INSTRUCTION MANUAL

234 FLOW METER/TRANSMITTER

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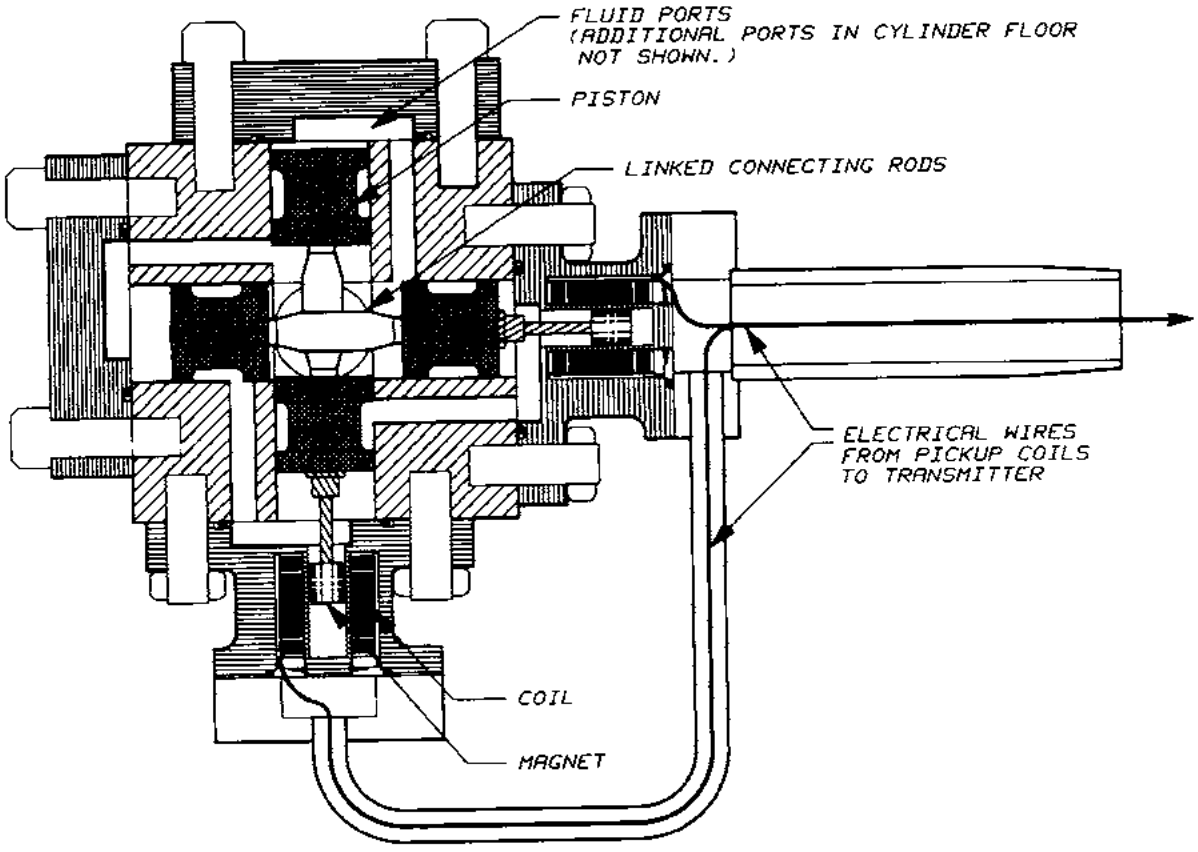
General Description

The *Max 234 Series Flow Meters* are positive displacement units specifically designed to be compatible with aqueous based solutions. Metering is accomplished by four radial pistons which are moved by the fluid stream being monitored. The motion of the pistons, which is proportional to flow, moves a pair of magnets. A built in electronic transmitter detects the magnetic motion and provides five volt CMOS/TTL compatible square wave and quadrature outputs.

The Model 234 is generally used to monitor flows in the 10 cc/min to 1.5 gpm range with fluid temperatures up to 230^{0}F. Weather-tight or amphenol electronic connector versions are available to meet environmental conditions. Optional seal materials may be specified for optimal fluid compatibility.

