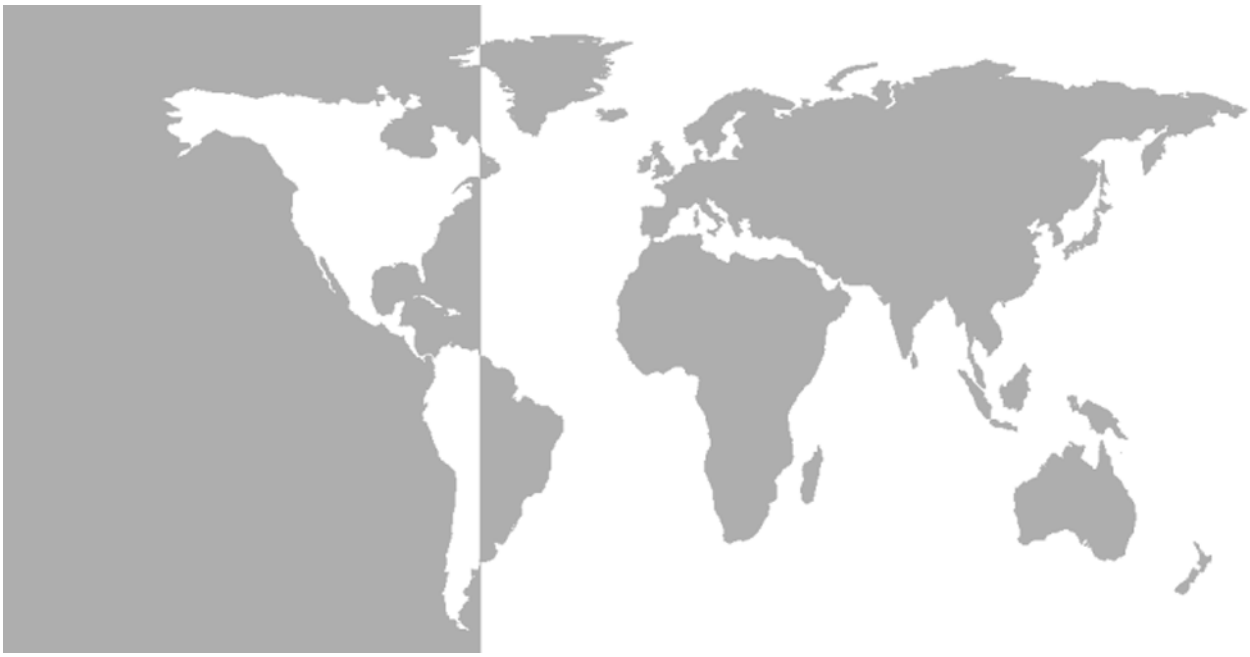
GE
Sensing & Inspection Technologies



DigitalFlow™ DF868

Panametrics Liquid Ultrasonic Flowmeter

Abridged Manual

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Sensing & Inspection Technologies

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Abridged Manual

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The *DigitalFlow DF868* is a GE Panametrics product. GE Panametrics has joined other GE high-technology businesses under a new name—GE Sensing & Inspection Technologies.

Warranty

Each instrument manufactured by GE Sensing, Inc. is warranted to be free from defects in material and workmanship. Liability under this warranty is limited to restoring the instrument to normal operation or replacing the instrument, at the sole discretion of GE. Fuses and batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. If GE determines that the equipment was defective, the warranty period is:

- one year for general electronic failures of the instrument
- one year for mechanical failures of the sensor

If GE determines that the equipment was damaged by misuse, improper installation, the use of unauthorized replacement parts, or operating conditions outside the guidelines specified by GE, the repairs are not covered under this warranty.

The warranties set forth herein are exclusive and are in lieu of all other warranties whether statutory, express or implied (including warranties of merchantability and fitness for a particular purpose, and warranties arising from course of dealing or usage or trade).

Return Policy

If a GE Sensing, Inc. instrument malfunctions within the warranty period, the following procedure must be completed:

1. Notify GE, giving full details of the problem, and provide the model number and serial number of the instrument. If the nature of the problem indicates the need for factory service, GE will issue a RETURN AUTHORIZATION number (RA), and shipping instructions for the return of the instrument to a service center will be provided.
2. If GE instructs you to send your instrument to a service center, it must be shipped prepaid to the authorized repair station indicated in the shipping instructions.
3. Upon receipt, GE will evaluate the instrument to determine the cause of the malfunction.

Then, one of the following courses of action will then be taken:

- If the damage is covered under the terms of the warranty, the instrument will be repaired at no cost to the owner and returned.
- If GE determines that the damage is not covered under the terms of the warranty, or if the warranty has expired, an estimate for the cost of the repairs at standard rates will be provided. Upon receipt of the owner's approval to proceed, the instrument will be repaired and returned.

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Chapter 1

Installation

Introduction

To ensure safe and reliable operation of the *DF868 Ultrasonic Liquid Flowmeter*, the system must be installed in accordance with the guidelines established by GE engineers.

WARNING!
The Model DF868 flowmeter can measure the flow rate of many liquids, some of which are potentially hazardous. In such cases, proper safety practices must be observed.

Be sure to follow all applicable local safety codes and regulations for installing electrical equipment and working with hazardous liquids or flow conditions. Consult company safety personnel or local safety authorities to verify the safety of any procedure or practice.

Site Considerations

Because the relative physical locations of the flowcell and the DF868 electronics console are important, use the guidelines in this section to plan the DF868 system installation.

Electronics Console Location

The standard DF868 electronics enclosure is a Type-4X weather-resistant, dust-tight, indoor/outdoor type. Typically, the electronics console is mounted in a meter shed. When choosing a mounting site, make sure that the location permits easy access to the console for programming, testing, and servicing.

Note: *For compliance with the European Union's Low Voltage Directive (73/23/EEC), this unit requires an external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible, and located within 1.8 m (6 ft) of the unit.*

Flowcell Location

The pipeline flowcell consists of the flow transducers and any temperature transducers employed as part of the flowmeter system. Ideally, choose a section of pipe with clear access to the flowcell, such as a long stretch of pipe that is above ground. However, if the flowcell is mounted on an underground pipe, dig a pit around the pipe to facilitate installation of the transducers.

Transducer Location

For a given fluid and pipe, the DF868 accuracy depends primarily on the location and alignment of the transducers. In addition to accessibility, when planning for transducer location, adhere to the following guidelines:

1. Locate the transducers so that there are at least 10 pipe diameters of straight, undisturbed flow upstream and 5 pipe diameters of straight, undisturbed flow downstream from the measurement point. To ensure undisturbed flow, avoid sources of turbulence in the fluid such as valves, flanges, expansions and elbows.
2. Because sediment at the bottom of the pipe and gas at the top of the pipe may cause attenuation of the ultrasonic signal, locate the transducers on the side of a horizontal pipe when possible. If limited pipe access necessitates top-mounted transducers and the ultrasonic path includes a reflection, shift the transducers to at least 10° off top center. This will minimize the influence of any sediment or gas on the reflected ultrasonic signals.

Cable Lengths

Locate the flowcell and transducers as close as possible to the electronics console. GE supplies transducer cables up to 300 m (1,000 ft) in length. If longer cables are required, consult the factory for assistance.

Temperature Transmitters

When installing temperature transmitters in the flowcell, locate them downstream of the flow transducers. These transmitters should be positioned no closer to the flow transducers than 2 pipe diameters and no further away from the flow transducers than 20 pipe diameters.

Transducer Cables

When installing the transducer cables, always observe established standard practices for the installation of electrical cables. Specifically, do not route transducer cables alongside high amperage AC power lines or any other cables that could cause electrical interference. Also, protect the transducer cables and connections from the weather and corrosive atmospheres.

Note: *When using non-GE cables to connect the flow transducers to the DF868 electronics console, the cables must have electrical characteristics identical to the GE cables. Type* RG 62 a/u *coaxial cable should be used, and each cable must be the same length within ±4 in. (±10 cm).*

Installing a Flowcell

A flowcell is the section of pipe where the transducers are mounted. It can be created either by mounting the transducers on the existing pipeline or by mounting them on a spoolpiece. A spoolpiece is a separately manufactured pipe section, matched to the existing pipe, which contains ports for mounting the transducers. This approach allows the transducers to be aligned and calibrated before inserting the spoolpiece into the pipeline.

Figure 1-1 below shows a diagram of a typical DF868 system.

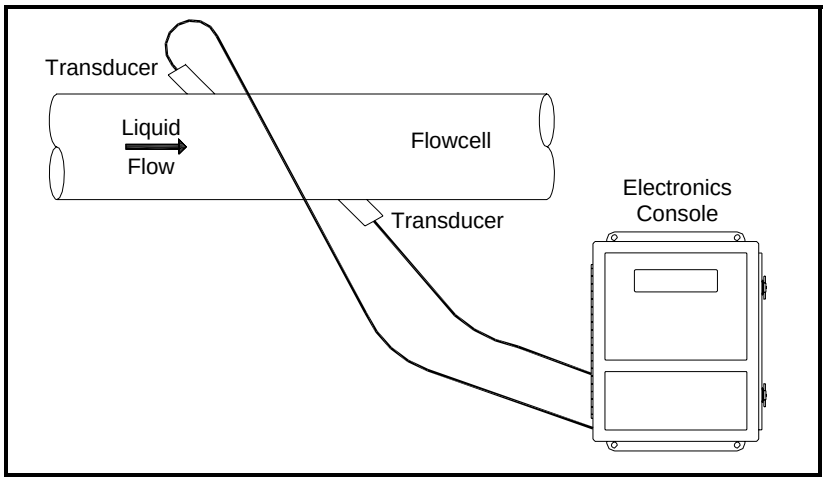


Figure 1-1: A Typical Model DF868 System

Installing Temperature Transmitters

Optional temperature transmitters may be installed as part of the flowcell, near the ultrasonic transducer ports. These transmitters must use a 0/4-20 mA signal to transmit the temperature values to the DF868 electronics console. The electronics console will provide a 24 VDC signal to power the transmitters. Any type of transmitters or sensors may be used, but they must have an accuracy equal to ±0.5% or better.

Note: *Resistive Thermal Devices (RTDs) are a good choice for the temperature sensor.*

Installing Temperature Transmitters (cont.)

Typically, a 1/2” NPT female threaded port is used to mount the transmitters on the flowcell. If the pipeline is insulated, the coupling may need to be extended to provide convenient access. Of course, other types of mounting ports, including flanged ports, may be used for the transmitters.

Figure 1-2 below shows a typical mounting arrangement for a temperature transmitter. The temperature sensor should protrude 1/4 to 1/2 way into the pipe.

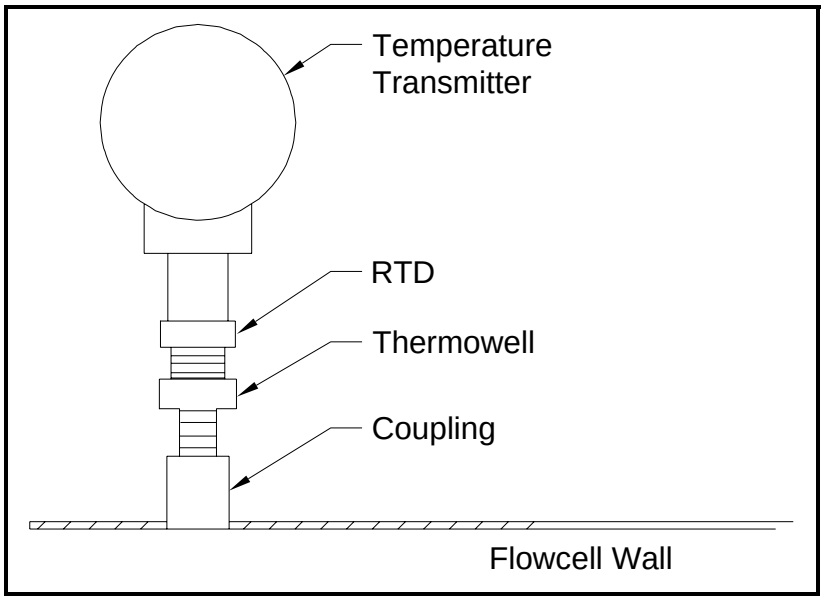


Figure 1-2: Typical Temperature Transmitter Mounting

Mounting the DF868 Electronic Console

The standard DF868 electronics package is housed in a NEMA-4X weather-resistant enclosure. Refer to *Figure 1-9* on page 1-19 for the mounting dimensions of this enclosure.

WARNING!
Proper grounding of the DF868 chassis is required to prevent the possibility of electric shock. See Figure 1-10 on page 1-20 to locate the internal ground connection.

CE Mark Compliance

For CE Mark compliance, the DF868 flowmeter must be wired in accordance with the instructions in this section.

IMPORTANT: *CE Mark compliance is required for all units intended for use in EEC countries.*

Wiring

The DF868 must be wired with the recommended cable, and all connections must be properly shielded and grounded. Refer to *Table 1-1* below for the specific requirements.

Table 1-1: Wiring Modifications

Connection	Cable Type	Termination Modification
Transducer	RG62 a/u	Add a metallic cable clamp from the braid to the chassis ground.
	Armored RG62 a/u or conduit	None - grounded using a cable gland.
Input/Output	22 AWG shielded (e.g. Baystate #78-1197)	Terminate the shield to the chassis ground.
	Armored conduit	None - grounded using a cable gland.
Power	14 AWG, 3 conductor, shielded (e.g. Belden #19364)	An external ground to the chassis is required.
	Armored Conduit	None - grounded using a cable gland.
Shielding	For CE compliance, power and I/O cables must be shielded. Cables to be terminated within a cable gland at the DF868. Shielded cable is not required when installations include metal conduit.	

External Grounding

For CE Mark compliance, the electronics enclosure and the transducer fixture must each have an external ground wire attached.

Note: *If the DF868 is wired as described in this section, the unit will comply with the EMC Directive 89/336/EEC.*

Making Electrical Connections

ATTENTION EUROPEAN USERS!
To meet CE Mark requirements, all cables must be installed as described on the previous page.

This section contains instructions for making all the necessary electrical connections to the DF868 flowmeter. Refer to Figure 1-10 on page 1-20 for a complete wiring diagram of the meter.

Except for the power connector, all electrical connectors are stored in their terminal blocks during shipment and may be removed from the enclosure for more convenient wiring. Feed the cables through the conduit holes on the bottom of the enclosure, attach the wires to the appropriate connectors and plug the connectors back into their terminal blocks.

Note: *For compliance with the European Union's Low Voltage Directive (73/23/EEC), a transparent plastic shroud protects the electrical connections. The shroud must remain in place, except while wiring the unit. Reinstall the shroud after the wiring has been completed.*

After the DF868 is completely wired, proceed to Chapter 2, *Initial Setup*, to configure the unit for operation.

Wiring the Line Power

ATTENTION EUROPEAN USERS!
To meet CE Mark requirements, all cables must be installed as described on the previous page.

The DF868 may be ordered for operation with power inputs of:

- 100-120 VAC
- 220-240 VAC
- 12-28 VDC

The label on the shroud inside the electronics enclosure, just above the TB1 line power terminal block, lists the required line voltage and the fuse rating for the meter. Be sure to connect the meter only to the specified line voltage.

Note: *For compliance with the European Union's Low Voltage Directive (73/23/EEC), this unit requires an external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible, and located within 1.8 m (6 ft) of the unit.*

Refer to *Figure 1-3* on the next page or Figure 1-10 on page 1-20 to locate terminal block TB1 and connect the line power as follows:

WARNING!
Improper connection of the line power leads or connecting the meter to the incorrect line voltage will damage the unit. It will also result in hazardous voltages at the flowcell and associated piping and within the electronics console.

Wiring the Line Power (cont.)

