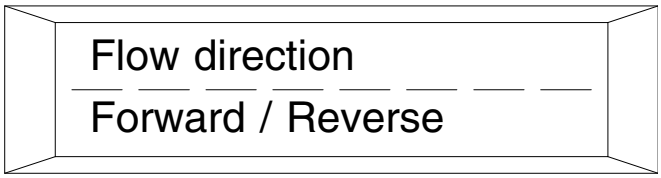
If desired, a multiplexed parameter for the second display line can also be chosen from the above list by selecting from the "2nd line multiplex" menu.

7.20 Submenu Operating Mode Tabular Entry

This submenu enables selection of several operating parameters



7.20.1 Direction Tabular entry

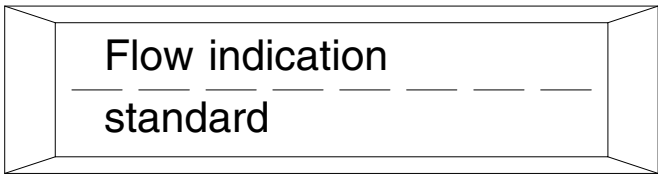


This menu allows flow to be indicated in either forward and reverse directions or in the forward direction only.

After pressing ENTER at the Submenu Operating Mode, scroll to the Direction menu using either the STEP or DATA buttons.

Pressing ENTER allows changing of the "Direction" setting by using the STEP or DATA buttons.

7.20.2 Display Direction Tabular entry



Two selections are possible in this menu:

- standard
- opposite

The arrow on the primary indicates the standard flow direction and defines the meter's standard forward-flow direction.

standard = flow direction same as arrow on meter body

opposite = flow direction opposite arrow on meter body

If the meter is inadvertantly installed backwards and forward flow direction is displayed when the flow is in the reverse direction, the direction may be conveniently interchanged using the **Flow indication** selection (shown above) and by selecting "**opposite**".

7.21 Load Data From External EEPROM Tabular entry

Configuration data is saved in two EEPROM locations in the Model DT43. The EEPROM module located on the display PCB is defined as the "external" EEPROM and contains all information specific to the Primary. The other EEPROM (really an "FRAM") is located on the Digital Board.

In certain cases, data may be changed or circuit boards may be replaced and will require activating the **Store Data in external EEPROM** and **Load Data from external EEPROM** functions in order to insure that data in both EEPROMs is identical.

When a Converter is replaced, the Converter checks both EEPROMs at power-up to see if the data contained in them is identical. If the data is different, a "load" cycle is conducted automatically to make both EEPROMs match.

In the event that the data in the NVRAM becomes corrupted, an **ERROR 5** message would be generated. Generally this may be cleared by performing the "Load data from external EEPROM" function.

To activate the load data function, toggle through the menu parameters to this menu and press ENTER.

7.22 Store Data in External EEPROM

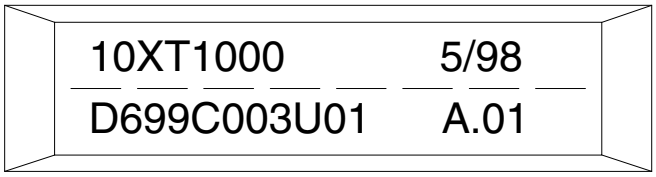
After the "start-up" procedure (refer to Section 5.2) has been completed and whenever menu changes are made, the data is not written into both EEPROMs simultaneously. Therefore if the changes are to be retained, they must be saved to the external EEPROM by using this command.

To activate the store data function, toggle through the menu parameters to this menu and press ENTER.

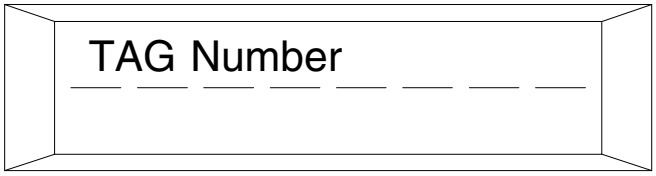
7.23 Software Version read-only

The model number is displayed on the first line of the display and the revision level of the software is displayed on the second line.

This is a read-only parameter and cannot be changed. A typical display is shown below.



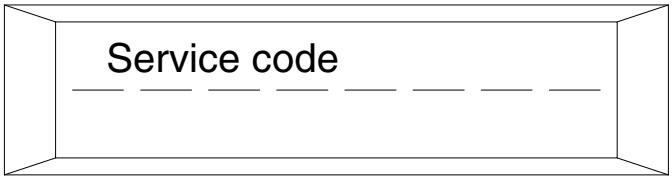
7.24 TAG Number Numeric



This menu item permits entry of a TAG number to further identify the meter and differentiate it from other meters in a multiple-meter installation.

The TAG number may be alphanumeric and may be up to 16 characters long.

7.25 Service-Code Numeric entry



The code number parameter provides a means to access the calibration parameters. Available only for ABB Automation Service personnel.

In the event the Program Protection code is forgotten, entering the Service Code is **the only way** to reveal the Program Protection code.