234 Cross Section



Materials Of Construction

Body	316 Stainless Steel
Fasteners-Structural	316 Stainless Steel
Pistons	Carbon
Bearings	Teflon
Pickup Magnet	Ferro Ceramic
Seals	Teflon®
Electrical Enclosure	Aluminum, 303 Stainless Steel

Maximum Flow Rate

Continuous	4000 cc/min
Intermittent	6000 cc/min

Maximum Pressure ..... 2000 psi

Pressure Drop ..... See page 10

Accuracy ..... ±0.75% (See Page 10)

Filtration ..... 10 Micron

Displacement ..... 10.8 cc/revolution

Temperature

Operating	-18^{0}C to 55^{0}C (0^{0}F to 130^{0}F)
Metered Fluid	5^{0}C to 110^{0}C (40^{0}F to 230^{0}F)
Storage	-55^{0}C to 80^{0}C (-67^{0}F to 175^{0}F)

Transmitter Output Signal

Square wave	5VDC (Standard) - Equal to supply voltage (optional) Selectable resolution: 16, 25, 50, 100, 150, 250, 300, 500 pulses/revolution
Quadrature (Bidirectional)	5VDC (Standard) - Equal to supply voltage (optional) 1/2 of the resolution assigned to each phase

Transmitter Power Requirements

Operating	4.5 to 24 VDC @ 25mA

Electrical Construction

Weather-tight Version	Designed to NEMA, 1/2" NPT conduit fitting
Amphenol Connector Version	Designed to NEMA 1

Mechanical Installation

Orientation: The Model 234 is internally ported to allow air to be fully expelled from the meter provided the fluid enters from the bottom (as shown below). Air in the system can cause response delays and errors in measurement. If the meter has to be mounted 90 degrees from what is shown, accuracy at low flows (less than flow rate in cc's x viscosity in centipoise = 200) may be affected. This is due to the weight of the piston assembly adding slightly to the pressure drop required to lift the assembly during operation.

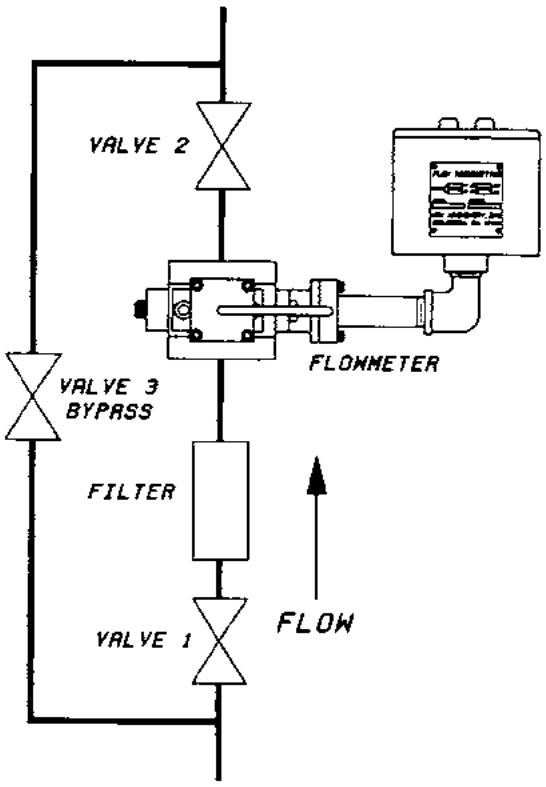
Line and Bypass Valves: These valves allow filter cleaning or flow meter removal without completely shutting the system down and draining the lines. They also allow system start-up under conditions which could damage the meter, such as air in the lines (which can overspeed the meter), high temperature conditions or initial line surges.