1. Remove the plastic shroud that covers the terminal blocks.
2. Strip 1/4” (6 mm) of insulation from the end of the line and neutral AC power leads (or the positive and negative DC power leads), and 1/2” (12 mm) from the end of the ground lead.
3. Connect the ground lead to the internal ground connection located on the side panel of the enclosure (see *Figure 1-3* below).

IMPORTANT: *The incoming ground lead must be connected to the internal ground connection.*

4. Connect the neutral AC power lead (or the negative – DC power lead) to TB1-2 and the line AC power lead (or the positive DC power lead) to TB1-3 as shown in *Figure 1-3* below.

IMPORTANT: *Do not remove the existing PC board ground wire or the cover ground wire.*

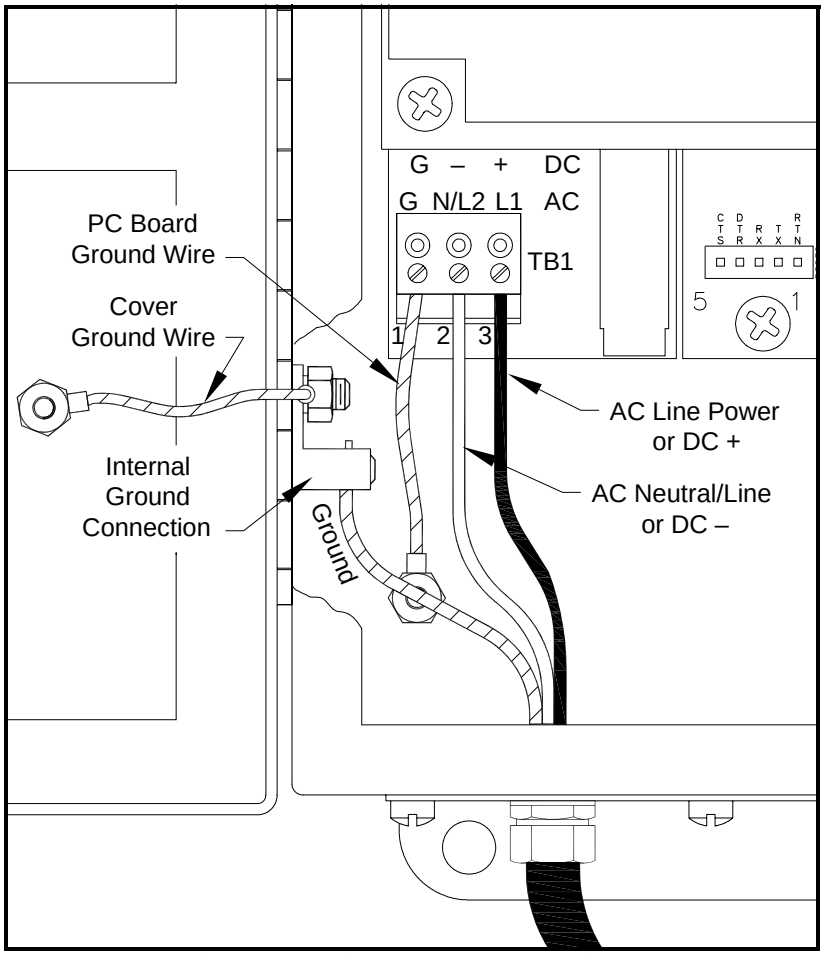


Figure 1-3: Line Power Connections

Wiring the Transducers

To wire the ultrasonic flow transducers, complete the following steps:

WARNING!
Before connecting the transducers, take them to a safe area and discharge any static buildup by shorting the center conductor of the transducer cables to the metal shield on the cable connector.

1. If an optional lightning protector is being installed, connect it to the electronics end of the cables according to the instructions provided.
2. Locate the CH1 transducer cables and connect them to the two CH1 transducers.
3. Refer to the wiring diagram in *Figure 1-10* on page 1-20 and connect the transducer cables to the CH1 terminal block. Then, secure the cable clamp.
4. For a 2-channel DF868 flowmeter, repeat steps 2-3 to wire the CH2 transducers to terminal block CH2.

Note: *It is not required that* CH2 *of a 2-channel DF868 be used. This channel may be left inactive for future use.*

After the wiring has been completed, the transducer channel(s) must be activated before measurements can begin. See Chapter 2, *Initial Setup*, for instructions.

Wiring the 0/4-20 mA Analog Outputs

The standard DF868 flowmeter includes two isolated 0/4-20 mA analog outputs (designated as A and B). Connections to these outputs may be made with standard twisted-pair wiring. The current loop impedance for these circuits must not exceed 550 ohms.

Refer to *Figure 1-10* on page 1-20 for the location of terminal block I/O and wire the terminal block as shown.

Wiring the Serial Port

The DF868 is equipped with a built-in serial communications port. The standard port is an RS232 interface, but an optional RS485 interface is available upon request. Proceed to the appropriate section for wiring instructions.

Wiring the RS232 Interface

Use the serial port to connect the DF868 flowmeter to a printer, an ANSI terminal or a personal computer. The RS232 interface is wired as Data Terminal Equipment (DTE), and the signals available at terminal block J1 are shown in *Table 1-2* below. Refer to *Figure 1-10* on page 1-20 and complete the following steps:

1. Disconnect the main power to the unit.
2. Install the required cable clamp in the chosen conduit hole on the side of the electronics enclosure.
3. Use the information in Table 1-2 below to construct a suitable cable for connecting the DF868 to the external device. If desired, an appropriate cable may be purchased from GE.

Table 1-2: RS232 Connection to DCE or DTE Device

J1 Pin #	Signal Description	DCE DB25 Pin #	DCE DB9 Pin #	DTE DB25 Pin #	DTE DB9 Pin #
5	DTR (Data Terminal Ready)	20	4	20	4
6	CTS (Clear to Send)	4	7	5	8
7	COM (Ground)	7	5	7	5
8	RX (Receive)	2	3	3	2
9	TX (Transmit)	3	2	2	3

Wiring the RS232 Interface (cont.)

4. Feed the flying leads end of the cable through the conduit hole and wire it to terminal block J1. Connect the other end of the cable to the printer, ANSI terminal or personal computer, and secure the cable clamp.

After the wiring has been completed, consult the *User's Manual* for the external device to configure it for use with the DF868.

Wiring the RS485 Interface

Use the optional RS485 serial port to network multiple DF868 flowmeters to a single computer terminal. Upon request, the standard RS232 port on the DF868 may be configured as a two-wire, half-duplex RS485 interface, through a device such as the INMAC Model 800052 RS232-RS422/RS485 converter.

IMPORTANT: *The DF868 must be configured at the factory for RS485 operation.*

To wire the RS485 serial port, refer to Figure 1-10 on page 1-20 and complete the following steps:

1. Disconnect the main power to the unit.
2. Install the required cable clamp in the chosen conduit hole on the side of the electronics enclosure.
3. Feed one end of the cable through the conduit hole, wire it to terminal block J1 and secure the cable clamp. Connect the other end of the cable to the converter, as shown in *Figure 1-4* below.

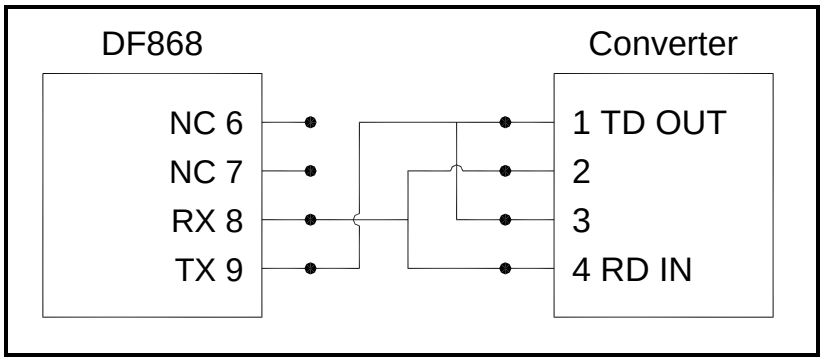


Figure 1-4: Typical RS485 Connections

Wiring the Ethernet Interface

The DF868 can be configured to use an ethernet connection to communicate with an internal network as follows:

1. Install an *ethernet option card* in either slot 5 or slot 6 of the DF868 electronics console. This card has a unique MAC (IP) address and it includes an RJ45 connector.
2. Plug one end of a standard ethernet cable into the RJ45 connector on the option card, and route the cable through one of the cable glands on the bottom of the DF868.
3. Connect the other end of the ethernet cable to the Ethernet network according to the network administrator's instructions.
4. Make an external connection between the Ethernet option card and the RS232 connector on the DF868, as indicated in *Table 1-3* below.

Note: *The MAC address for the DF868 option card is included with the documentation. For more information on setting up the MAC address consult your network administrator.*

Table 1-3: External Connections

FROM: RS232 Terminal Block (on main circuit board)	TO: Terminal Block TB1 (on ethernet card)
TX	Pin 1
RX	Pin 2
RTN	Pin 3

Wiring the MODBUS/TCP Interface

The DF868 can be configured to use a MODBUS/TCP interface to communicate with an internal network as follows:

1. Install a *MODBUS/TCP option card* in either slot 5 or slot 6 of the DF868 electronics console. This card has a unique MAC (IP) address and it includes an RJ45 connector.
2. Plug one end of a standard ethernet cable into the RJ45 connector on the option card, and route the cable through one of the cable glands on the bottom of the DF868.
3. Connect the other end of the ethernet cable to the Ethernet network according to the network administrator's instructions.

Note: *The MAC address for the DF868 option card is included with the documentation. For more information on setting up the MAC address consult your network administrator.*

Wiring the Foundation Fieldbus Network

The DF868 can be wired for Foundation Fieldbus network communication as follows:

Note: *Depending on the configuration of your DF868, either connector J8 or connector J9 will be available. Figure 1-5 below shows a meter with the J8 connector installed.*

1. Make the Fieldbus network connections to Pins 1 and 2 of connector J8 or J9 (see *Figure 1-5* below).
2. An optional shield connection may be made to Pin 3 of the network connector.

For normal operation, no connections are made pins 7 and 9 of the connector. However, these pins may be used to reset the network board to factory the defaults as follows:

1. Connect a temporary jumper between Pin 7 and Pin 9.
2. Reboot the instrument by turning the power OFF and then back ON.
3. Ten seconds after the power has been restored to the unit, remove the jumper to return the network board to normal operation.

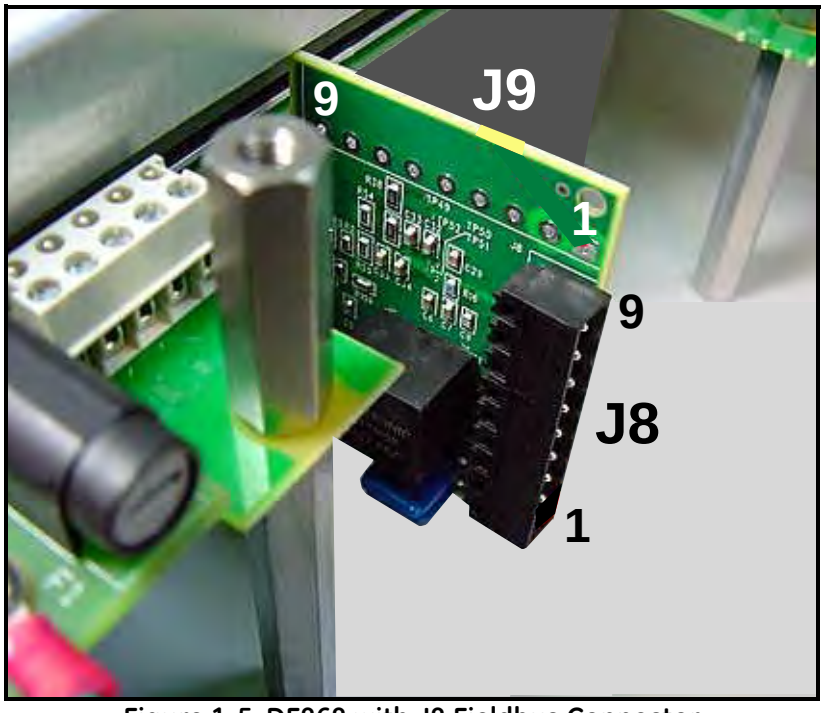


Figure 1-5: DF868 with J8 Fieldbus Connector

Wiring an Alarms Option Card

The DF868 can have up to 4 alarms option cards. Each card includes three *Form C relays* (designated as A, B and C). These relays may be either *General Purpose* types or *Hermetically Sealed* types for use in Class I, Division 2 hazardous areas.

The alarm relays can be wired as either *Normally Open* (NO) or *Normally Closed* (NC), and they may be wired for either *conventional* or *fail-safe* operation. *Figure 1-6* below shows the operation of a NO alarm relay in both conventional and fail-safe mode.

- Connect the two wires required for each alarm relay as shown in *Figure 1-10* on page 1-20.

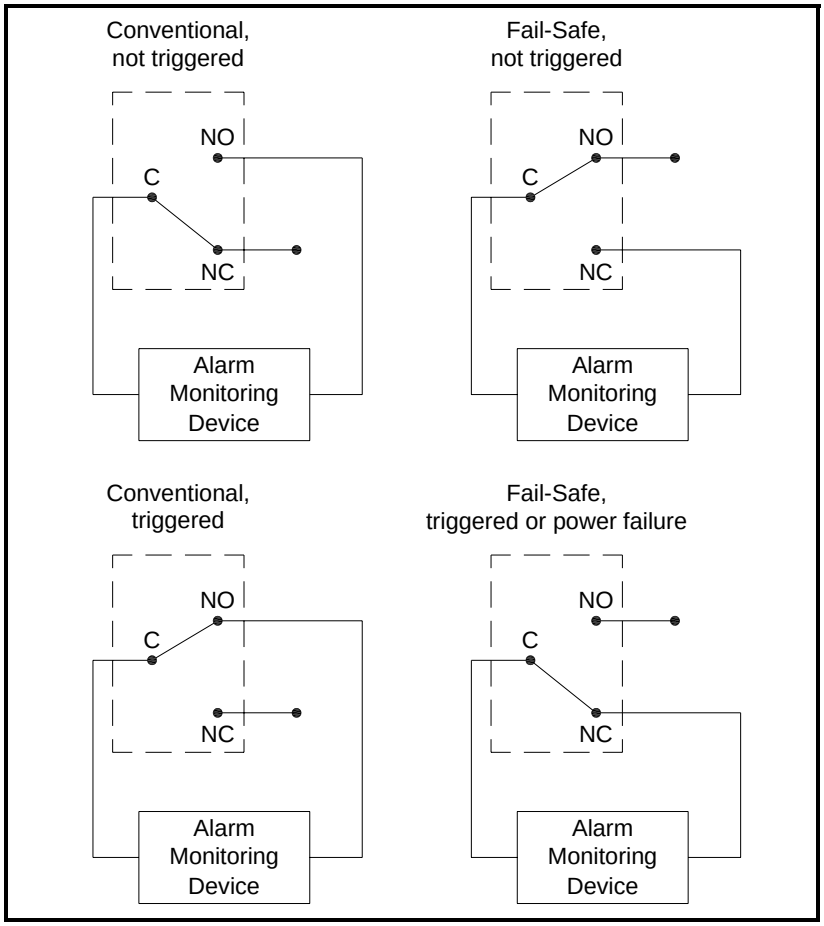


Figure 1-6: Conventional and Fail-Safe Alarm Operation

Wiring a 0/4-20 mA Analog Inputs Option Card

Temperature and pressure transmitters installed in the flowcell can provide data to the DF868 via an optional 0/4-20 mA analog inputs card. This option card includes two isolated 0/4-20 mA analog inputs (designated as A and B), each of which includes a 24 VDC power supply for loop-powered transmitters.