8.0 BLOCK DIAGRAM

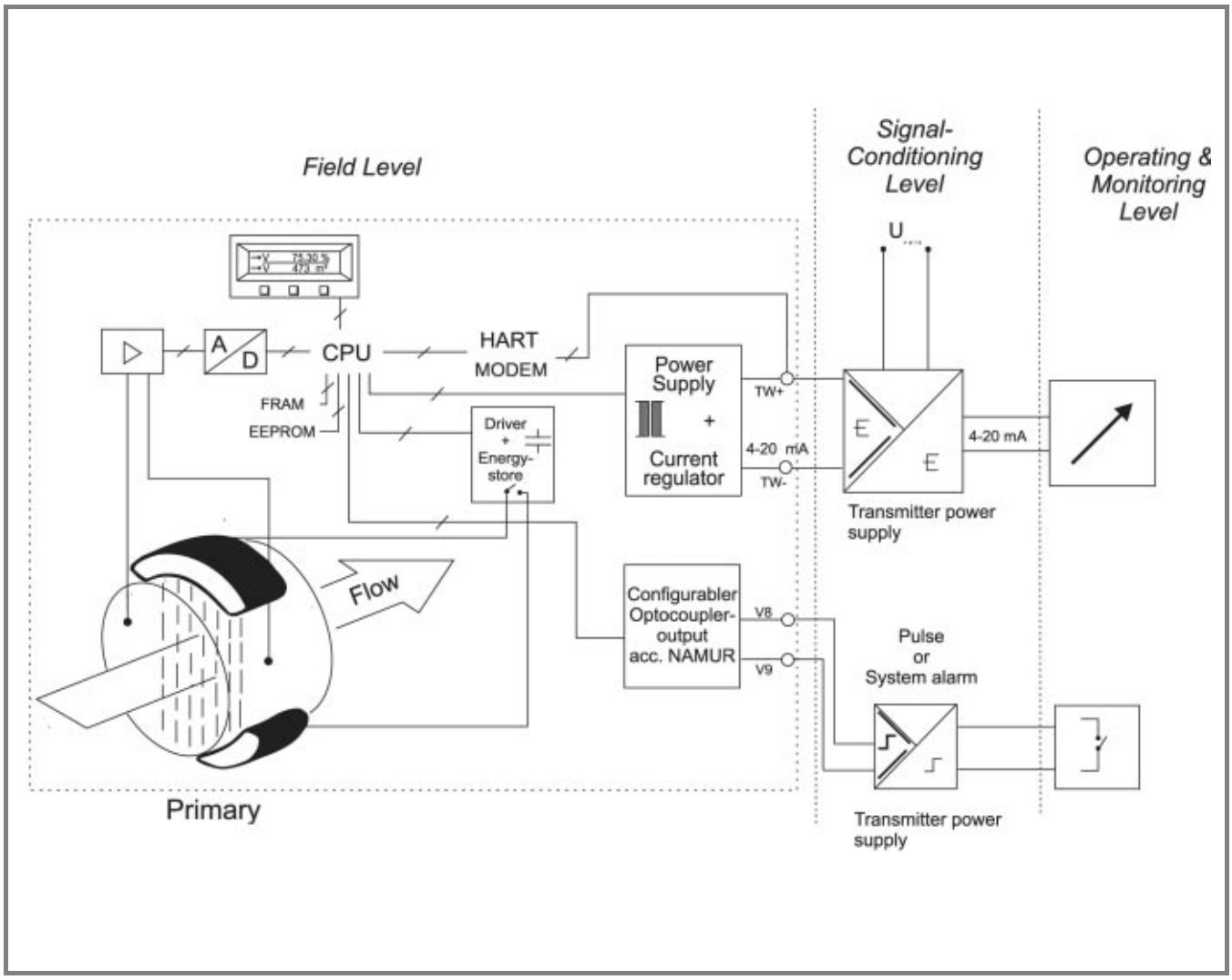


FIGURE 8-1. BLOCK DIAGRAM OF COPA-XT

9.0 TECHNICAL DATA

9.1 Meter Size, Pressure Rating, Measuring Range and Flow Rate Nomograph

Table 9-1

Meter Size		Standard Pressure Rating	Min. Meas. Range flow velocity = 0 to 1.64 ft/s	Max. Meas. Range flow velocity = 0 to 32.8 ft/s
in.	DN	psi (bar)	GPM	GPM
½	15	580 (40)	0 to 1.3	0 to 26.4
1	25	580 (40)	0 to 2.6	0 to 52.8
1½	40	580 (40)	0 to 7.9	0 to 158.5
2	50	580 (40)	0 to 13.2	0 to 264.2
3	80	580 (40)	0 to 39.6	0 to 792.6
4	100	232 (16)	0 to 52.8	0 to 1,057

9.1.1 Flow Rate Nomograph

The volumetric flow rate is a function of the flow velocity and the meter size of the flowmeter. The flow rate nomograph (FIGURE 9-1) indicates the flow rate range available for a specific instrument size and which size is best suited for a particular flow rate .

Example (see Nomograph):

Maximum expected flow volume = 30.8 gpm (7 m^3/h). Primaries sizes 1 in. (DN 25), 1 1/2 in. (DN40) and 2 in. (DN50) would be suitable for a flow velocity from 1.64 to 33 ft/s (0.5 to 10 m/s).