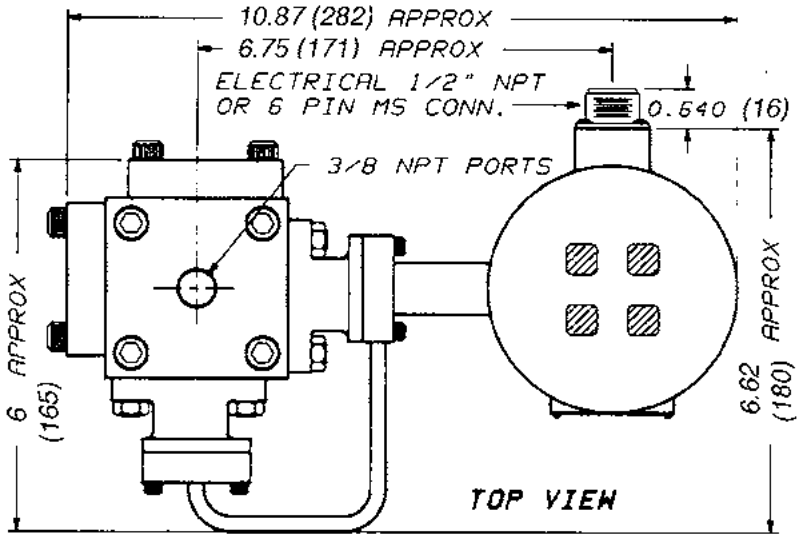
Filtration: The meter cannot tolerate contamination such as Teflon® tape, broken pipe threads, welding slag, sand or other particulate matter. In general, a 10 micron filter is recommended, although in some applications finer filtration may be worthwhile. If bidirectional flow is used, a filter should be installed on both sides of the flow meter.

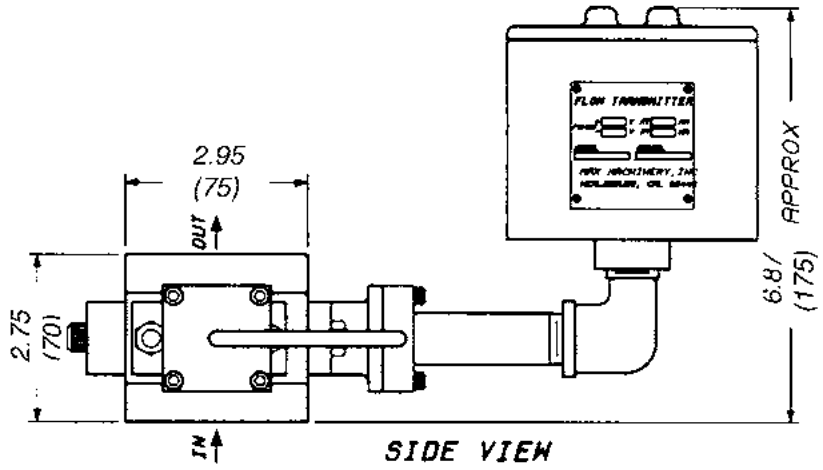
When the fluid contains large amounts of soft materials, it may pass through the meter satisfactorily but tend to clog the filter. In this case, the filter may not be appropriate. A Max Sales or Technical Service Engineer can be consulted for information regarding specific materials.

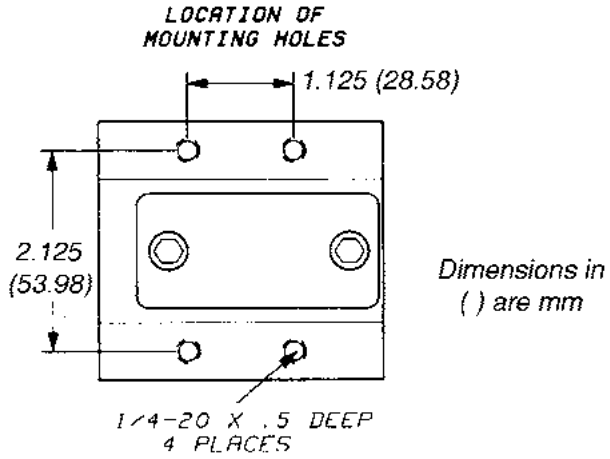
Clean Plumbing: Before installing the flow meter, clean the inside of the pipe line with compressed air or steam. This is particularly important with new pipe.

Typical Installation




10.87 (282) APPROX
6.75 (171) APPROX
ELECTRICAL 1/2" NPT
OR 6 PIN MS CONN.
0.640 (16)
3/8 NPT PORTS
6 APPROX
(165)
6.62 APPROX
(180)
TOP VIEW


2.95
(75)
OUT
2.75
(70)
IN
6.8/ APPROX
(175)
SIDE VIEW


LOCATION OF
MOUNTING HOLES
1.125 (28.58)
2.125
(53.98)
1/4-20 X .5 DEEP
4 PLACES
Dimensions in
( ) are mm

Electronic Installation

Environment: The transmitter housing should be kept as cool as possible due to the temperature limits of the electronic components. If the ambient temperature rises above 130^0F (55^0C), the maximum fluid temperature at the flow meter will have to be derated.