Note: *To program the DF868 to use the option card, it is necessary to know which input is assigned to which parameter.*

The analog inputs, which have an impedance of 118 ohms, should be connected with standard twisted-pair wiring. Power to the transmitters may be supplied either by the integral 24 VDC power supply on the analog input card or by an external power supply. *Figure 1-7* below shows typical wiring diagrams, with and without an external power supply, for one of the analog inputs.

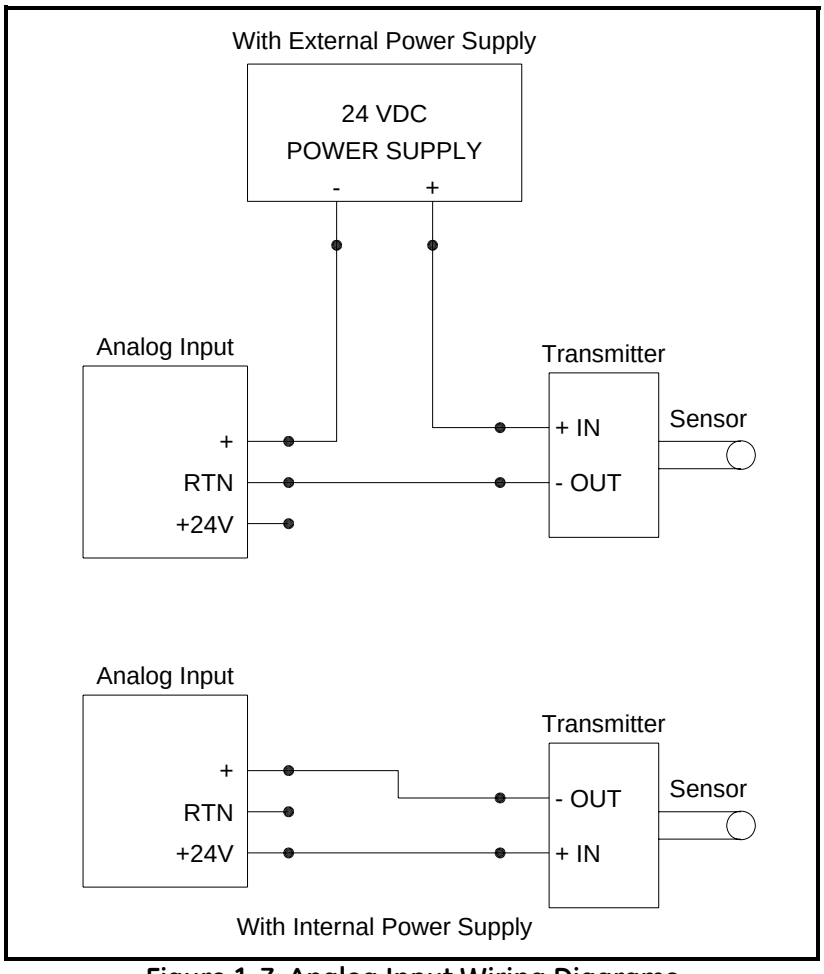


Figure 1-7: Analog Input Wiring Diagrams

Wiring a 0/4-20 mA Analog Inputs Option Card (cont.)

Wire the analog input option card terminal block in accordance with the pin number assignments shown in *Figure 1-10* on page 1-20.

Note: *If the flowmeter system includes additional transmitters, the DF868 can accommodate up to three more analog inputs option cards.*

IMPORTANT: *The analog inputs on the option card must be calibrated before use. This can be done with the DF868 built-in analog outputs, but you must calibrate the analog outputs first.*

Wiring a Totalizer/Frequency Outputs Option Card

The DF868 can accommodate up to four totalizer/frequency outputs option cards. Each totalizer/frequency outputs option card provides four outputs (designated as A, B, C, and D) that can be used as either totalizer or frequency outputs.

Each totalizer/frequency output requires two wires, which must be connected in accordance with the pin number assignments shown in *Figure 1-10* on page 1-20. *Figure 1-8* below shows sample wiring diagrams for totalizer and frequency output circuits.

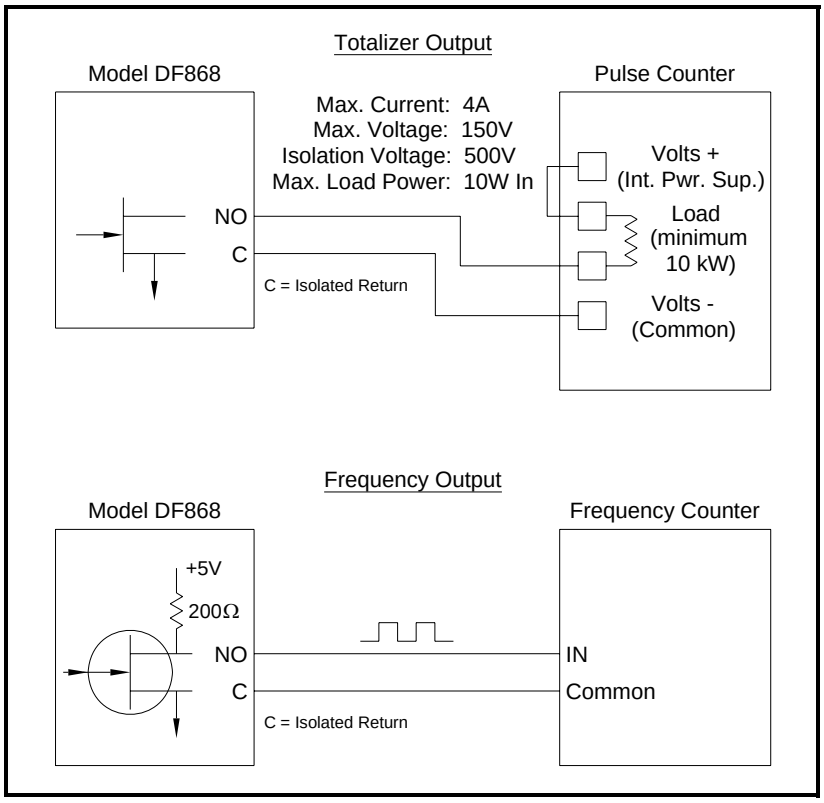


Figure 1-8: Totalizer/Frequency Outputs Wiring

Wiring an RTD Inputs Option Card

The DF868 can accommodate up to four RTD inputs option cards. Each RTD inputs option card provides two direct RTD inputs (designated as A and B). Each RTD input requires three wires, which should be fed through one of the conduit holes on the bottom of the electronics console.

Note: *For maximum accuracy, the three wires must be of equal length.*

Wire the option card terminal block in accordance with the pin number assignments shown in *Figure 1-10* on page 1-20.

Wiring a 0/4-20 mA Analog Outputs Option Card

The DF868 flowmeter can accommodate up to 4 analog outputs option cards. Each analog outputs option card includes four isolated 0/4-20 mA outputs (designated as A, B, C and D).

Connections to these outputs may be made with standard twisted-pair wiring. The total current loop impedance for these circuits must not exceed 1000 ohms. Wire the option card terminal block in accordance with the pin number assignments shown in *Figure 1-10* on page 1-20.

Wiring a MODBUS Option Card

A properly configured DF868 can use the RS485 standard for MODBUS communications. This standard allows up to 32 nodes (drivers and receivers) on one multidrop network, at distances up to 4,000 ft (1200 m). To connect the instrument to the host system, GE recommends using a 24-gauge (24 AWG) twisted-pair cable with a characteristic impedance of 120 ohms and a 120-ohm termination at each end of the communications line.

The MODBUS option card must be installed in either slot 5 or slot 6 of the DF868. On the option card, pin 1 is the [TMT-] inverting or negative connection and pin 2 is the [TMT+] non-inverting or positive connection. To link the DF868 to the control system, connect the two wires of the twisted-pair cable from these terminals to the corresponding terminals at the control system, in accordance with the pin number assignments shown in *Figure 1-10* on page 1-20.

IMPORTANT: *If two MODBUS option cards are installed in the DF868, only the card in slot 5 is recognized.*

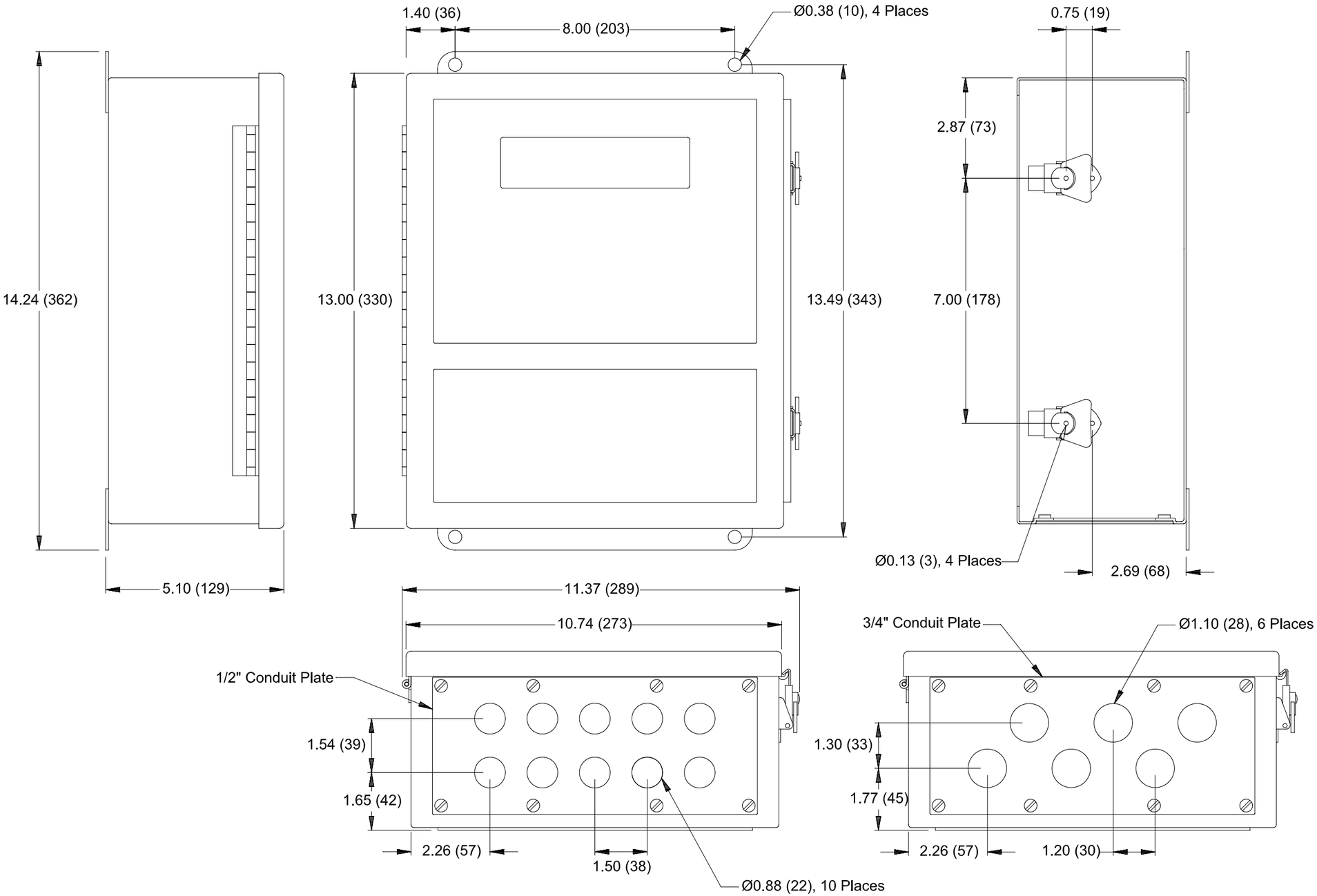


Figure 1-9: DF868 Type 4X Enclosure (ref. dwg #425-208)

RS232 SERIAL PORT	
Pin #	Description
1	RTN - Digital Return
2	TX - Transmit
3	RX - Receive
4	DTR - Data Terminal Ready
5	CTS - Clear to Send

RS485 PORT (MODBUS)	
Pin #	Description
1	TMT-
2	TMT+
3	Unused
4	Unused
5	Unused

NOTE: For compliance with the European Union's Low Voltage Directive (73/23/EEC), this unit requires an external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible and located within 1.8 m (6 ft) of the Model DF868.

TB1 POWER INPUT 12 - 28 VDC	
Pin #	Description
1	G - Earth Ground
2	– Negative
3	+ Positive

OR

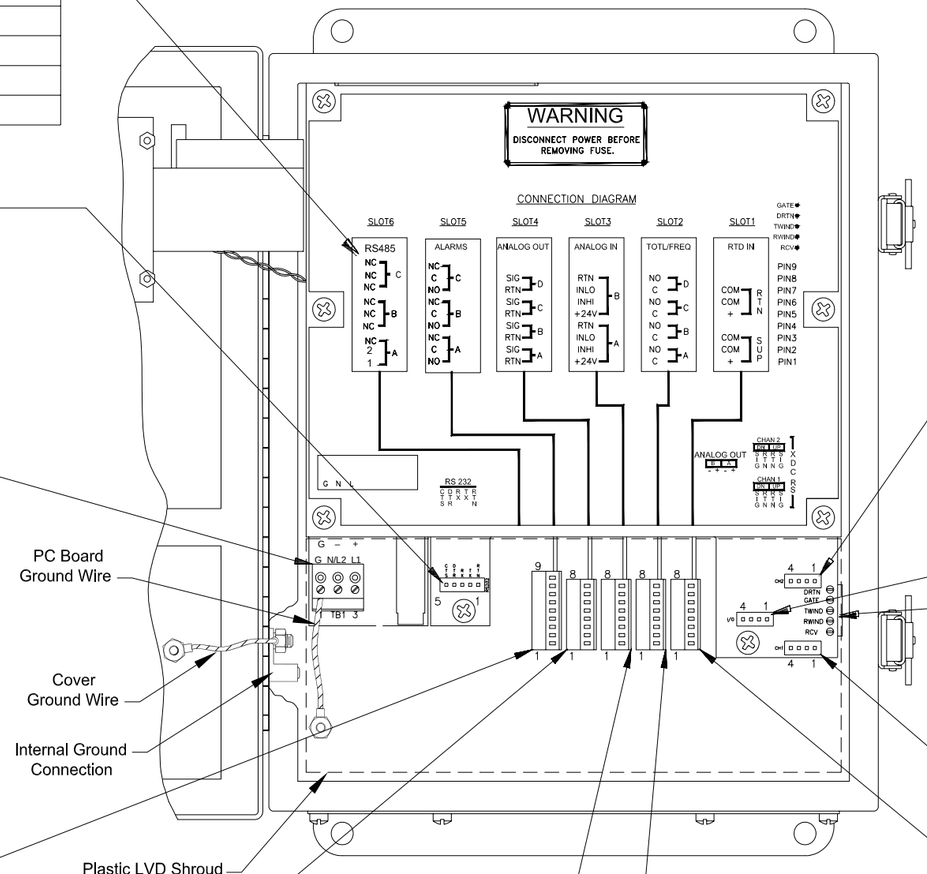
TB1 POWER INPUT 100 or 120 VAC	
Pin #	Description
1	G - Earth Ground
2	N - Line Neutral
3	L1 - Line Power

OR

TB1 POWER INPUT 220 or 240 VAC	
Pin #	Description
1	G - Earth Ground
2	L2 - Line Power
3	L1 - Line Power

NOTE: For compliance with the European Union's Low Voltage Directive (73/23/EEC), a transparent plastic shroud protects the electrical connections. The shroud must remain in place, except while wiring the unit. Reinstall the shroud after the wiring has been completed.

NOTE
One option card of each available type is shown in this diagram. These cards are not always installed in the same slots used for this example.