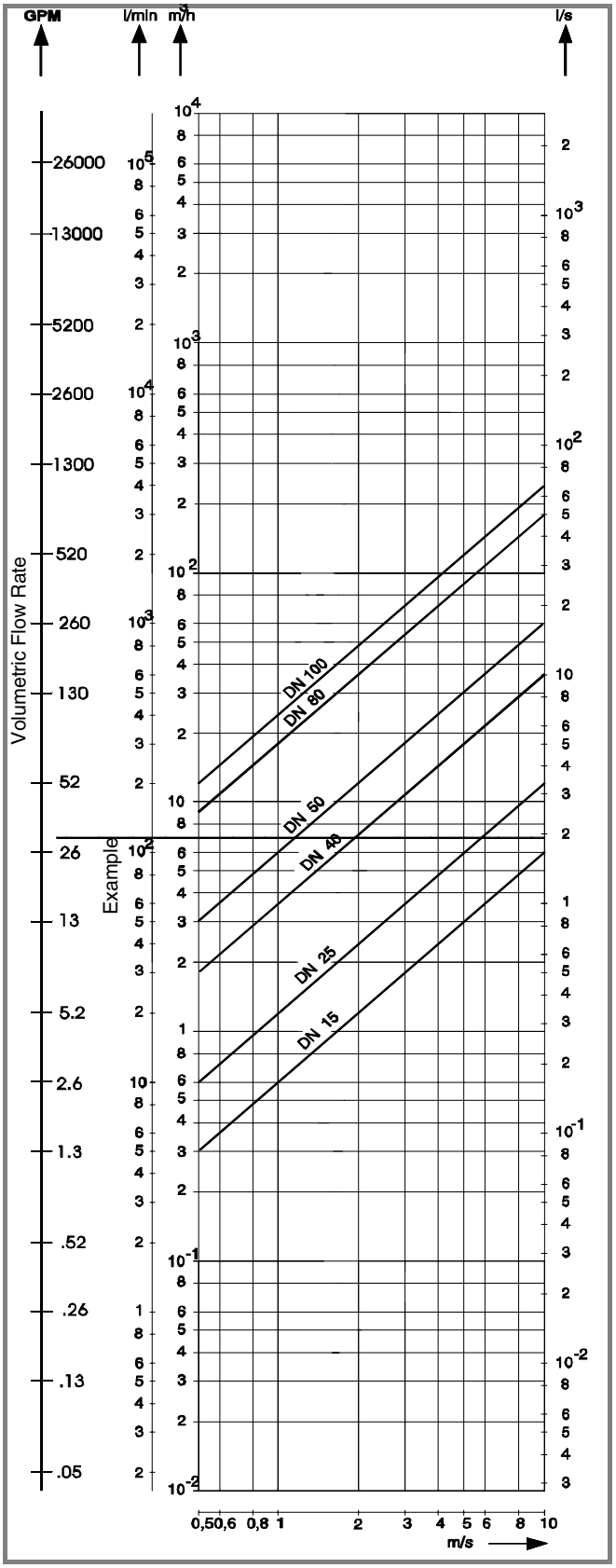


FIGURE 9-1. FLOW RATE NOMOGRAPH 1/2 to 4 inch (DN15 to DN100)

9.2 Primary Specifications

Temperature diagram

Table 9-2. Pressure Ratings
PSIG (Mpa)

FLANGE CLASS	FLANGE MAT'L	TEMPERATURE			
		≤ 100°F (38°C)	â 175°F (80°C)	≤ 190°F (88°C)	≤266°F (130°C)
ANSI 150	Carbon Steel	285 (1.96)	260 (1.79)	255 (1.76)	235 (1.62)
	Stainless Steel	275 (1.90)	245 (1.69)	240 (1.65)	215 (1.48)
ANSI 300	Carbon Steel	740 (5.10)	690 (4.76)	680 (4.69)	660 (4.55)
	Stainless Steel	720 (4.96)	630 (4.34)	615 (4.24)	555 (3.83)
DIN PN10	Carbon Steel	145 (1.00)	145 (1.00)	145 (1.00)	145 (1.00)
	Stainless Steel	140 (0.97)	137 (0.94)	137 (0.94)	133 (0.92)
DIN PN16	Carbon Steel	232 (1.60)	232 (1.60)	232 (1.60)	232 (1.60)
	Stainless Steel	224 (1.54)	219 (1.51)	218 (1.50)	212 (1.46)
DIN PN25	Carbon Steel	362 (2.50)	362 (2.50)	362 (2.50)	362 (2.50)
	Stainless Steel	352 (2.43)	331 (2.28)	327 (2.25)	304 (2.10)
DIN PN40	Carbon Steel	580 (4.00)	580 (4.00)	580 (4.00)	580 (4.00)
	Stainless Steel	564 (3.89)	530 (3.65)	525 (3.62)	488 (3.36)

Table 9-3. Process Temperature Ratings

LINER MATERIAL	T_{max} - °F (°C)	T_{min} - oF (°C)
Teflon (PTFE)	266 (130)	-13 (-25)
Tefzel (ETFE)	266 (130)	
Neoprene/Polyurethane	190 (88)	
Hard Rubber/Soft Rubber	175 (80)	

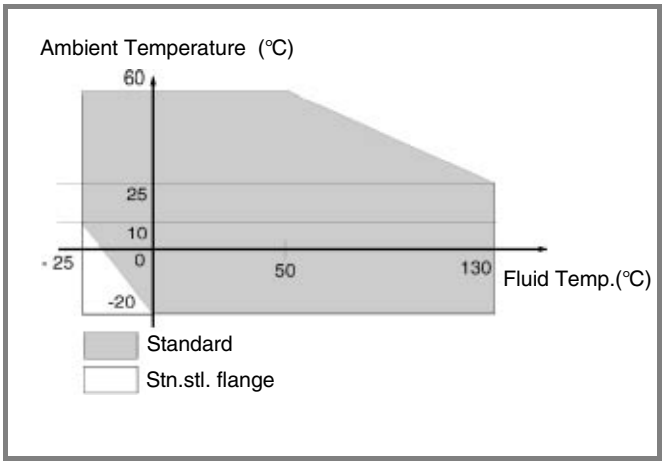


FIGURE 9-2. FLUID TEMPERATURE vs. AMBIENT TEMPERATURE

Table 9-4. Maximum Cleaning Temperature

CIP (cleaning in place)	Liner material	T_{max} °F °C	t_{max} Minutes	$T_{Amb.}$ °F °C
with steam	PTFE	302 150	60	77 25
with liqiud	PTFE	284 140	60	77 25

If ambient temperature is > 25 °C, deduct difference of max. cleaning temperature. T_{max} - Δ °C where Δ °C= ($T_{Amb.}$ - 25 °C)

9.2.1 Enclosure classification

NEMA 4X (IP67)

9.2.2 Mechanical pipeline vibration limits

Max. allowable = 1.5G @ (10 – 150 Hz)

9.2.3 Explosion protection

Application for Explosion protection per European standards EEx ed [ib] IIC has been made.