The weather-tight versions of the flow meter require that the electrical conduit connection be sealed with pipe dope or a potting fitting. If this precaution is not taken, moisture may form inside the transmitter housing, resulting in inaccurate readings or circuit failure. The amphenol connector versions of the Model 234 offer moderate protection from moisture and dust, but are not totally sealed.

Grounding: Two dip switches are provided. The Ground Switch S1-1, when activated, connects the circuit common to the case terminal. The Filter Switch S1-2 connects common to case through two back to back electrolytic capacitors. These two switches facilitate system grounding procedures which will reduce electrical noise problems. It is advisable to have the common of any system physically grounded at one point only. If your system is grounded at the receiving or indicator end, then it is not advisable to also ground it at the transmitter end. This may cause a ground loop. In this case, it is advantageous to connect the circuit common to case via the capacitors (filter). This will give some extra immunity to electrical noise.

Interconnections: The cable connection to the Model 234 should be made with shielded cable, with the shield itself connected only at the receiving end. The transmitter output stage is designed to drive up to 1000 feet (300 m.) of cable without problems. Even longer lengths may prove feasible depending on such factors as external electromoagnetic interference and the sensitivity of the receiving indicator.

K-Factors: Each Model 234 Flow Meter is supplied with a calibration sheet showing the actual number of pulses output per cubic centimeter (or other engineering unit) of metered fluid at several different flow rates. These numbers are termed "K-Factors". The individual or average K-Factor is used to calibrate the receiving indicator for the proper display in the desired engineering units.

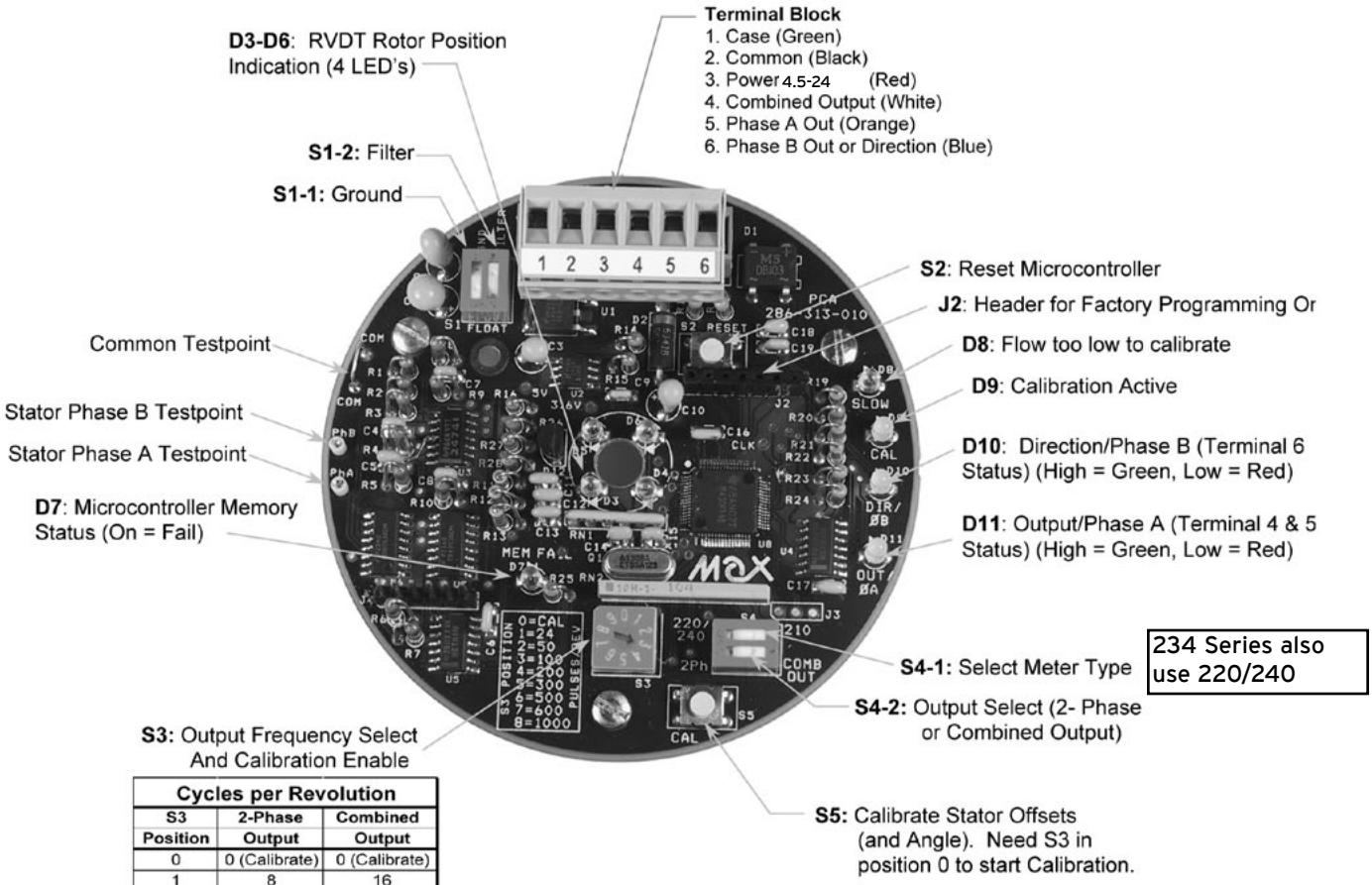
Reverse Flow Buffer: The transmitter square wave signal employs a reverse flow buffer designed to eliminate false ouputs when the flow meter is subjected to hydraulic or mechanical oscillations with no actual net flow. Flow through the meter must total 1/2 of a revolution (approx. 5.4 cc) before a pulse is output in either the forward or reverse direction. At low flows, a noticeable period of time will be required to fill up this buffer. For instance, at 20 cc/min, 15 seconds will elapse before an output signal is observed.