CH2 TRANSDUCER	
Pin #	Description
1	Upstream SIG(+)
2	Upstream RTN(-)
3	Downstream RTN(-)
4	Downstream SIG(+)

0/4-20 mA ANALOG OUTPUTS	
Pin #	Description
1	Output A - SIG(+)
2	Output A - RTN(-)
3	Output B - SIG(+)
4	Output B - RTN(-)

CH1 TRANSDUCER	
Pin #	Description
1	Upstream SIG(+)
2	Upstream RTN(-)
3	Downstream RTN(-)
4	Downstream SIG(+)

ALARM RELAYS	
Pin #	Description
1	Relay A - Normally Open (NO)
2	Relay A - Common (C)
3	Relay A - Normally Closed (NC)
4	Relay B - Normally Open (NO)
5	Relay B - Common (C)
6	Relay B - Normally Closed (NC)
7	Relay C - Normally Open (NO)
8	Relay C - Common (C)
9	Relay C - Normally Closed (NC)

0/4-20 mA ANALOG OUTPUTS	
Pin #	Description
1	Output A - RTN(-)
2	Output A - SIG(+)
3	Output B - RTN(-)
4	Output B - SIG(+)
5	Output C - RTN(-)
6	Output C - SIG(+)
7	Output D - RTN(-)
8	Output D - SIG(+)

0/4-20 mA ANALOG INPUTS	
Pin #	Description
1	Input A - +24V
2	Input A - INHI
3	Input A - INLO
4	Input A - RTN
5	Input B - +24V
6	Input B - INHI
7	Input B - INLO
8	Input B - RTN

TOTALIZER/FREQUENCY OUTPUTS	
Pin #	Description
1	Output A - Common (C)
2	Output A - Normally Open (NO)
3	Output B - Common (C)
4	Output B - Normally Open (NO)
5	Output C - Common (C)
6	Output C - Normally Open (NO)
7	Output D - Common (C)
8	Output D - Normally Open (NO)

RTD INPUTS	
Pin #	Description
1	Input A - SIG(+)
2	Input A - Common (C)
3	Input A - Common (C)
4	Unused
5	Input B - SIG(+)
6	Input B - Common (C)
7	Input B - Common (C)
8	Unused

Figure 1-10: DF868 Electronics Console Wiring (ref. dwg #702-213)

Chapter 2

Initial Setup

Introduction

This chapter provides instructions for entering the basic programming data required to place the DF868 flowmeter into operation. Before the DF868 can begin taking measurements and displaying valid data, the system and pipe parameters must be programmed into the meter. In addition, if you plan to use both channels of a 2-channel meter, each channel must be activated prior to use.

Navigating Through the User Program

To program the DF868 for initial use, the following menus within the *User Program* will be accessed:

- ACTIV - to select the desired measurement method and, for a 2-channel meter, to activate the channels
- SYSTM - to enter the required system data
- PIPE - to enter the required pipe parameters

As a guide in following the programming instructions in this chapter, the relevant portions of the DF868 menu map have been reproduced in *Figure 2-1* on page 2-17 and *Figure 2-2* on page 2-18.

Note: *There are minor differences at the start of the* ACTIV *and* SYSTM *submenus for the 1-Channel and 2-Channel models, but the* PIPE *menus are identical.*

In this chapter, it is assumed that the left DF868 display screen is active. If the right display screen is active, only the function key designations change. That is, replace [F1]-[F4] with [F5]-[F8].

Use the keypad to navigate through the *User Program*. The menu map may be followed in sequence, or the [↑] and [↓] keys may be used to scroll through the prompt screens. The [←] key may be used to delete the last alphanumeric character that was entered from the keypad.

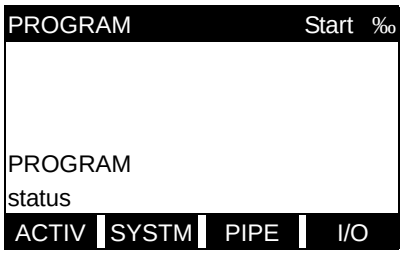
Accessing the User Program

To access the *User Program*, press the [PROG] key on the keypad.

Note: *If the security feature is active, enter the password and press* [ENT] *to enter the* User Program

1-Channel Meter

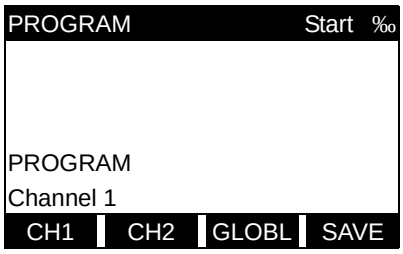
For a 1-Channel DF868, the measurement mode screen is replaced by the following initial programming mode screen:



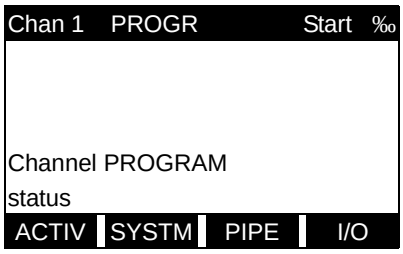
At the *User Program* screen shown, press [F1] and proceed to the next page for instructions.

2-Channel Meter

For a 2-Channel DF868, the following two-step sequence is required to reach the initial programming screen:



Press [F1] or [F2] to select the submenu for Channel 1 or Channel 2, respectively, from the option bar.



At the *User Program* screen shown, press [F1] and proceed to the next page for instructions.

Note: *In this manual, only the programming of Channel 1 is described. To program Channel 2, simply repeat the same procedures presented for Channel 1.*

Activating a Channel

The ACTIV submenu permits selection of the desired measurement method. In addition, it is used to activate/deactivate one or both of the channels in a 2-Channel DF868.

1-Channel Meter

1. Enter the ACTIV submenu by pressing [F1] at the User PROGRAM prompt.
2. Press [F1] to activate the channel in Transit-Time mode, or [F2] to activate the channel in TransFlection mode.

2-Channel Meter

1. Enter the ACTIV submenu by pressing [F1] at the Channel PROGRAM prompt.
2. Press [F1] (Off) to deactivate the channel and return to the Channel PROGRAM prompt, or press [F2] to activate the channel in Transit-Time mode, or [F3] to activate TransFlection mode.

Note: *If your DF868 is not equipped with TransFlection mode, the* TRNFL *option does not appear.*

Proceed directly to the next section to program the SYSTM submenu.

Entering System Data for a Channel

Begin the programming of the SYSTM submenu in either the *1-Channel* section below or the *2-Channel* section on the next page.

1-Channel Meter

For the 1-Channel DF868, the information entered in the SYSTM submenu pertains to the global operation of the flowmeter.

1. At the *User Program* screen, press the [F2] function key to program the SYSTM submenu.
2. Enter a *Site Label* of up to 9 characters and press the [ENT] key. (While taking measurements, the site label appears on the locator bar.)
3. Enter a *Site Message* of up to 21 characters. Use this screen to enter a brief description of the site. When the message has been entered, press the [ENT] key.
4. Press [F1] to turn the *Energy Option* OFF or press [F2] to turn it ON. (The Energy Option calculates the energy of a system based on temperatures at the supply and return points, and the flow of fluid.)
5. To select the *System Units*, press [F1] to display parameters and measurements in English units or press [F2] to display parameters and measurements in Metric units.
6. To program the *Totalizer Option*, press [F1] to measure totals automatically, or press [F2] to measure totals manually.

The remainder of the SYSTM submenu is identical for the 1-Channel and 2-Channel versions of the DF868. Proceed to the *1- and 2-Channel Meters* section on page 2-6 to complete the programming of this submenu.

2-Channel Meter

For the 2-Channel DF868, the information entered in the SYSTM submenu pertains only to the currently selected channel.

1. At the *User Program* screen shown, press [F2] to program the SYSTM submenu.
2. Enter a *Channel Label* of up to 9 characters. While taking measurements, the channel label will appear on the locator bar. Press [ENT].
3. Enter a *Channel Message* of up to 21 characters. Press [ENT].
4. Press [F1] to turn the Energy Option OFF or press [F2] to turn it ON. (The Energy Option calculates the energy of a system based on temperatures at the supply and return points, and the flow of fluid.)

Note: *For a 2-Channel DF868, the* System Units *and* Totalizer *prompts, which are not required to make the unit operational, are located in the* GLOBL *submenu.*

The remainder of the SYSTM submenu is identical for the 1-Channel and 2-Channel versions of the DF868. Proceed to the *1- and 2-Channel Meters* section on page 2-6 to complete the programming of this submenu.

1- and 2-Channel Meters

1. Use the [F1]-[F4] and [→] keys to select the desired *Volumetric Units* for the flow rate display.

The abbreviations and definitions of all the available volumetric units are shown in *Table 2-1* below. The choices shown on the option bar are determined by the selections made at the previous SYSTEM UNITS prompt screen.

Table 2-1: Volumetric Unit Options

English Volumetric Units	Metric Volumetric Units
GAL/S - U.S. Gallons per Second	L/S - Liter per Second
GAL/M - U.S. Gallons per Minute	L/M - Liters per Minute
GAL/H - U.S. Gallons per Hour	L/H - Liters per Hour
MGD - Millions of U.S. Gallons per Day	ML/D - Millions of Liters per Day
ft^3/s - Cubic Feet per Second	m^3/s - Cubic Meters per Second
ft^3/m - Cubic Feet per Minute	m^3/m - Cubic Meters per Minute
ft^3/h - Cubic Feet per Hour	Mm^3/h - Millions of Cubic Meters per Hour
Mft^3/d - Millions of Cubic Feet per Day	Mm^3/d - Millions of Cubic Meters per Day
BBL/S - Barrels per Second	BBL/S - Barrels per Second
BBL/M - Barrels per Minute	BBL/M - Barrels per Minute
BBL/H - Barrels per Hour	BBL/H - Barrels per Hour
BBL/D - Barrels per Day	BBL/D - Barrels per Day
MBBL/D - Millions of Barrels per Day	MBBL/D - Millions of Barrels per Day
Acre-inch/sec - Acre-inches per second	N/A
Acre-inch/min - Acre-inches per minute	N/A
Acre-inch/hr - Acre-inches per hour	N/A
Acre-inch/day - Acre-inches per day	N/A
Acre-foot/sec - Acre-feet per second	N/A
Acre-foot/min - Acre-feet per minute	N/A
Acre-foot/hr - Acre-feet per hour	N/A
Acre-foot/day - Acre-feet per day	N/A

1- and 2-Channel Meters (cont.)

2. Press [F1]-[F4] to select the *Vol Decimal Digits* (the desired number of digits to the right of the decimal point) in the volumetric flow rate display.

3. Use the [F1]-[F4] and [→] keys to select the *Totalizer Units.*

The abbreviations and definitions of all the available totalizer units are shown in *Table 2-2* below. The choices shown on the option bar in the prompt screen above are determined by the selections made at the previous SYSTEM UNITS prompt screen.

Table 2-2: Totalizer Unit Options

English Totalizer Units	Metric Totalizer Units
Gal - U.S. Gallons	L - Liters
MGAL - Mega U.S. gallons	ML - Megaliters
ft^3 - Cubic Feet	m^3- Cubic Meters
Mft^3 - Mega Cubic Feet	Mm^3- Mega Cubic Meters
BBL - Barrels	BBL - Barrels
MBBL - Megabarrels	MBBL - Megabarrels
Acre-inches	
Acre-feet	

4. Press [F1]-[F4] to select the *Total Decimal Digits* (the digits to the right of the decimal point) in the totalized flow display.

Mass Flow

If the Mass Flow prompt in the SETUP submenu is not enabled, skip this section. However, the following programming sequence appears if Mass Flow is enabled.

1. Use the [F1]-[F4] keys to select the desired *Mass Flow* units, listed in *Table 2-3* below.

Table 2-3: Available Mass Flow Units

English	Metric
LB = Pounds	KG = Kilograms
KLB = Thousands of LB	TONNE = Metric Tons (1000 KG)
MMLB = Millions of LB	
TONS = Tons (2000 LB)	

2. Use the [F1]-[F4] keys to select the desired *Mass Flow Time* units.
3. Use the [F1]-[F4] keys to select the *MDOT Decimal Digits* (the digits to the right of the decimal point) for displaying mass flow.
4. Use the [F1]-[F4] keys to select the *Mass (Totalizer)* units, listed in *Table 2-3* above.
5. Use the [F1]-[F4] keys to select the *Mass Decimal Digits* (the digits to the right of the decimal point) for displaying totalized mass flow.

Energy Option

If you did not select the *Energy Option* earlier, the meter now returns to the initial *User* (or *Channel) Program* screen. But if you selected the Energy Option, several more prompts appear.

1. Use the [F1]-[F4] keys to select the desired *Power* units, listed in *Table 2-4* below.

Table 2-4: Power Unit Options

English Power Units	Metric Power Units
kBTU—Thousands of British Thermal Units per Hour	kCAL/sec—Kilocalories/second
MMBTU—Millions of British Thermal Units per Hour	MCAL/sec—MegaCalories/second
kW—kilowatts	kW—kilowatts
Tons	MW—Megawatts

Energy Option (cont.)

2. Use the [F1]-[F4] keys to select the *Power Decimal Digits* (the digits to the right of the decimal point) for displaying power.
3. Use the [F1]-[F4] keys to select the *Total Energy* units, shown in *Table 2-5* below.

Table 2-5: Energy Unit Options

English Energy Units	Metric Energy Units
kBTU—Thousands of British Thermal Units	kCAL—Kilocalories
MMBTU—Millions of British Thermal Units	MCAL—MegaCalories
kWHr—Kilowatt-Hours	kW—Kilowatt-Hour
Tons	MW—Megawatt-Hour

4. Use the [F1]-[F4] keys to select the *Energy Decimal Digits* (the digits to the right of the decimal point) for displaying total energy.
5. Press [F1] to make measurements in a *Cooling* system, or [F2] to make measurements in a *Heating* system.
6. Press [F1] to conduct *Flow Measurement* at the point of return (where the liquid exits), or [F2] to measure flow at the point of supply (where the liquid enters).

When the above selection has been made, the meter exits the SYSTM submenu and returns to the initial *User Program* screen. Proceed directly to the next section to program the PIPE submenu.

Entering Pipe Data

The PIPE submenu is used to program the transducer and pipe data into the DF868. To use this menu, complete the following steps:

1. At the *User (or Channel) Program* screen, press [F3] to program the PIPE submenu.

Transducer Number

2. Enter the *Transducer Number* engraved on the head of the transducer and press [ENT]. If there is no engraved number, you must complete the steps below. Otherwise, proceed to step 3 on the next page for a clamp-on transducer, or to step 4 for a wetted transducer.

   a. Assign a number between 91 and 99 to the *Special Transducer* and press [ENT]. (The meter will only accept values from 1 to 199.)

   b. Use the [F1]-[F3] keys to select the *Wedge Type*. Three choices are available: Rayleigh or Shear wave (for clamp-on transducers) or wetted transducers.

   c. Use the [F1]-[F3] keys to select the *Frequency* of the special transducer.

   d. Enter the special transducer *Time Delay (Tw)* value supplied by GE and press [ENT].

If you have selected a special wetted transducer, the meter now rejoins the standard programming sequence. However, if you have selected a special clamp-on transducer, the following two additional prompts appear:

   e. Use the numeric keys to enter the *Wedge Angle* (the angle of the ultrasonic transmission) in degrees and press [ENT].

Note: *In TransFlection mode, you must enter a separate wedge angle for both the transmit transducer and the receive transducer.*

   f. Use the numeric keys to enter the *Wedge Soundspeed* in ft/sec or m/sec and press [ENT].