FM ClI, DivI approved

Table 9-5 Materials, Wetted parts

Parts	Standard	Others
Liner material	PTFE, ETFE, Hard rubber, Soft rubber, Neoprene, Polyurethane	–
Electrode for liner material - Hard rubber, Soft rubber	316 Stainless Steel	Hast. B-2, Hast. C-4, Titanium, Tantalum, Platinum-Iridium
- PTFE, ETFE	Hast.-C-4	316 Stainless Steel Hast. B-2 Titanium, Tantalum Platinum-Iridium
Grounding ring	316 Stainless Steel	upon request
Protective flange	316 Stainless Steel	upon request

Table 9-6 Materials, Non-wetted parts

Parts	½ in. to 4 in. (15 to 100 mm)
Housing	Two-part housing cast aluminum, painted, paint 60 µm thick, agate gray, RAL 7038
Terminal box	Cast aluminum, painted, paint 60 µm thick Frame: sky blue, RAL 5015 Lid: agate gray, RAL 7038
Meter pipe	304 Stainless Steel

Table 9-7 Vacuum Limits

Meter Size	Liner Material	Temperature
½ - 4 in. (15 - 100 mm)	Teflon / Tefzel	Full vacuum to 266°F (130°C)
	Neoprene, Polyurethane,	Full vacuum to 190°F (88°C)
	Hard rubber, Soft rubber	Full vacuum to 175°F (80°C)

9.2.4 Types of design (Flange per DIN 2501)

Meter sizes ½ to 4 in. (15 to 100 mm) of DIN-flanged design correspond with specified lay length of VDI / VDE 2641, ISO 13359 and of DVGW* sheet W420 water meter type WP, ISO 4064 short.

*(DVGW=Deutscher Verein des Gas- und Wasserfaches e.V.)

9.3 Converter Specifications

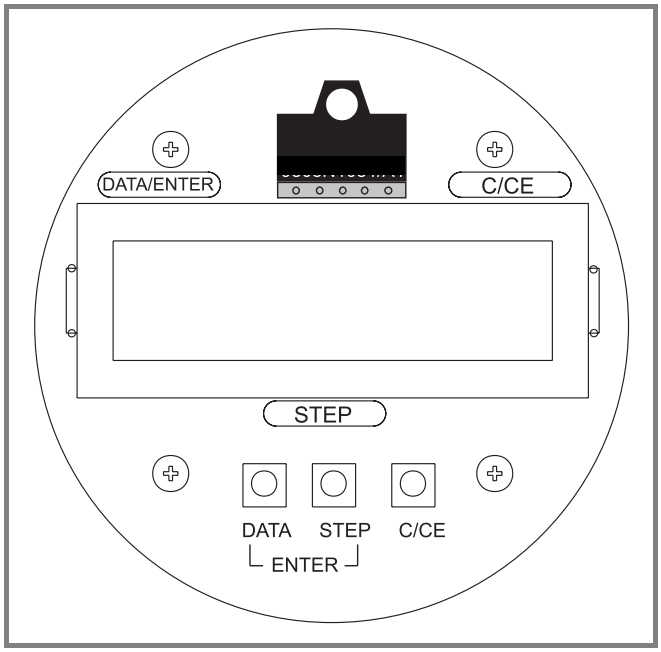


FIGURE 9-3. CONVERTER DISPLAY AND PUSHBUTTONS

9.3.1 Flow Rate Range

Continually adjustable between 1.64 and 33 ft/s (0.5 and 10 m/s)

9.3.2 Accuracy

± 0.5 % of rate for 6.6 to 33 ft/s (2 to 10 m/s) fluid velocity

± 0.03 ft/s (0.01 m/s) for < 6.6 ft/s (2 m/s) fluid velocity.

9.3.3 Reproducibility

≤ 0.2 % of rate for >6.6 ft/s (2 m/s) fluid velocity.

9.3.4 Minimum Conductivity

50 µS/cm

9.3.5 Response Time

As a step function 0-99% = 2 to 100 sec. depending on "damping" value (refer to Section 7.8).

9.3.6 Power Supply

14 to 55 VDC @ 22mA max.

9.3.7 Power Consumption

Maximum of 1.21W consumed from power supply

9.3.8 Ambient Temperature

-4 to +140 °F (-20 to +60 °C) see temperature diagram page 9-2

9.3.9 Electrical Connections

- Four cage-clamp terminals for wiring
- ½ in. NPT internally threaded conduit fittings supplied with ANSI flanged meters.
- Cable seal entry supplied with DIN flanged meters (**not FM approved**)

9.3.10 Parameter Entry

Parameter entry is possible with optional closed or opened instrument.

9.3.11 Forward/Reverse Flow Measurement

An arrow in the display indicates the flow direction, and an optocoupler contact provides an external indication of flow direction. Signalling takes place at forward flow.

9.3.12 Display

LCD dot matrix display, non-backlit, 2 lines x16 digits. The internal flow totalizer integrates in both forward and reverse flow directions and in 10 different units. The flow volume display may be in percent or 32 different units.

For better readability, the converter housing may be rotated 90° and the display can be placed in three different positions in 90° increments.

The units listed below are set by means of the arrow buttons. The unit refers to $Q_{max}DN$, Q_{max} forward and reverse flow and to the flow volume indication, if these are displayed in engineering units.