Two-Phase or Square Wave Select:
S4-2: Depress side that corresponds to desired output. '2PH' gives a 2-phase quadrature output with the two phases separated by 90° (Ph A on Terminal 5 and Ph B on Terminal 6). The 'COMB OUT' setting gives a single square wave output that combines the information in the two phases into a single output of double the frequency (Combined Output on Terminal 4, Direction on Terminal 6). If S4-2 is set wrong, an unexpected output signal will result since the same output circuitry is used for the two distinct output options.

Terminal Output Signals vs. S4-2 Setting		
Connector Terminal(s)	S4-2 = 'COMB OUT' (combined output)	S4-2 = '2PH' (2-phase output)
4,5	Pulse Output	Phase A
6	Direction	Phase B

Output Frequency Select:
S3: Rotary switch allows selection of output resolutions of 16 to 500 pulses per revolution (square wave output), or 8 to 250 pulses per revolution (per phase) if the 2-phase output option is selected. The resolution can be changed while the tachometer is operating, and the new value will take effect immediately. Please Note: The screen printed resolution on the circuit board applies to 210/220/240 Series meters. See table for resolution.

Output Indicators:
D10, D11: These bi-color (red, green) LEDs indicate the status of the outputs. If the 2-phase output mode has been selected, the state of Phase A and Phase B are each shown on the corresponding LEDs ('OUT/∅A' and 'DIR/∅B'). If the combined output mode has been selected, the LED labeled 'OUT/∅A' shows the status of the pulse output channel, and the LED labeled 'DIR/∅B' indicates the direction.



Cycles per Revolution		
S3 Position	2-Phase Output	Combined Output
0	0 (Calibrate)	0 (Calibrate)
1	8	16
2	12	25
3	25	50
4	50	100
5	75	150
6	125	250
7	150	300
8	250	500
9	*	*

* Not Specified, Usually same as S3=8

Due to the single sine wave output of the LVDT encoder, the resolution is 1/2 of the values screenprinted on the PCB.

Microprocessor Reset:
S2: In the event that the tachometer does not appear to be operating correctly, resetting the microprocessor by momentarily depressing S2 may solve the problem. While the reset button is depressed, the 'MEM FAIL' LED will turn on, and if the memory is good, the LED should turn back off when the button is released.