Pipe Material

3. Use the [F1]-[F4] and [→] keys to select the *Pipe Material*, as listed in *Table 2-6* below.

Table 2-6: Pipe Materials

Pipe Material Category	Specific Material
Steel	Carbon Steel or Stainless Steel
Iron	Ductile Iron or Cast Iron
Cu - Copper	None
Al - Aluminum	None
Brass	None
CuNi - Copper/Nickel	70% Cu 30% Ni or 90% Cu 10% Ni
Glass	Pyrex, Flint, or Crown
Plastic	Nylon, Polyester, Polypropylene, PVC (CPVC), Acrylic
Other	Any material

Note: *Depending on the pipe material choice, another window may appear, asking you to specify the specific material. If you selected* "Other," *you will be asked to enter the sound speed.*

Pipe OD

4. Enter the known *Pipe OD* or circumference and press [F1]-[F4] to select the appropriate units, as shown in *Table 2-7* below. Press [ENT]. (The meter will only accept values from 1/8 to 648 in.)

Note: *The first two lines of text in the prompt area depend on the selection made at the* TRANSDUCER NUMBER *prompt. The option bar choices may appear in English or Metric units.*

Table 2-7: Available Pipe OD Units

English	Metric
inch = pipe OD in inches	mm = pipe OD in millimeters
feet = pipe OD in feet	m = pipe OD in meters
in/PI = pipe circumference in inches	mm/PI = pipe circumference in millimeters
ft/PI = pipe circumference in feet	m/PI = pipe circumference in meters

Pipe Wall

5. Enter the known thickness of the *Pipe Wall* in the same units used for the pipe OD, and press [ENT].

If the pipe wall thickness is not available, look up the value in a table of standard pipe size data.

For wetted transducers, skip to step 7.

Lining

6. Press [F1] if the pipe does not have a *Lining*, or [F2] if it does have a lining. If you select YES, complete the steps below.

   a. Use the [F1]-[F4] and [→] keys to select the *Lining Material*. Options include Tar, Pyrex, Asbestos, Mortar, Rubber, PTFE and Other. If you choose "Other," the DF868 then asks you to enter the lining sound speed.

   b. Enter the known *Lining Thickness*, in the same units used for the pipe OD, and press [ENT]. Then proceed to step 9.

Path and Axial Length

7. Enter the *Path Length* of the ultrasonic signal. Press [F1] or [F2] to select the desired units, and press [ENT].

Note: *GE has calculated both the transducer signal path length* (P) *and the transducer signal axial length* (L)*, based on the exact transducer configuration used for the application. These values are engraved on the flowcell and/or are included in the documentation supplied with the meter. See* Appendix A *for an explanation of how these values are calculated.*

8. The next prompt varies, depending on whether you selected Transit-Time or TransFlection in the ACTIV menu.

   - If you selected Transit-Time, the DF868 asks for the *Axial Length*. Enter the supplied value. Press [F1] or [F2] to select the desired units, and press [ENT].

   - If you have selected TransFlection, enter the number of degrees for the *Transducer Angle*, and press [ENT]. Skip to step 10.

Tracking Windows

Note: *This step only appears if you have selected Transit-Time.*

9. Press [F1] if you do not want *Tracking Windows*, or [F2] if you want to enable the windows. (Tracking windows are used to detect the receive signal when you are unsure of the fluid soundspeed.)

Fluid Type

10. Use the [F1]-[F4] and [→] keys to select the *Fluid Type*. The selections for the fluid type vary, depending on whether:

- the ENERGY OPTION is ON or OFF
- the TRACKING WINDOW is enabled or disabled

Refer to Table 2-8 below if ENERGY OPTION is OFF, or to Table 2-9 on page 2-13 if ENERGY OPTION is ON.

Table 2-8: Fluid Types for ENERGY OFF

Tracking Windows =			
NO	**Additional Selections**	**YES**	**Additional Selections**
WATER	Select **NORML** or **SEA** and press **[ENT]**. If **NORML** is selected, enter the Water Temperature and press **[ENT]**.	W100	No additional selections required.
OIL	Select **LUBE** or **CRUDE** and press **[ENT].**	W260	No additional selections required.
METH	No additional selections required.	OIL	No additional selections required.
ETH	Enter the Fluid Soundspeed and press **[ENT].**	OTHER	Enter the Minimum Sound-speed and press **[ENT].** Then enter the Maximum Sound-speed and press **[ENT].**
LN2	No additional selections required.		
FREON	No additional selections required.		
OTHER	Enter the Fluid Soundspeed and press **[ENT].**		

Table 2-9: Fluid Types for ENERGY ON

Tracking Windows =			
NO	**Additional Selections**	**YES**	**Additional Selections**
WATER	Enter the Water Temperature and press **[ENT].**	W260	No additional selections required.
MIXED	Enter the Fluid Soundspeed and press **[ENT].** Then enter the Percentage of Water and press **[ENT].**	MIXED	Enter the Percentage of Water and press **[ENT].**
OTHER	Enter the Fluid Soundspeed and press **[ENT]**.	OTHER	Enter the Minimum Sound-speed and press **[ENT].** Then enter the Maximum Sound-speed and press **[ENT].**

Reynolds Correction

11. Press [F1] to turn *Reynolds Correction* off, or [F2] to turn it on.

Note: *Reynolds Correction should be enabled for most applications.*

12. When you enable the Reynolds Correction Factor, you must also enter the *Kinematic Viscosity* of your fluid. Use the numeric keys to enter a value, and press [ENT].

Calibration Factor

13. Enter a value for the flow *Calibration Factor* and press [ENT]. The default value is 1.00, but values between 0.50 and 2.00 may be entered.

14. The menu now varies, depending on whether you have activated the TransFlection or Transit-Time mode.

- If you activated the **TransFlection mode**, the program asks for the *Depth of Reflector.* This setting determines where in the pipe the DF868 looks for the reflected signal. The default value is 50%. Use the numeric keys to enter a value, and press [ENT].

Note: *GE recommends activating the Reynolds Correction Factor when the Depth of Reflector is set at 50%. You can disable the Reynolds Correction Factor when the Depth of Reflector is set at any other value.*

- If you activated the **Transit-Time mode**, these two steps appear.

  a. Use the [F1]-[F4] keys to select the desired *Number of Traverses*, the number of times the ultrasonic signal traverses the pipe, from 1 to 5.

  b. The *Transducer Spacing* prompt displays the spacing of the transducers, as calculated from the information you have entered. Record this number and use it to properly space transducers.

You have completed entering pipe parameters for clamp-on transducers. Press [ENT] to return to the start of the PIPE submenu, and [EXIT] to leave the submenu.

Entering Pipe Data (cont.)

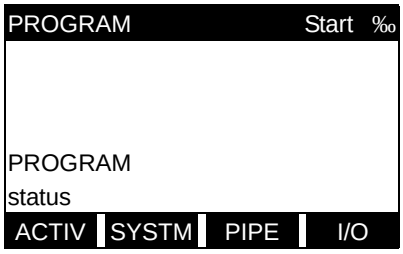
Table 2-10 below lists the numeric parameters in the PIPE submenu, with their high and low limits.

Table 2-10: Low and High Limits for PIPE Parameters

Parameter	Low Limit	High Limit
Wedge Angle	25°	90°
Pipe OD	0.12 in.	300 in.
Pipe Wall	0 in.	4.0 in.
Lining Thickness	0 in.	4.0 in.
Kinematic Viscosity	0.1	10,000 (E-6 ft^2/s)
Path Length	0.12 in.	480 in.
Axial Length	0.12 in.	480 in.

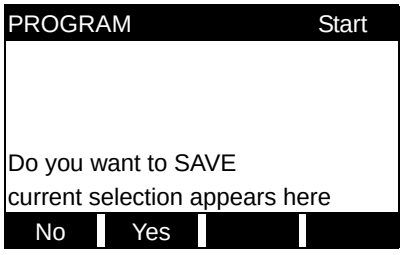
Exiting the User Program

After the calibration factor entry has been made, the meter will exit the PIPE submenu and return to the initial *User Program* screen.



To leave the *User Program* and begin taking measurements, press [EXIT].

At the conclusion of the initial setup programming sequence, the following screen appears:



At the *User Program* screen shown, press [F1] to return to measurement mode without saving the file or press [F2] to enter the SAVE submenu.

Note: *If you press* [NO]*, the DF868 still retains the newly programmed information in its active memory.*

Proceed to Chapter 3, *Operation,* for instructions on taking measurements.

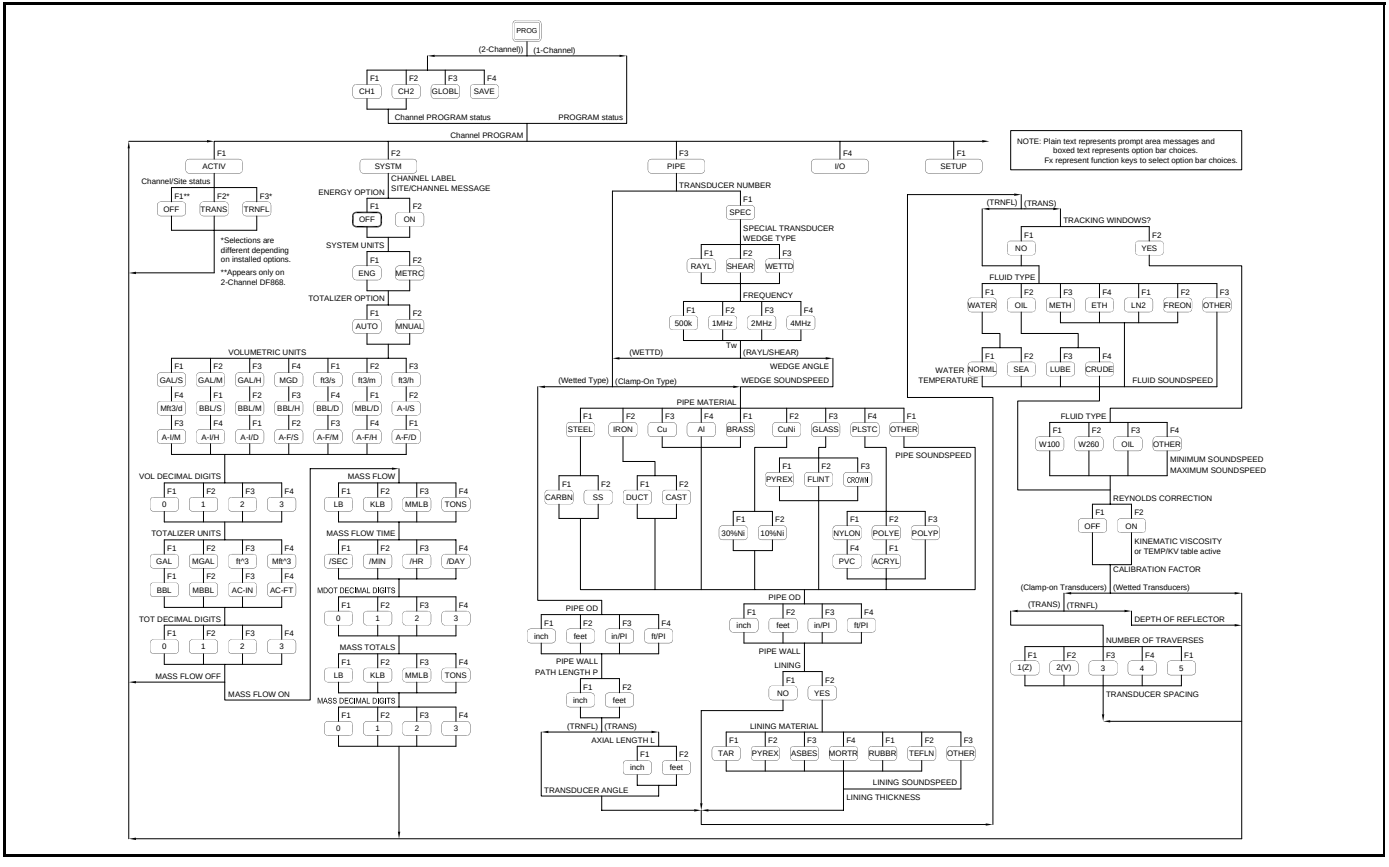


Figure 2-1. DF868 Initial Setup Menu Map with Energy Option OFF

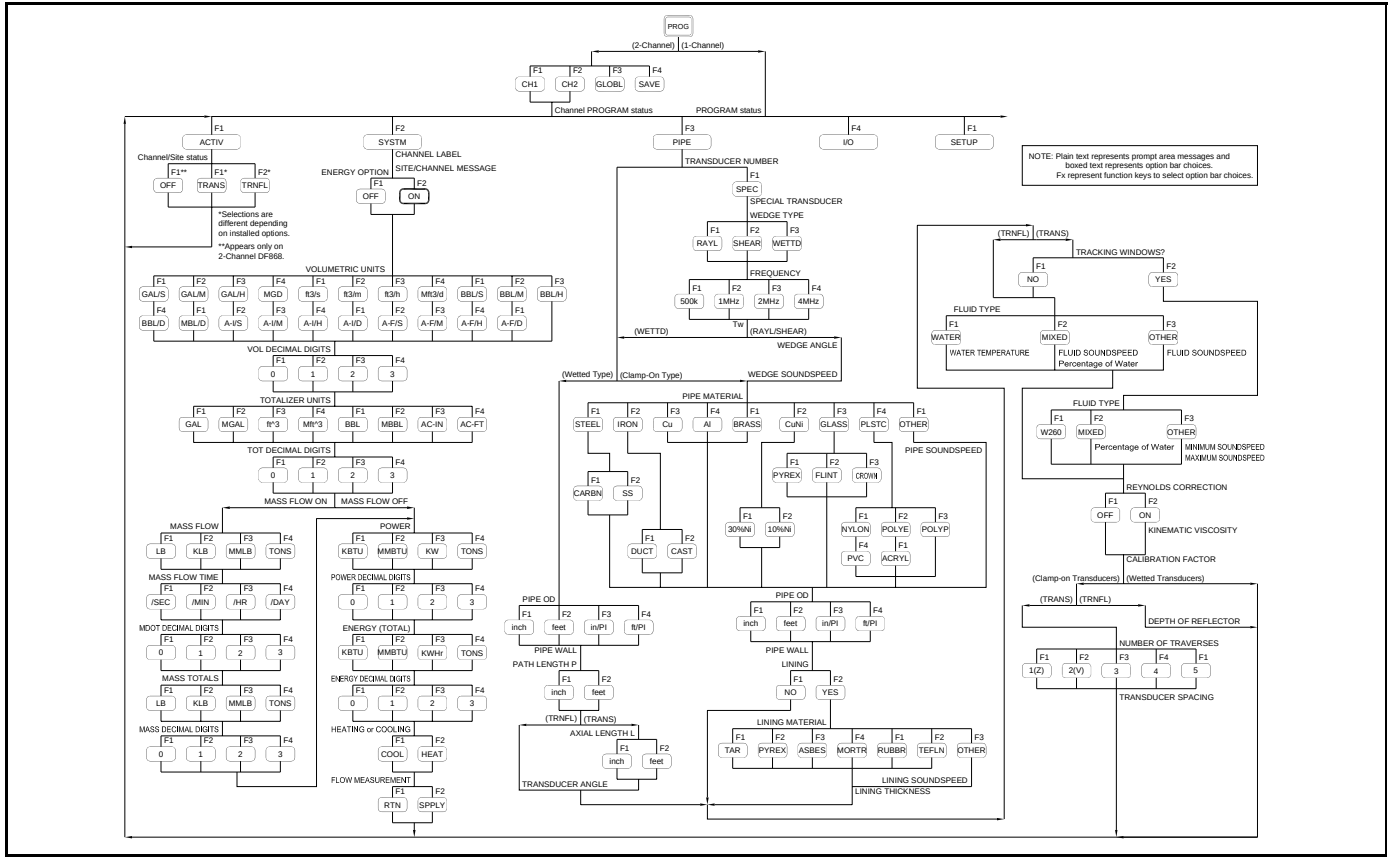


Figure 2-2: DF868 Initial Setup Menu Map with Energy Option ON

Chapter 3

Operation

Introduction

See Chapter 1, *Installation*, and Chapter 2, *Initial Setup*, to prepare the DF868 system for operation. When the meter is ready to take measurements, proceed with this chapter.