Table 9-8 Flow Unit Settings

Unit	Second	Minute	Hour	Day
Liter	l/s	l/min	l/h	-
Cubic meter	m^3/s	m^3/min	m^3/h	m^3/d
Imperial-gallon	igps	igpm	igph	igpd
U.S.-mill.-gall.	-	-	-	mgd
U.S.-gall.	-	gpm	gph	-
Barrel Brewery	bbl/s	bbl/min	bbl/h	bbl/d
Gram	g/s	g/min	g/h	-
Kilogram	Kg/s	Kg/min	Kg/h	kg/d
Metric ton	-	t/m	t/h	t/d
Pound	lbs/s	lbs/min	lbs/h	-
Kilo-gallons	kga/s	kga/min	kga/h	-

9.3.13 Data Security

If the power supply should fail, all data is stored in a NV-RAM for a period of more than 10 years without requiring external power. Additional data security is offered by an external serial EEPROM located in the converter for exchange or storage of process information.

9.3.14 Separation of Input / Output

Current and pulse output are galvanically isolated from the input circuit and from one another.

9.3.15 Input / Output Signals

9.3.15.1 V8 & V9 Contact Output

The following functions are selectable by software:

- Max. Alarm *
- Min. Alarm *
- Max./Min. Alarm *
- General Alarm *
- Forward/Reverse flow direction signal *
- Scaled Pulse Output
- No function

* Output state may be configured to open or close

Maximum scaled pulse output frequency is 100 Hz. The pulse multiplication factor may be set between 0.001 and 1000. The pulse width is adjustable from 0.1 ms to 2000 ms.

Optocoupler **Terminals V8, V9**,
$0\ V \le U_{CEL} \le 2\ V$, $16\ V \le U_{CEH} \le 28V$
$0\ mA \le I_{CEH} \le 0{,}2\ mA$, $2\ mA \le I_{CEL} \le 10\ mA$
$f_{max} \le 100\ Hz$

A 3v nominal Zener diode is connected in series with the collector of the opto-isolator's output transistor as shown in Figure 9-4 below.

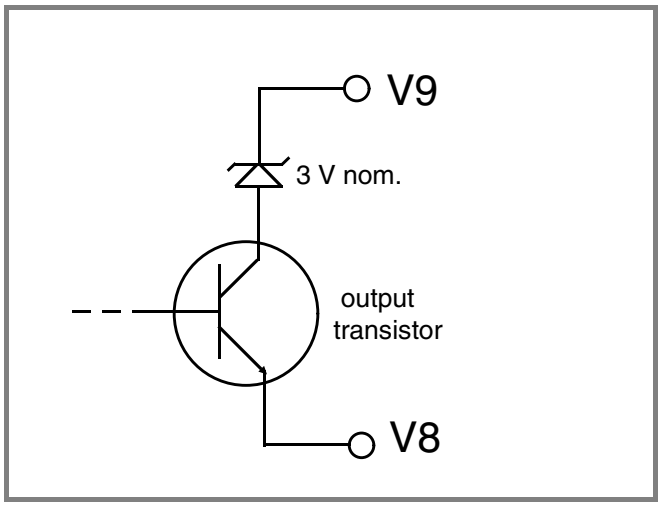


FIGURE 9-4. OUTPUT CIRCUIT

9.3.15.2 HART-Protocol (option)

The HART-Protocol provides a communication means between a process control system, a hand-held terminal and the magnetic flowmeter in the field. The digital communication occurs through use of an alternating voltage superimposed on the current output and which does not affect the instruments connected to this current output. This option is only available on "+/-" terminals with a 4-20 mA output current.

FSK current modulation is superimposed on the 4–20 mA current output in accordance with the Bell 202 standard. Maximum signal amplitude is 1.2 mA p-p.

Refer to Figure 9-5 for connections. **If HART-Protocol is to be used, it must be wired exactly as shown in Figure 9-5.**

9.3.15.2.1 HART Load, Current Output

Min.: >250 Ω, max. < 600 Ω

9.3.15.2.2 Cable

AWG 24 twisted

9.3.15.2.3 Maximum Cable Length

1500 meters (approx. 4900 feet)