LVDT Rotor Position Indication LED's:
D3-D6: These LED's provide a graphical representation of the position of the LVDT slugs. This can be a helpful troubleshooting aid when trying to determine if a meter is turning or not. The rotational pattern observed on the LED's corresponds directly to the speed of the LVDT slugs. At high speeds, the LED's will just look like they are blinking; the human eye can no longer discern the direction of motion. At very high speeds the blinking will not even be obvious and they will all appear to be a constant brightness. At these higher speeds, a divide-by-ten feature can be activated by pressing S5 (the 'CAL' button, make sure S3 is not in the 0 position, otherwise the calibration routine will be run!). This only slows down the Rotor Position indication LEDs, the output frequency does not change.

'CAL' LED:
D9: This LED changes color (red to green or green to red) 4 times per revolution while the microprocessor is performing the calibration routine on the stator coils. When calibration is complete, it will turn off. See Calibration Section for more information on calibration procedures

'SLOW' LED:
D8: If a calibration is initiated but the flow rate is too low to give acceptable results, the calibration will be aborted, and this LED will light up red for 10 seconds. See Calibration Section for more information on calibration procedures.

'MEMORY FAIL' LED:
D7: The microprocessor continually checks the integrity of its program storage memory. If one or more memory values do not read what they are supposed to, this LED will turn on. Two possible causes of memory failure are prolonged operation/storage at temperatures exceeding the ratings and transient voltages applied to inputs and/or outputs that exceed ratings. If the transmitter does not appear to be functioning correctly and this LED is on, the unit should be sent back to the factory for service.

The coils of the Model 234 stators and the printed circuit board need to be calibrated as a set. The calibration procedure initiates a routine that determines the offsets needed to balance the output signals from the coils. When used with a piston flow meter, the calibration procedure includes an additional routine that measures the linear position of the stator with respect to the meter. This allows the transmitter to compensate for cyclical variations in rotational velocity of the meter, resulting in a steady output frequency.

The recommended flow range for calibration is that which will turn the meter at 20-500 rpm. Lower flow rates (resulting in rotor speeds below 20 RPM) will cause the 'SLOW' LED to come on and the calibration will not take place. Successful calibration will occur at higher flow rates (rotor speeds above 500 RPM) but the results may not be as good as those which would be obtained at a lower flow rate. A flow rate resulting in a flow meter rotation of 100 rpm will give good calibration results.

When doing a calibration on a piston meter, it is critical that the flow rate remains constant (less than 10% variation) for the routine that determines the linear position to be successful. When a steady flow passes through a four-piston meter, the meter speeds up and slows down 4 times per revolution. The phase of this cyclic speed variation is determined during calibration by finding the position of the 4 speed peaks in a revolution. These speed peak locations are measured for 8 revolutions (32 peaks), then run through an averaging procedure. Once this is done, the tachometer can internally compensate for the speed variations to output a steady frequency under steady flow conditions.

Error can be introduced into this phasing procedure if the system flow rate is pulsating (i.e.: driven by a piston pump). If there are peaks in the flow rate that overshadow the speed peaks due to the 4-piston geometry, the calibration routine will incorrectly determine the phase of the cyclic speed variation and will subsequently apply the compensation out of phase.

The phase balancing routine that occurs for all types of meters requires 16 revolutions of the meter to reach completion. The 'CAL' LED changes color (red to green or green to red) 4 times per revolution, or 64 blinks for the entire calibration. The linear position determination (phasing) requires 8 revolutions, so the 'CAL' LED will blink an additional 32 times after the 64 phase balancing blinks when calibration is performed on a piston meter. If the flow is stopped part way through a calibration, the blinking will stop and the calibration will not reach completion since it requires a fixed number of meter revolutions. In such a case, a new calibration should be done at a steady flow rate.

When to Calibrate

Calibration should be performed under the following conditions:

1. If the circuit board of the transmitter is changed.

2. If the connector between the pickup coils and the circuit board is reversed.

3. If it is suspected that the output signal contains more frequency modulation than it should have. (i.e.: Pulse widths vary by more than ±15%, and variations are not random, but cyclical at 4 times per revolution)

Calibration Procedure

1. Set up a steady flow rate through the meter that results in a meter rpm between 20 and 500, ideally somewhere around 100 rpm. The position indication LED's in the center of the circuit board can aid in rpm determination (i.e.: at 100 rpm, each light will blink 10 times in 6 seconds).