!WARNING!
To ensure the safe operation of the DF868, it must be installed and operated as described in this manual. In addition, be sure to follow all applicable local safety codes and regulations for the installation of electrical equipment.

Powering Up

Because the DF868 does not have an ON/OFF switch, it will power up as soon as the connected power source is energized. Immediately upon power up, the DF868 displays the GE logo and the software version in the left display pane. The DF868 then performs a series of internal checks and shows the results in the right display pane.

Note: *If the DF868 fails any of the internal checks, disconnect the power and then reboot the unit. If the meter continues to fail any of the internal checks, contact GE for assistance.*

After successfully performing the internal checks, the DF868 begins taking measurements. The power up display is replaced by a measurement mode display similar to that shown in *Figure 3-1* below.

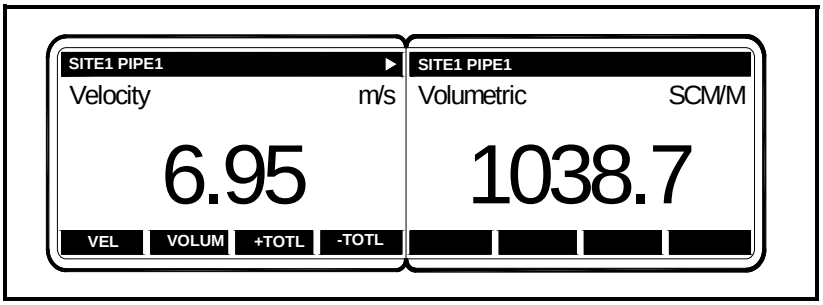


Figure 3-1: A Typical Measurement Display

Using the Display

The DF868 display is divided into a left pane and a right pane. The two screen panes can be set independently to display any of the available measurement or diagnostic parameters. The components of a typical measurement mode screen are shown in *Figure 3-2* below.

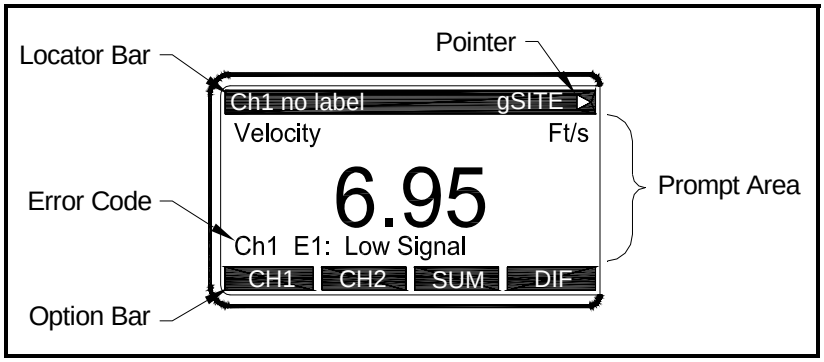


Figure 3-2: Display Screen Components

Both panes of the display screen are continuously updated, but only one pane at a time may be programmed or changed. To select a pane, press the corresponding side of the [SCREEN] key on the keypad. The currently selected screen pane will have function names in the option bar, while the other screen pane will have a blank option bar. See the *Programming Manual* for detailed instructions on using the keypad.

As shown in *Figure 3-2* above, each pane of the display screen is divided into the following three general areas:

- the locator bar
- the prompt area
- the option bar.

The upper portion of the screen pane is called the *locator bar.* While the meter is taking measurements, the locator bar displays the name of the currently selected site file. In addition, the locator bar identifies the task that is currently being performed and the status of that task. For example, pressing the [PROG] key on the keypad will cause the locator bar to display "PROGRAM" and "Start" to indicate that the meter is ready to be programmed from the start of the *User Program*.

Using the Display (cont.)

At various times, one or more of the following four symbols may be displayed on the far right of the locator bar:

- ‰: This symbol, which is called the *pointer,* indicates that additional option bar entries are available. These options can be accessed by using the [←] and [→] keys.
- *: A flashing asterisk indicates that the DF868 is currently logging information.
- S or S_L: This symbol indicates the status of the red [SHIFT] key. "S" indicates that the [SHIFT] key is activated for the next keystroke only, while "S_L" indicates that the [SHIFT] key is locked.

Note: *See the next section for instructions on using the keypad.*

- T: This symbol indicates that the DF868 is currently totalizing data.

The middle portion of the screen pane is the *prompt area*. This area displays data, graphs, and logs in measurement mode and menu prompts in programming mode. In addition, error code messages, are displayed in the prompt area.

The lower portion of the screen pane is called the *option bar.* The option bar displays the functions assigned to the four keys immediately below the display screen ([F1]-[F4] for the left pane and [F5]-[F8] for the right pane). Press a function key to select the function listed in the option bar immediately above it. If more than four functions are available, a pointer (➤) appears on the far right of the locator bar. Press the [←] or [→] keys to display the additional functions on the option bar.

Using the Keypad

The DF868 keypad contains 39 keys, which are labeled with their primary (unshifted) functions. In addition, pressing the red [SHIFT] key will access the secondary functions assigned to most of the keys. These functions are printed on the panel just above each key.

Note: *Only the* [SHIFT] *key and the eight* [Fx] *keys have no shifted function.*

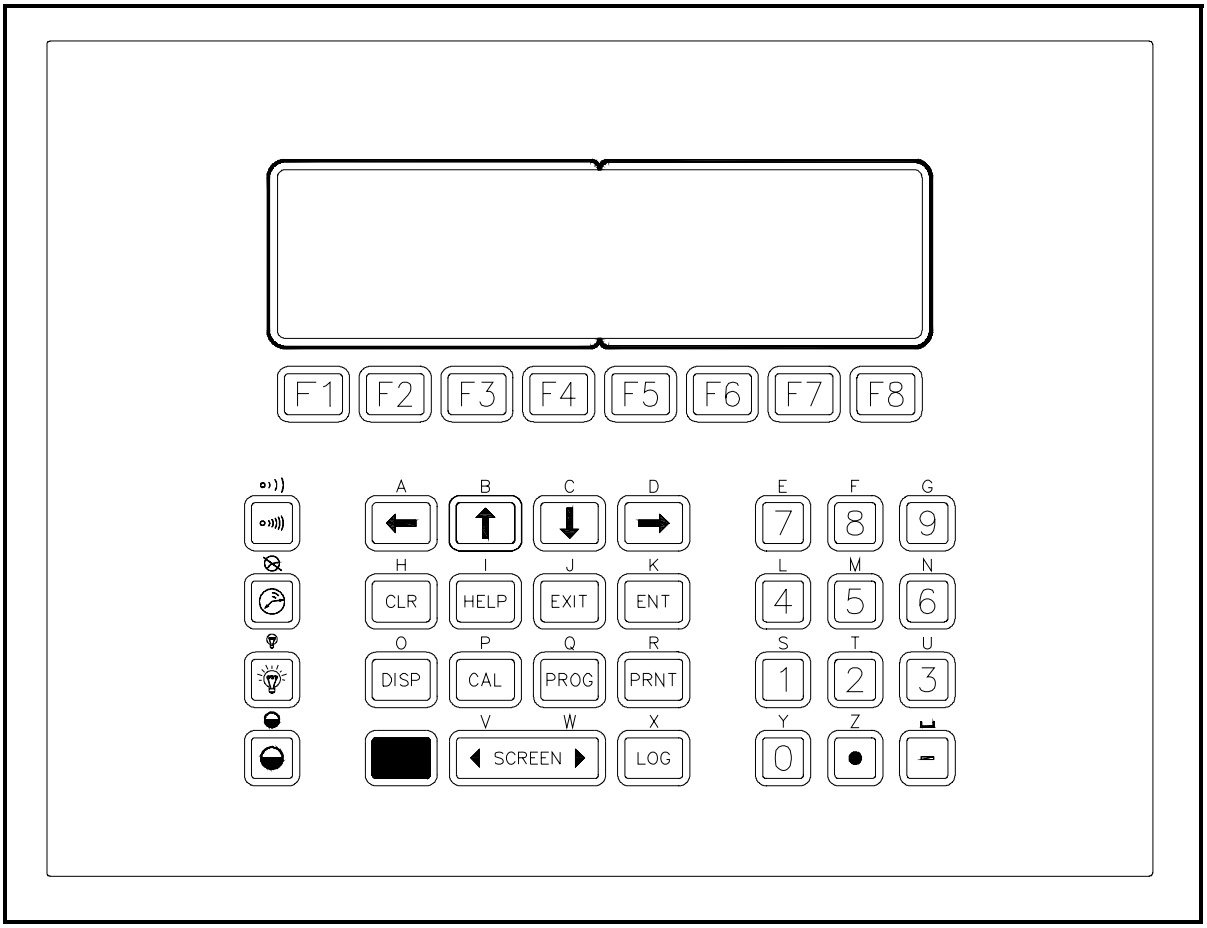


Figure 3-3: The DF868 Keypad

Using the Console Control Keys

The DF868 has four console control keys, which are located on the left side of the keypad (see *Figure 3-3* on the previous page). Use these keys as follows:

Audio Alarm Volume

Use the top console control key to adjust the audio alarm volume.

Discrete presses will incrementally increase the volume of the audio alarm. Hold the key down for continuous increase. Use the key in shifted mode to decrease the volume of the audio alarm.

Stopwatch Totalizer

Use the second console control key for the stopwatch totalizer.

Press the key once to start the stopwatch totalizer. Press the key once, in shifted mode, to stop the stopwatch totalizer.

Display Brightness

Use the third console control key to adjust the display backlight.

Discrete presses of this key will increase the backlight brightness through settings of Off, Mid and Full. Discrete presses of this key in shifted mode, will decrease the backlight brightness through settings of Full, Mid and Off.

Note: *The display backlight has an automatic time-off feature.*

Display Contrast

Use the bottom console key to adjust the display contrast.

Discrete presses will incrementally increase the display contrast. Hold the key down for continuous increase. Use the same key, in shifted mode, to decrease display contrast.

Setting the Clock

Use the CLOCK submenu to enter the current date and time into the DF868 internal clock.

1. To enter the GLOBAL menu, press [F3]=GLOBL.
2. To enter the CLOCK submenu, press [F1]=CLOCK.

Setting the Date

3. The first prompt displays the programmed *Date*.
   - If the displayed date is correct, press [F1] and proceed to step 4.
   - If the displayed date is incorrect, press [F2] to change the date, and complete the steps below.

   a. Enter the current *Year* and press [ENT]. The allowable range is 0 to 99.

   b. Use the [←], [→] and [F1]-[F4] keys to select the current *Month*.

   c. Enter the current *Day* and press [ENT]. The allowable range is 1 to the number of days in the current month.

Setting the Time

4. The first prompt displays the programmed *Time*.
   - If the displayed time is correct, press [F1] and return to the Global PROGRAM.
   - If the displayed time is incorrect, press [F2] to change the time, and complete the steps below.

   a. Press [F1] = AM or [F2] = PM. Then enter the current *Hour* and press [ENT]. The allowable range is 1 to 12.

Note: *A time of 12 PM represents Noon and a time of 12 AM represents Midnight.*

   b. Enter the current *Minutes* and press [ENT]. The allowable range is 0 to 59.

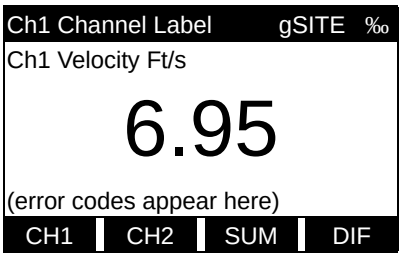
   c. Enter the current *Seconds* and press [ENT]. The allowable range is 0 to 59.

Taking Measurements

The DF868 is capable of displaying several different variables in a variety of formats. However, this manual only discusses the basic measurement displays in the default screen format.

Note: *This section assumes that the left pane of the display screen is currently active. However, the same instructions apply equally to the right screen pane, when it is active. Just change the function keys from* [F1]-[F4] *to* [F5]-[F8].

For a 2-channel DF868, the following initial screen appears immediately upon completion of the internal checks. As an example, the display shows the measured velocity in ft/sec for Channel 1.



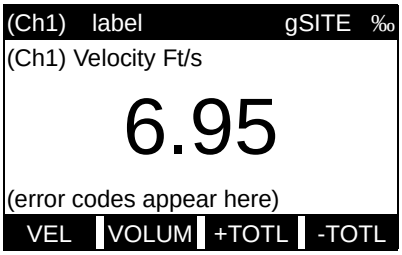
To select a different channel display option, press [F1]-[F4] (or [→] and [F1]). See *Table 3-1* below for a complete description of the available options.

Table 3-1: Channel Display Options

Option Bar Choice	Description
[F1] = CH1	Channel 1
[F2] = CH2	Channel 2
[F3] = SUM	(Channel 1) + (Channel 2)
[F4] = DIF	(Channel 1) - (Channel 2)
[→] + [F1] = AVE	[(Channel 1) + (Channel 2)]/2

Taking Measurements (cont.)

The following screen appears after selection of the channel mode display option for a 2-channel DF868 or immediately after the internal checks for a 1-channel DF868.



Use the [F1]-[F4], [←] and [→] keys to select the desired display parameter option. See *Table 3-2* below for a complete description of the available options.

Note: Ch1 *(or* Ch2*), which is shown in parentheses above, appears only with a 2-Channel DF868.*

Table 3-2: Measurement Parameter Options

Option Bar Choice	Description
[F1] = VEL	Flow Velocity
[F2] = VOLUM	Volumetric Flow
[F3] = +TOTL	Forward Totalized Volume Flow
[F4] = -TOTL	Reverse Totalized Volume Flow
[→] + [F1] = TIME	Total Flow Measurement Time
[→] + [F2] = MDOT*	Mass Flow
[→] + [F3] = +MASS*	Forward Totalized Mass Flow
[→] + [F4] = -MASS*	Reverse Totalized Mass Flow
[→] + [→] + [F1] = POWER**	Energy Flow Power
[→] + [→] + [F2] = +ENRG**	Forward Energy Flow
[→] + [→] + [F3] = -ENRG**	Reverse Energy Flow
[→] + [→] + [F4] = DIAG	Diagnostic
* Available only if Mass Flow is enabled ** Available only if Energy Option is enabled	

In the SETUP submenu, the Advanced Features option offers a MASS (Mass Flow) option. The SYSTEM submenu offers an ENERGY OPTION. If you enable these options, the related options listed in *Table 3-2* above are available. However, if you do not enable these options, the six options indicated do not appear and the DIAG option will appear in the [F2] position on the second option bar screen.

Foundation Fieldbus Communications

Foundation Fieldbus provides a means of communicating with the flowmeter. This Foundation Fieldbus device supports two Analog Input (AI) blocks, which can be configured to supply the following measurements on the network (see Table 3-3 below).