9.3.15.2.4 Baud Rate

1200 Baud
Logical 1: 1200 Hz
Logical 0: 2200 Hz

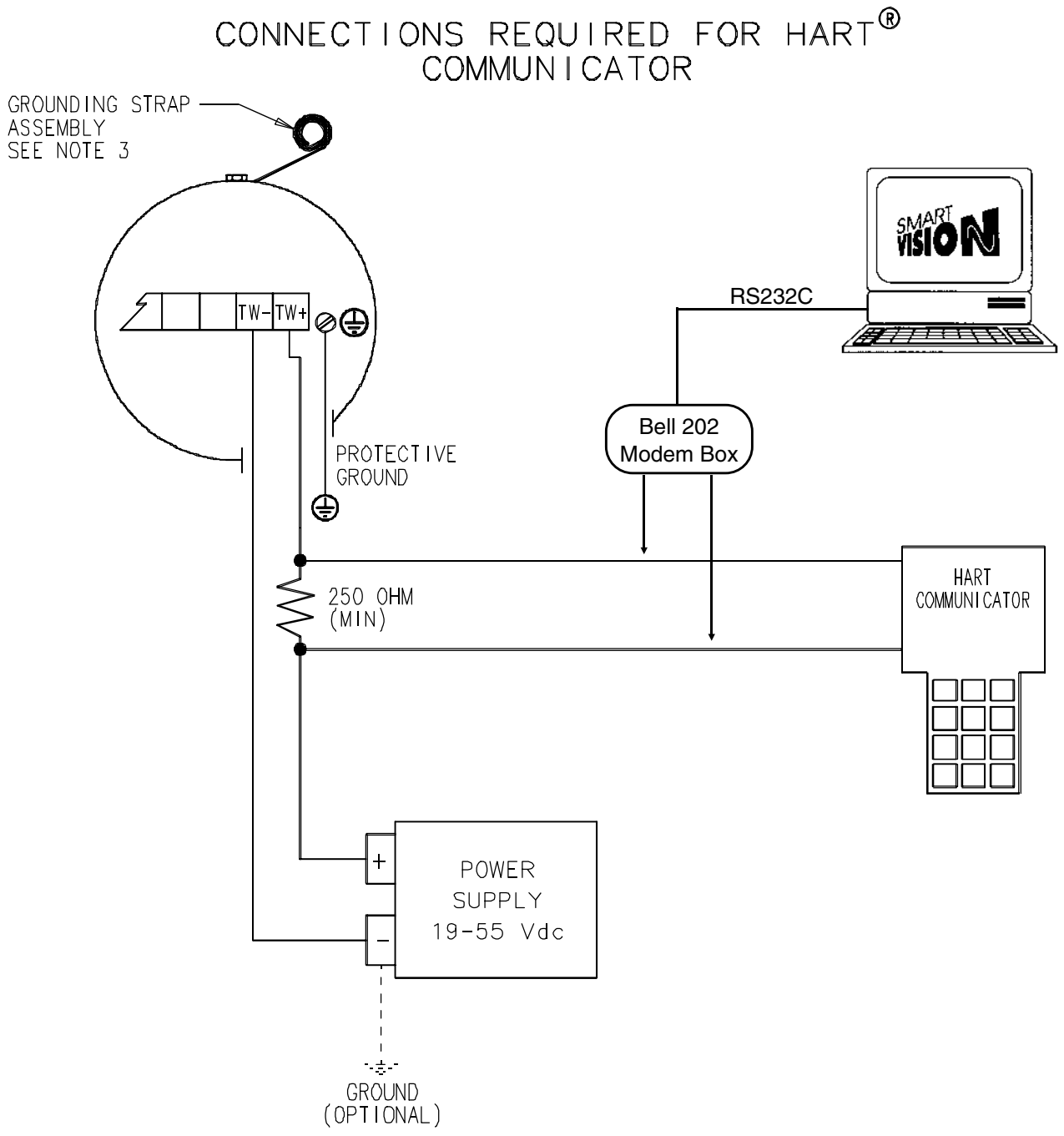


FIGURE 9-5. HART PROTOCOL COMMUNICATION

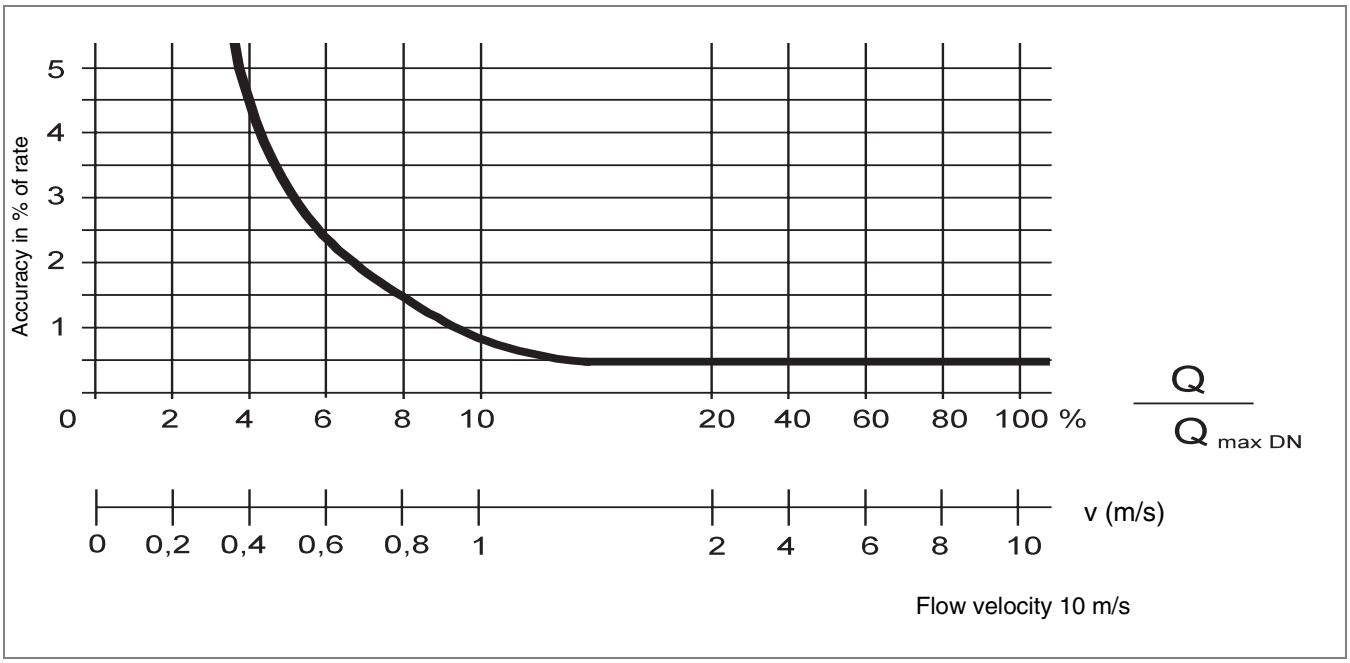


FIGURE 9-6. COPA-XT SYSTEM ACCURACY UNDER REFERENCE CONDITIONS

9.3.16 Reference Conditions (Refer to FIGURE 9-6)

9.3.16.1 Fluid Temperature

20 °C ± 2 °C

9.3.16.2 Ambient Temperature

20 °C ± 2 °C

9.3.16.3 Power Supply

24 VDC Nominal ± 1%

9.3.16.4 Installation Conditions of Straight Pipe Section

Upstream of primary > 10 x DN
Downstream of primary > 5 x DN

where DN = nominal Primary meter size

9.3.16.5 Warm-Up Time

30 minutes

9.3.16.6 Analog Output Influence

Additional ± 0.1% of rate based on the value of the digital flow rate indication.

DIM	SIZE	1/2 [15]		1 [25]		1-1/2 [40]		2 [50]		3 [80]		4 [100]	
	FLANGE CLASS	150	300	150	300	150	300	150	300	150	300	150	300
	MODEL NO.												
L	DT43F	7-7/8 [200]	9 [229]	7-7/8 [200]	9 [229]	7-7/8 [200]	9 [229]	7-7/8 [200]	9 [229]	7-7/8 [200]	9 [229]	9-7/8 [250]	11 [280]
	LINER												
RF	POLY/ TEFL/TEFZ	1-3/8 [35]		2 [51]		2-7/8 [73]		3-5/8 [92]		5 [127]		6-3/16 [157]	
B	POLY/NEO/ RUBBER	N/A		N/A		N/A		15/16 [24]	1-1/16 [27]	1-1/8 [29]	1-5/16 [33]	1-1/8 [29]	1-7/16 [36]
	TEFLON	1/2 [13]	5/8 [16]	11/16 [17]	13/16 [21]	27/32 [21]	31/32 [25]	29/32 [23]	1-1/32 [26]	1-3/32 [27]	1-9/32 [32]	1-3/32 [27]	1-13/32 [35]
	TEFZEL			5/8 [16]	3/4 [19]	3/4 [19]	7/8 [22]	27/32 [21]	31/32 [25]	3/4 [19]	1-1/4 [32]	1-3/32 [27]	1-3/8 [35]
d		5/8 [16]		5/8 [16]	3/4 [19]	5/8 [16]	7/8 [22]	3/4 [19]		3/4 [19]	7/8 [22]	3/4 [19]	7/8 [22]
N		4		4		4		4	8	4	8	8	8
BC		2-3/8 [60]	2-5/8 [67]	3-1/8 [79]	3-1/2 [89]	3-7/8 [98]	4-1/2 [114]	4-3/4 [121]	5 [127]	6 [152]	6-5/8 [168]	7-1/2 [191]	7-7/8 [200]
OD		3-1/2 [89]	3-3/4 [95]	4-1/4 [108]	4-7/8 [124]	5 [127]	6-1/8 [156]	6 [152]	6-1/2 [165]	7-1/2 [190]	8-1/4 [210]	9 [229]	10 [254]
A		2-15/16 [75]		3-7/16 [87]		3-15/16 [100]		4-9/16 [116]		3-15/16 [100]		5-1/8 [130]	
C		2-7/16 [62]		2-7/8 [73]		3-7/32 [82]		3-17/32 [90]		4-11/32 [110]		5-1/8 [130]	
E		6-17/32 [166]		6-31/32 [177]		7-5/16 [186]		7-21/32 [194]		8-7/16 [214]		9-7/32 [234]	
F		8-31/32 [228]		9-13/32 [239]		9-3/4 [248]		10-3/32 [256]		10-7/8 [276]		11-21/32 [296]	

NOTES:
1) ALL DIMENSIONS ARE IN INCHES. DIMENSIONS IN BRACKETS [ ] ARE IN MILLIMETERS [MM].
2) DIMENSIONS ARE GUARANTEED ONLY IF THIS PRINT IS CERTIFIED.
3) THIS DRAWING IS THIRD ANGLE PROJECTION AS SHOWN.
4) FLANGE BOLTS STRADDLE CENTERLINES.
5) FLOW MUST BE IN SAME DIRECTION AS FLOW ARROW.
6) METER MUST BE COMPLETELY FILLED WITH LIQUID TO INSURE ACCURACY.
7) ALL DIMENSIONS SUBJECT TO MANUFACTURING TOLERANCES OF +/- 1/8 [3].