Table 3-3: Available Measurements Using Foundation Fieldbus

Channel 1	Units	Channel 2	Units	Average	Units
Ch1 Velocity	ft/s or m/s*	Ch2 Velocity	ft/s or m/s*	Avg Velocity	ft/s or m/s*
Ch1 Act Volumetric	VOL_U	Ch2 Act Volumetric	VOL_U	Avg Act Volumetric	VOL_U
Ch1 Std Volumetric	VOL_U	Ch2 Std Volumetric	VOL_U	Avg Std Volumetric	VOL_U
Ch1 Fwd Totals	TOT_U	Ch2 Fwd Totals	TOT_U	Avg Fwd Totals	TOT_U
Ch1 Rev Totals	TOT_U	Ch2 Rev Totals	TOT_U	Avg Rev Totals	TOT_U
Ch1 #Tot Digits**	none	Ch2 #Tot Digits**	none	Avg #Tot Digits**	none
Ch1 Mass Flow	MASS_U	Ch2 Mass Flow	MASS_U	Avg Mass Flow	MASS_U
Ch1 Fwd Mass Totals	MTOT_U	Ch2 Fwd Mass Totals	MTOT_U	Avg Fwd Mass Totals	MTOT_U
Ch1 Rev Mass Totals	MTOT_U	Ch2 Rev Mass Totals	MTOT_U	Avg Rev Mass Totals	MTOT_U
Ch1 #Mass Tot Digits	none	Ch2 #Mass Tot Digits	none	Avg #Mass Tot Digits	none
Ch1 Timer	sec	Ch2 Timer	sec	Avg Timer	sec
Ch1 Error Code	none	Ch2 Error Code	none	Avg Error Code	none
Ch1 SSUP	none	Ch2 SSUP	none	Avg SSUP	none
Ch1 SSDN	none	Ch2 SSDN	none	Avg SSDN	none
Ch1 Sound Speed	ft/s or m/s*	Ch2 Sound Speed	ft/s or m/s*	Avg Sound Speed	ft/s or m/s*
Ch1 Density***	see note	Ch2 Density***	see note		
Ch1 Temperature	Deg F or C*	Ch2 Temperature	Deg F or C*		
Ch1 Pressure	PRESS_U	Ch2 Pressure	PRESS_U		

*Metric or English units are determined by the setup of the flowmeter.

**Totalizer digits are available for informational purposes only. Respective totals are automatically scaled by the Tot Digits value selected in the flowmeter setup.

***If the meter is outputting Mole Weight, the unit is “mw”, otherwise it is the programmed pressure unit.

VOL_U, TOT_U, MASS_U, MTOT_U and PRESS_U are determined by the units chosen for these measurements in the flowmeter setup. See the instrument User's Manual for the setup of these parameters.

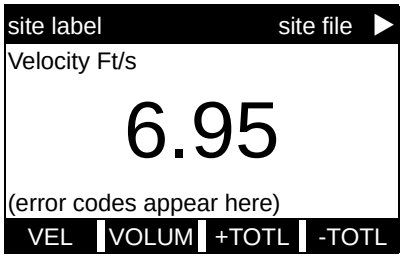
Displaying Data

This section explains how to display measurement data in various formats. Each of the two display screen panes may be programmed independently.

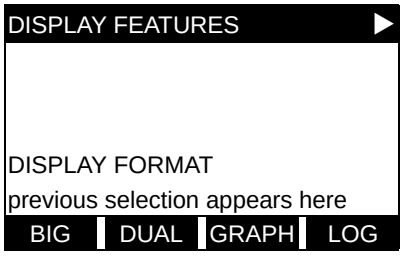
Note: *The instructions in this section assume that the left display pane is active. If the right display pane is active, simply change all* [F1]-[F4] *designations to* [F5]-[F8].

The BIG Format

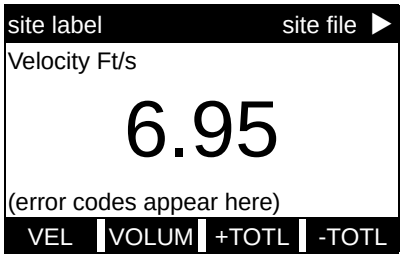
The BIG format, which is the DF868 default power up format, displays one measurement in large print. Upon power up, a standard measurement mode display appears. Press the appropriate side of the [SCREEN] key to activate the desired pane of the display screen, and complete the following steps:



The default power up screen is already in BIG mode. If a different display mode is active, access the *Display Menu* by pressing the [DISP] key.



Press [F1] to select the BIG option. The measurement mode screen reappears with the display in the BIG format.



Use the [F1]-[F4], [←] and [→] keys to select the desired display parameter option. See *Table 3-4* on the next page for a complete description of the available options.

The BIG Format (cont.)

Table 3-4: Measurement Parameter Options

Option Bar Choice	Description
[F1] = VEL	Flow Velocity
[F2] = VOLUM	Volumetric Flow
[F3] = +TOTL	Forward Totalized Volume Flow
[F4] = -TOTL	Reverse Totalized Volume Flow
[→] + [F1] = TIME	Total Flow Measurement Time
[→] + [F2] = MDOT	Mass Flow
[→] + [F3] = +MASS	Forward Totalized Mass Flow
[→] + [F4] = -MASS	Reverse Totalized Mass Flow
[→] + [→] + [F1] = DIAG	Diagnostic

The DUAL Format

The DUAL format displays two measurements simultaneously in normal size. To select the DUAL format and the measurements to display in this format, follow the instructions in this section.

Upon power up, a standard measurement mode display appears in BIG format. Press the appropriate side of the [SCREEN] key to activate the desired pane of the display screen, and complete the following steps:

1. To access the *Display Menu*, press the [DISP] key.
2. Press [F2] = DUAL. The measurement mode display reappears and the display is now in the DUAL format.
3. Use the [F1]-[F4], [←] and [→] keys to select the desired display parameter option. See Table 3-3 above for a complete description of the available options.

With the DUAL format display screen active, when a measurement parameter is selected, the top line of the prompt area will be changed to show that parameter. The parameter previously displayed at the top of the display is moved to the bottom of the display, and the previous bottom parameter is no longer shown.

Setting the LCD Backlight

Use the BACKL submenu to specify the number of minutes the LCD display backlight remains on before it is automatically turned off.

Note: *For this discussion, it is assumed that the left pane of the display screen is active. If the right pane is active, replace the* [F1]-[F4] *keys designations by the* [F5]-[F8] *keys.*

1. To access the *Display Menu*, press the [DISP] key.
2. Press [→] and [F2] = BACKL.
3. Use the numeric keys to enter a value from 1 to 60 minutes and press [ENT]. To keep the backlight on constantly, enter a value of 0 and press [ENT].

The DF868 automatically returns to the previous data display screen and the programmed backlight timeout interval will begin.

If no entries are made from the keypad before the backlight timeout interval expires, the backlight will automatically be turned off. At the next keypad entry, the backlight will be turned on and the specified timeout interval will begin again.

Activating Sleep Mode

When the display is not used, use the SLEEP submenu to temporarily suspend LCD display activity, which allows the DF868 to process data more quickly.

Note: *For this discussion, it is assumed that the left pane of the display screen is active. If the right pane is active, replace the* [F1]-[F4] *keys designations by the* [F5]-[F8] *keys.*

1. To access the *Display Menu*, press the [DISP] key.
2. Press [→] and [F3] = SLEEP. The message "LCD SLEEP MODE -Press any key . . ." appears.
3. To reactivate the display and return to the previous data screen, press any key on the keypad. The DF868 automatically returns to the previous data display screen.

Note: *With* BIG *as the display format, exiting* SLEEP *mode may not erase the sleep mode message and the data screen will be superimposed on the message. If this occurs, enter the* DISP *menu and reselect the* BIG *format to refresh the screen.*

Chapter 4

Calibration

Introduction

The DF868 includes six expansion slots for the installation of option cards. These slots are numbered 1-6, from right to left. In addition, every DF868 flowmeter includes two built-in analog outputs (A and B) at terminal block **I/O**, which is designated as Slot 0. Calibrating the DF868 analog outputs and inputs is explained in this chapter.

Note: *Convention in this manual identifies any expansion slot as* Slot x*, where* x *is a number from 0-6.*

The *Calibration Menu* is accessed by pressing the [CAL] key on the keypad. Use this menu to calibrate and test the Slot 0 analog outputs, as well as to calibrate and test any option cards that are installed in the expansion slots.

The following discussion assumes that the left screen pane is active. If the right screen pane is active, only the function key designations change. That is, replace [F1]-[F4] with [F5]-[F8].

Note: *While in the* Calibration Menu*, if there is no keypad activity for two minutes, the DF868 will automatically reboot and return to measurement mode.*

Calibrating the Analog Outputs

Every DF868 flowmeter includes two built-in analog outputs (A and B) at terminal block **I/O**, which is designated as Slot 0. Additional analog outputs may be added to the DF868 by installing an *Analog Outputs Option Card* in up to 4 of the expansion slots. Each option card contains four analog outputs, which are designated as A, B, C and D. Both the zero-point and full-scale values for each output must be calibrated, with an accuracy of ±5.0 μA (±0.03% of full scale).

Note: *The zero point of the analog output may be set for either 0 mA or 4 mA. However, the calibration procedure always uses the 4 mA point and the meter extrapolates this value to obtain the 0 mA point.*

Calibrating the Analog Outputs (cont.)

Prepare for the calibration of Output A by connecting an ammeter as shown in either *Figure 4-1* or *Figure 4-2* below.

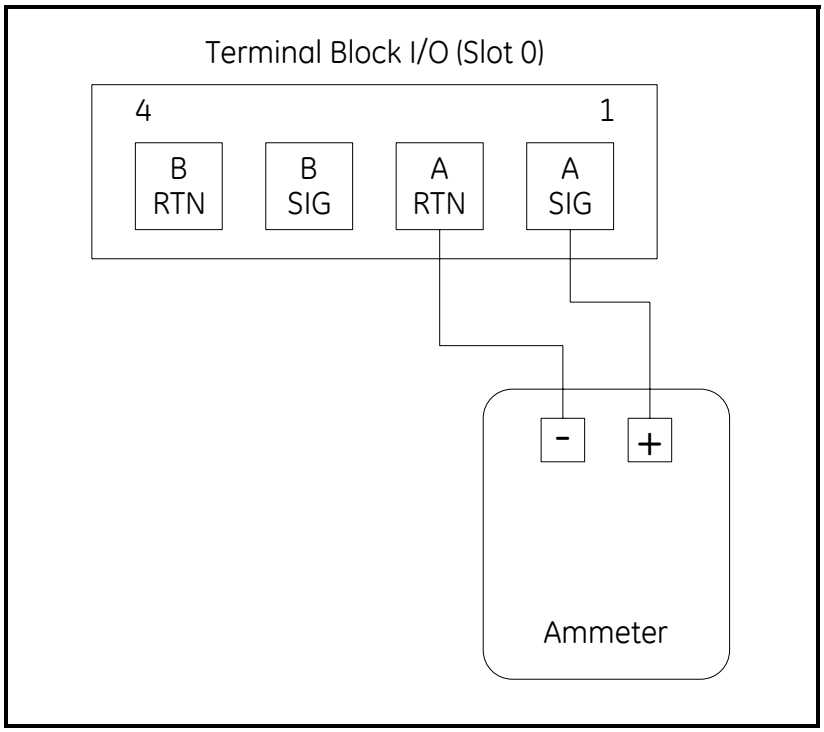


Figure 4-1: Ammeter Connection for Slot 0 (Output A)

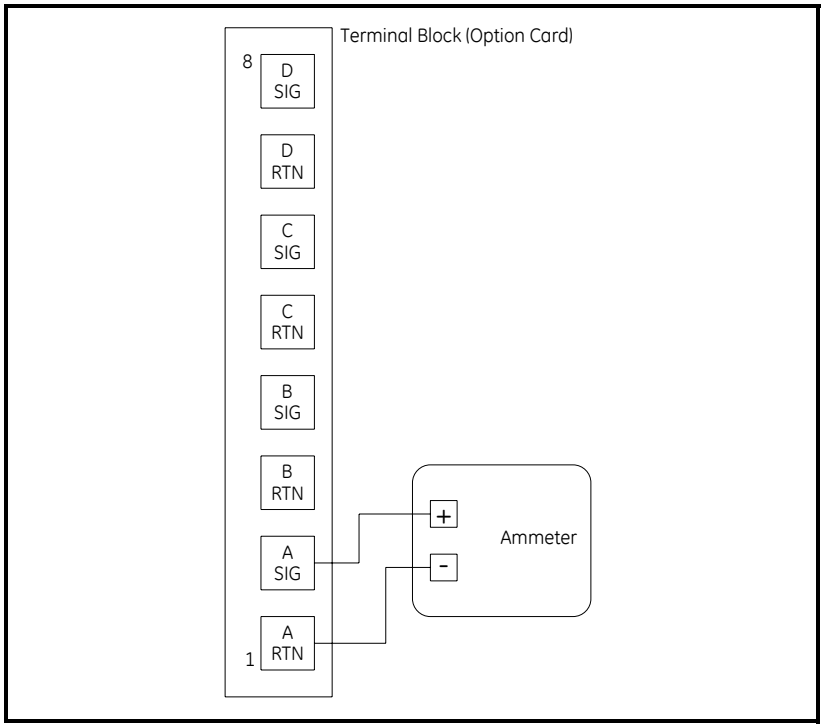


Figure 4-2: Ammeter Connection for Slots 1-6 (Output A)

Press the [CAL] key to enter the *Calibration Program*:

Accessing the Calibration Menu

1. Press the [CAL] key to enter the *Calibration Menu*.
2. Press [Fx] to calibrate the desired slot. (the option bar will include a slot listing for each installed option card.)
3. Press [Fx] to select the desired output.

IMPORTANT: *The procedure for calibrating all the outputs is the same. However when calibrating an output, be sure to connect the ammeter to the appropriate pins on the terminal block.*

Calibrating the Low End of the Output Range

1. Press [F1] to calibrate the low end of the output range.
2. Press [F1] or [F2] to adjust the ammeter reading UP or DOWN, until a 4 mA reading is achieved. If you press [F3], Numer, enter a numeric value for the calibration point and press [ENT].
3. Press [F4] to STORE the setting, or press [→] and [F1] to ABORT the calibration.

Note: *If the ammeter reading cannot be adjusted within 5.0 μA of the 4 mA setting, contact the factory for assistance.*

Calibrating the High End of the Output Range

1. Press [F2] to calibrate the high end of the output range.
2. Press [F1] or [F2] to adjust the ammeter reading UP or DOWN, until a 20 mA reading is achieved. If you press [F3], Numer, enter a numeric value for the calibration point and press [ENT].
3. Press [F4] to STORE the setting, or press [→] and [F1] to ABORT the calibration.

Note: *If the ammeter reading cannot be adjusted within 5.0 μA of the 20 mA setting, contact the factory for assistance.*

Testing the Analog Output Linearity

1. Press [F3] to TEST the linearity of the currently selected analog output.
2. Check the ammeter reading at the 50% output level.
3. Then, enter a different output level (0-100%) and press [ENT].
4. Check the ammeter reading at this setting. Press [ENT] when done.

Table 4-1 below lists the expected ammeter readings at various *% Full Scale* settings, for both 4-20 mA and 0-20 mA scales. Refer to this table to verify the accuracy of the ammeter readings taken above.

Table 4-1: Expected Ammeter Readings

% Full Scale	4-20 mA Scale*	0-20 mA Scale*
0%	4.000	0.000
10%	5.600	2.000
20%	7.200	4.000
30%	8.800	6.000
40%	10.400	8.000
50%	12.000	10.000
60%	13.600	12.000
70%	15.200	14.000
80%	16.800	16.000
90%	18.400	18.000
100%	20.000	20.000
* All ammeter readings should be ±0.005 mA		

If the linearity test readings are not within ±5 μA of the values listed in *Table 1-1* above, check the accuracy and wiring of the ammeter. Then, repeat the low and high end calibrations. If the analog output still does not pass the linearity test, contact GE for assistance.

Calibrating the Analog Inputs

Analog inputs may be added to the DF868 flowmeter by installing an *Analog Inputs Option Card* in up to 4 expansion slots. Each option card contains two analog inputs, which are designated as A and B. Each of the inputs, which may be either a 0/4-20 mA input or an RTD input, must be calibrated at both the zero-point and full-scale values.

Calibration of the analog inputs requires the use of a calibrated current source. If an independent calibrated current source is not available, one of the Slot 0 analog outputs may be used for the calibration. During the analog input calibration, the Slot 0 analog output will supply the low reference, high reference, 4 mA and 20 mA signals at the appropriate times.