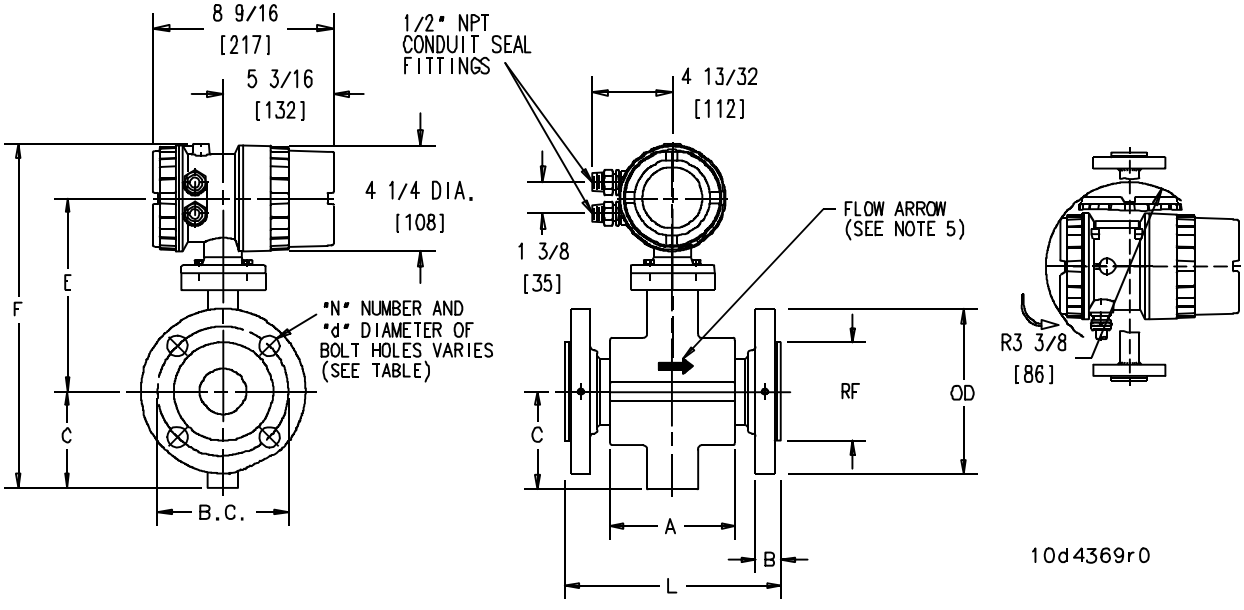


FIGURE 9-7. ANSI FLANGES, SIZES 1/2 THROUGH 4 INCHES

DIM	SIZE	1/2 [15]		1 [25]		1-1/2 [40]		2 [50]		3 [80]		4 [100]	
	DIN PN	10/16	25/40	10/16	25/40	10/16	25/40	10/16	25/40	10/16	25/40	10/16	25/40
	MODEL NO.												
L	DT43F	7-7/8 [200]	9 [229]	7-7/8 [200]	9 [229]	7-7/8 [200]	9 [229]	7-7/8 [200]	9 [229]	7-7/8 [200]	9 [229]	9-7/8 [250]	11 [280]
	LINER												
RF	POLY/ TEFL/TEFZ	1-25/32 [45]		2-11/16 [68]		3-15/32 [88]		4 [102]		5-7/16 [138]		6-7/32 [158]	6-3/8 [162]
B	POLY/NEO/ RUBBER	N/A		N/A		N/A		15/16 [24]	1-1/16 [27]	1-1/8 [29]	1-5/16 [33]	1-1/8 [29]	1-7/16 [36]
	TEFLON	1/2 [13]	5/8 [16]	11/16 [17]	13/16 [21]	27/32 [21]	31/32 [25]	29/32 [23]	1-1/32 [26]	1-3/32 [27]	1-9/32 [32]	1-3/32 [27]	1-13/32 [35]
	TEFZEL			5/8 [16]	3/4 [19]	3/4 [19]	7/8 [22]	27/32 [21]	31/32 [25]	3/4 [19]	1-1/4 [32]	1-3/32 [27]	1-3/8 [35]
d		9/16 [14]		9/16 [14]		23/32 [18]		23/32 [18]		23/32 [18]		23/32 [18]	7/8 [22]
N		4		4		4		4		8		8	
BC		2-9/16 [65]		3-11/32 [85]		4-11/32 [110]		4-29/32 [125]		6-5/16 [160]		7-3/32 [180]	7-1/2 [190]
OD		3-3/4 [95]		4-17/32 [115]		5-29/32 [150]		6-1/2 [165]		7-7/8 [200]		8-21/32 [220]	9-1/4 [235]
A		2-15/16 [75]		3-7/16 [87]		3-15/16 [100]		4-9/16 [116]		3-15/16 [100]		5-1/8 [130]	
C		2-7/16 [62]		2-7/8 [73]		3-7/32 [82]		3-17/32 [90]		4-11/32 [110]		5-1/8 [130]	
E		6-17/32 [166]		6-31/32 [177]		7-5/16 [186]		7-21/32 [194]		8-7/16 [214]		9-7/32 [234]	
F		8-31/32 [228]		9-13/32 [239]		9-3/4 [248]		10-3/32 [256]		10-7/8 [276]		11-21/32 [296]	

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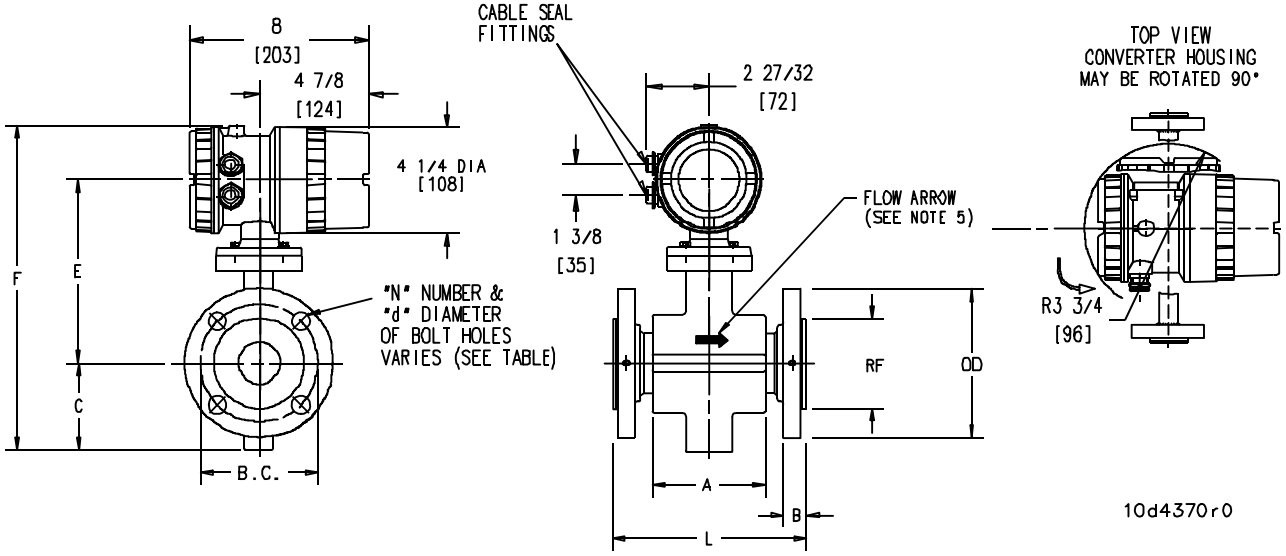

FIGURE 9-8. DIN FLANGES, SIZES 1/2 THROUGH 4 IN.

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