Note: *If a* Slot 0 *analog output is used to calibrate the analog inputs, make sure that the* Slot 0 *analog output calibration procedure has already been completed.*

Connect the Slot 0 analog outputs (or independent calibrated current sources) to the analog inputs on the option card, as shown in *Figure 4-3* below.

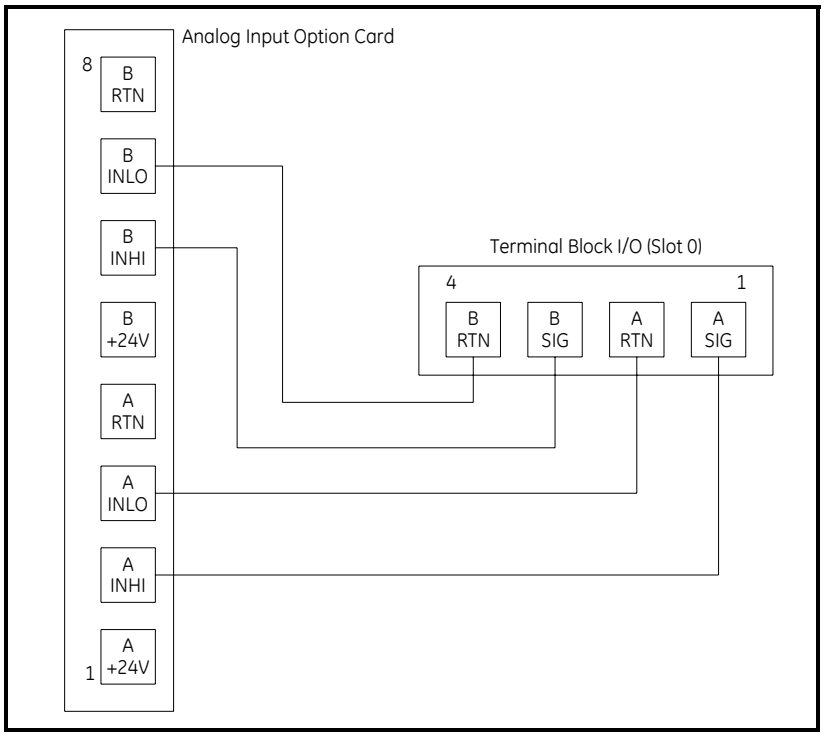


Figure 4-3: Analog Input Calibration Connections

Calibrating the Analog Inputs (cont.)

For this discussion, assume that the option card has been installed in Slot x.

Note: *The zero point of the analog input may be set for either 0 mA or 4 mA. However, the calibration procedure always uses the 4 mA point and the meter extrapolates this value to obtain the 0 mA point.*

Accessing the Calibration Menu

1. Press the [CAL] key to enter the *Calibration Menu*.
2. Press [Fx] to calibrate the desired slot. (The option bar will include a slot listing for each installed option card.)
3. Press [Fx] to select the desired input.

The procedure for calibrating Input A is identical to that for calibrating Input B. However, when calibrating Input B, be sure a calibrated current source is connected to the appropriate pins on the terminal block. See *Figure 4-3* on the previous page for the correct pin numbers.

Note: *To calibrate an* RTD input card, *proceed to the next section.*

4. Press [F1]-[F4] to select the reference point to be calibrated, and then continue as follows.
   - If you selected [F1] (aLOW), proceed to the aLOW Option below.
   - If you selected [F2] (aHIGH), proceed to the aHIGH Option below.
   - If you selected [F3] (4 mA), proceed to the 4 mA Option on the next page.
   - If you selected [F4] (20 mA), proceed to the 20 mA Option on the next page.

aLOW Option = [F1]

1. Enter the low reference value and press the [ENT] key.
2. Press [F1] to store the current low reference value or press [F2] to cancel the entry. In either case, the ANALOG INPUT prompt will reappear.
3. Press [F2] to proceed to the next section.

aHIGH Option = [F2]

1. Enter the high reference value and press the [ENT] key.
2. Press [F1] to store the current high reference value or press [F2] to cancel the entry. In either case, the ANALOG INPUT prompt will reappear.
3. Press [F2] to proceed to the next section.

4 mA Option = [F3]

1. Connect the 4 mA current source to the currently selected analog input, as shown in *Figure 4-3* on page 4-5.
2. Press [F1] to store the current 4 mA value or press [F2] to cancel the entry. In either case, the ANALOG INPUT prompt reappears.
3. Press [F4] to proceed to the next section.

20 mA Option = [F4]

1. Connect the 20 mA current source to the currently selected analog input, as shown in *Figure 4-3* on page 4-5.
2. Press [F1] to store the current 20 mA value or press [F2] to cancel the entry. In either case, the ANALOG INPUT prompt reappears.
3. Press [F4] to proceed to the next section.

Leaving the Calibration Menu

To leave the *Calibration Menu*, press [F4] (EXIT) twice.

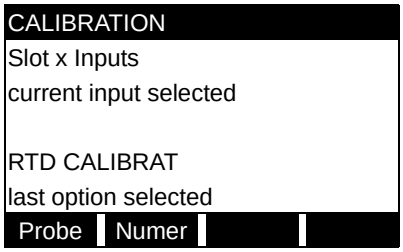
Calibrating the RTD Inputs

Calibrating an RTD option card involves a different procedure than for other analog input cards. However, you access the card in the same manner as other cards.

Accessing the Calibration Menu

1. Press the [CAL] key to enter the *Calibration Menu*.
2. Press [Fx] to calibrate the desired slot. (The option bar will include a slot listing for each installed option card.)

For an RTD option card, the following screen appears:



Press [F1] to select the Probe method of calibration, or [F2] to select the Numer method.

The Probe option allows the meter to calculate the temperature vs. resistance curve, based on input from the RTD in a temperature bath or from an RTD calibrator. The Numer option requires the user to calculate and input the curve values numerically.

IMPORTANT: *Use only one option for RTD calibration. Do not try to calibrate with both options.*

Calibrating an RTD option card involves a slightly different procedure than for other analog input cards. However, you access the card in the same manner.

Probe Option = [F1]

1. Press [F1] to select Input A, or [F2] to select Input B.

Set Point Temperature

2. Press [F1] to enter the set point temperature. This temperature should be at the low end of your expected operating range.
3. Enter the desired set point temperature, and press [ENT].
4. Press [F1] to STORE the entered temperature, or [F2] to ABORT the calibration. In either case, the screen returns to the ANALOG INPUT prompt.

Slope Point Temperature

5. Press [F2] to enter the slope point temperature. This temperature should be as far from your set point as your temperature bath will allow, within the range -100° to +350°C.

6. Enter the desired slope point temperature, and press [ENT].

7. Press [F1] to STORE the entered temperature, or [F2] to ABORT the calibration. In either case, the screen returns to the ANALOG INPUT prompt.

Numer Option = [F2]

The Numer option requires the user to calculate the temperature vs. resistance information. To do this, the user must first collect data using the RTD option in the PRINT menu. The RTD option allows you to know what point value the DF868 is reading at a given temperature. With this information, the Numer option enables you to enter the *Set Temperature* and the *Slope* of the RTD input in points/ degree, allowing absolute control over RTD calibration. Before attempting this step, obtain values at your set point and slope point.

1. Press [F1] to select Input A, or [F2] to select Input B.

Set Number

2. Press [F1] to enter the set number.

3. Enter the set point temperature, and press [ENT].

4. The program then asks for the set point number. Enter the points measured at the set temperature, and press [ENT].

Slope Number

5. Press [F2] to enter the slope number. Calculate the slope number with the formula:

$$\text{Slope} = \frac{\text{Slope Points} - \text{Set Points}}{\text{Slope Temp} - \text{Set Temp}}$$

6. Enter the RTD slope number and press [ENT].

Appendix A

Measuring P and L Dimensions

Measuring P and L

If you are using wetted transducers, the DF868 requires you to enter the path length (P) and the axial dimension (L). P is the transducer face-to-face distance, and L is the axial projection of P in the flow stream.

To determine L, physically measure the distance between the center of the transducer ports at the inside wall as shown in Figure A-1 below, if possible. If not, consult the factory.

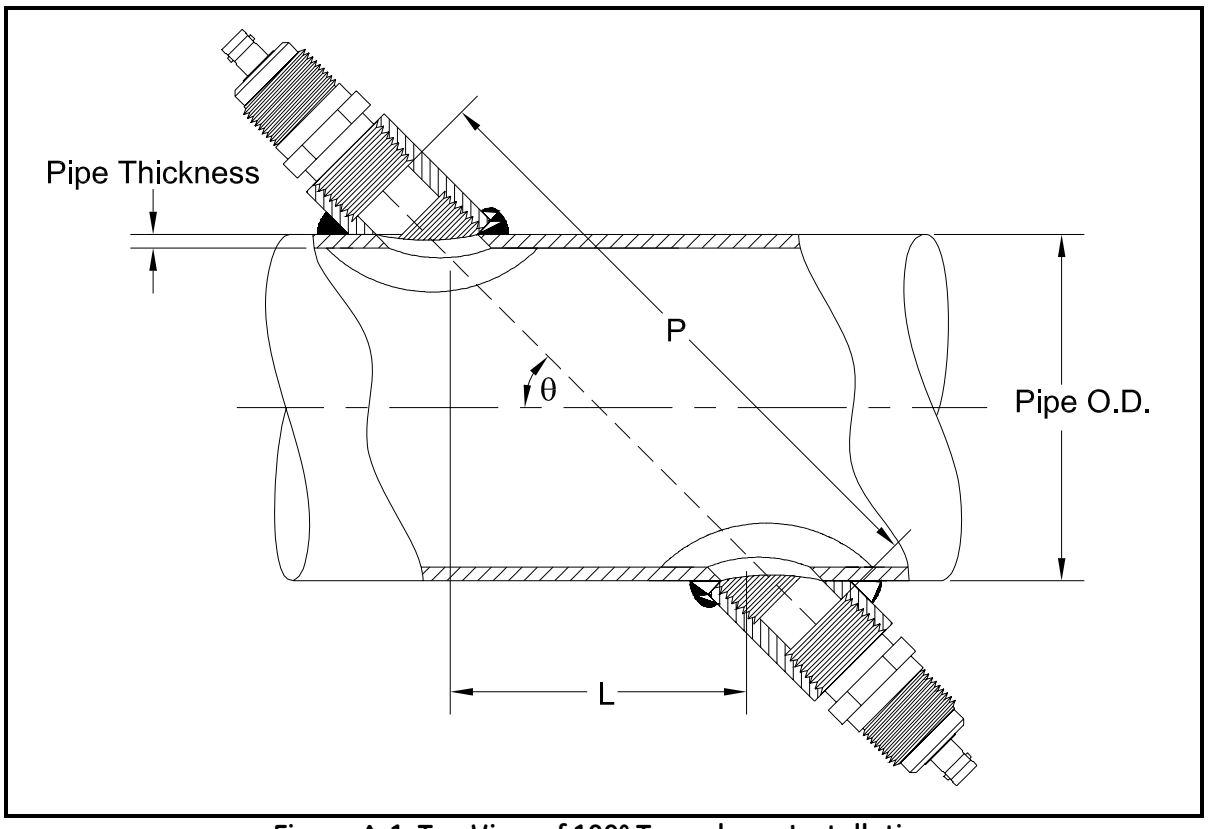


Figure A-1: Top View of 180° Transducer Installation

To determine P, you need the following data:

- the pipe inside diameter (ID)
- the wall thickness (WT)
- the installed pipe coupling length (CL)
- the transducers face depth (FD)
- the mounting angle (MA)

Measuring P and L (cont.)

Use Figure A-2 below to properly measure the coupling length. Typically, the transducer face is positioned just outside the inside diameter (ID) of the pipe, or slightly retracted inside the coupling.

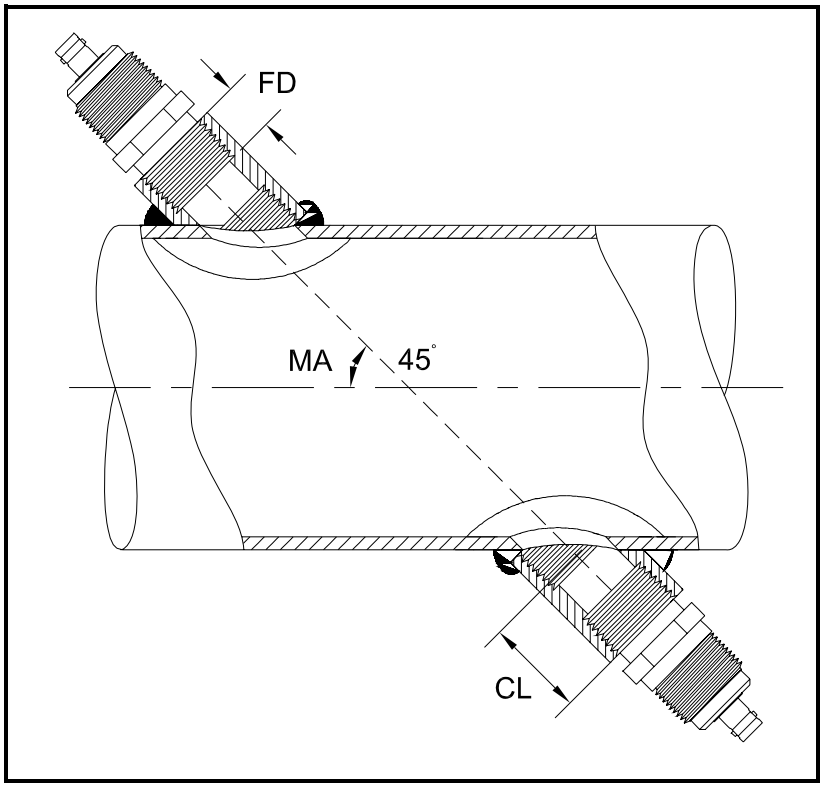


Figure A-2: Determining the Pipe Coupling Length

Use the following formula to determine the P dimension:

$$P = \frac{[ID + 2(WT)]}{\cos(MA)} + 2(CL - FD)$$

For example, if:

- inside diameter (ID) = 48”
- wall thickness (WT) = 3/8”
- installed coupling length (CL) = 2.0”
- transducer face depth (FD) = 1.75”
- mounting angle (MA) = 45°

Then, the P dimension would be:

$$P = \frac{[48 + 2(0.375)]}{\cos(45°)} + 2(2.0 - 1.75) = 69.4''$$

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DECLARATION OF CONFORMITY

We,

Panametrics Limited
Shannon Industrial Estate
Shannon, County Clare
Ireland

declare under our sole responsibility that the

DigitalFlow™ DF868 Liquid Ultrasonic Flowmeter
DigitalFlow™ GC868 Clamp-On Gas Ultrasonic Flowmeter
DigitalFlow™ GF868 Flare Gas Mass Ultrasonic Flowmeter
DigitalFlow™ GM868 General-Purpose Gas Ultrasonic Flowmeter
DigitalFlow™ GS868 Steam Ultrasonic Mass Flowmeter

to which this declaration relates, are in conformity with the following standards:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation
- EN 61010-1:1993 + A2:1995, Overvoltage Category II, Pollution Degree 2

following the provisions of the 89/336/EEC EMC Directive and the 73/23/EEC Low Voltage Directive.

The *units listed above and any transducers supplied with them (spoolpieces are addressed under a separate declaration of conformity)* do not bear CE marking for the Pressure Equipment Directive, as they are supplied in accordance with Article 3, Section 3 (sound engineering practices and codes of good workmanship) of the Pressure Equipment Directive 97/23/EC for DN<25.

Shannon - June 1, 2002

Mr. James Gibson
GENERAL MANAGER

CE

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