2. Rotate S3 to the '0' position to enable calibration.

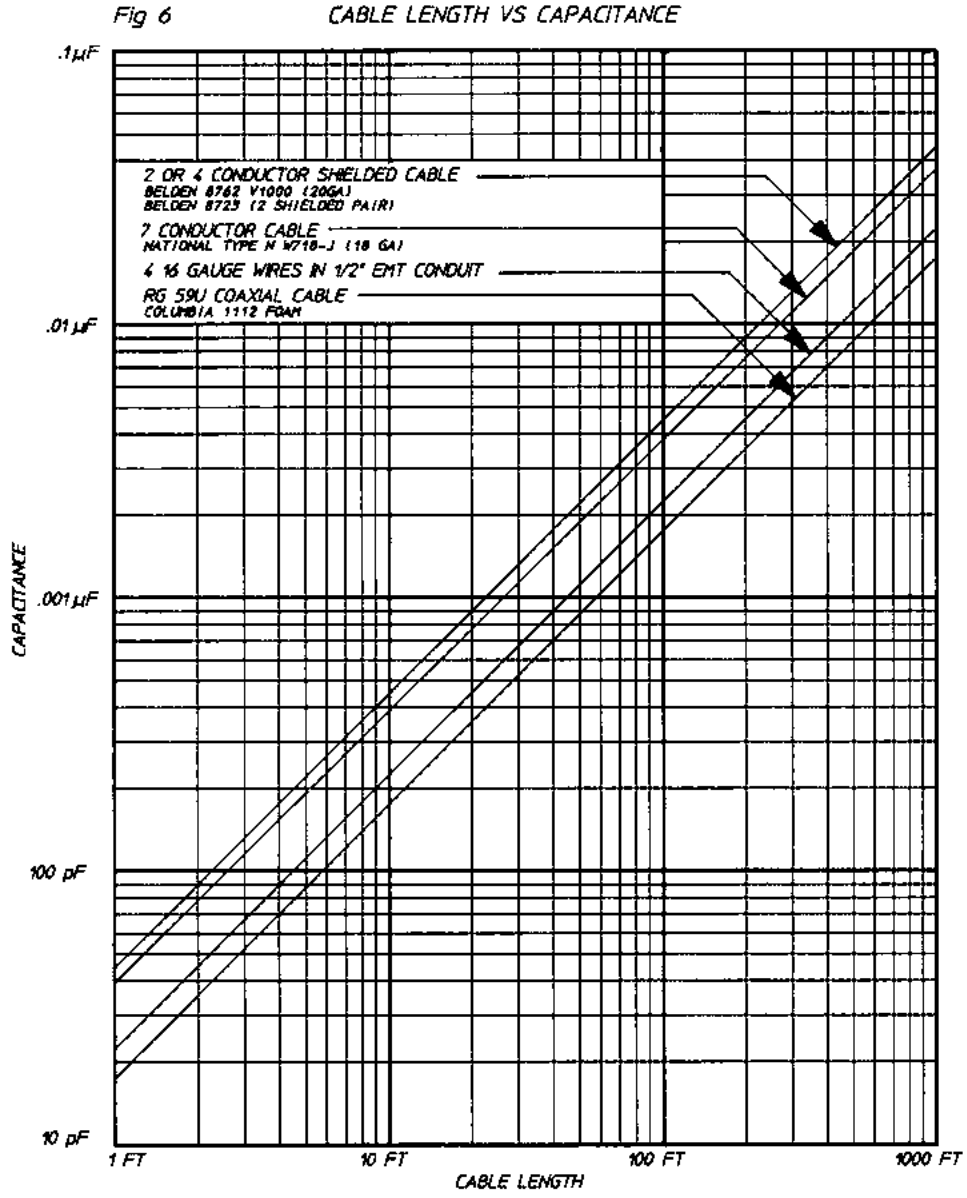
3. Press the 'CAL' button, S5. If the 'SLOW' LED (D8) comes on, wait 10 seconds for it to go off, increase the flow rate and try pressing the 'CAL' button again.

4. Wait for the 'CAL' LED (D9) to stop blinking and turn back off. While the calibration is active, the position indication LED's in the center of the board will pause. As soon as the calibration is complete, they will resume activity.

5. The calibration is now complete. Return S3 to the appropriate setting to get the desired number of output pulses per revolution.

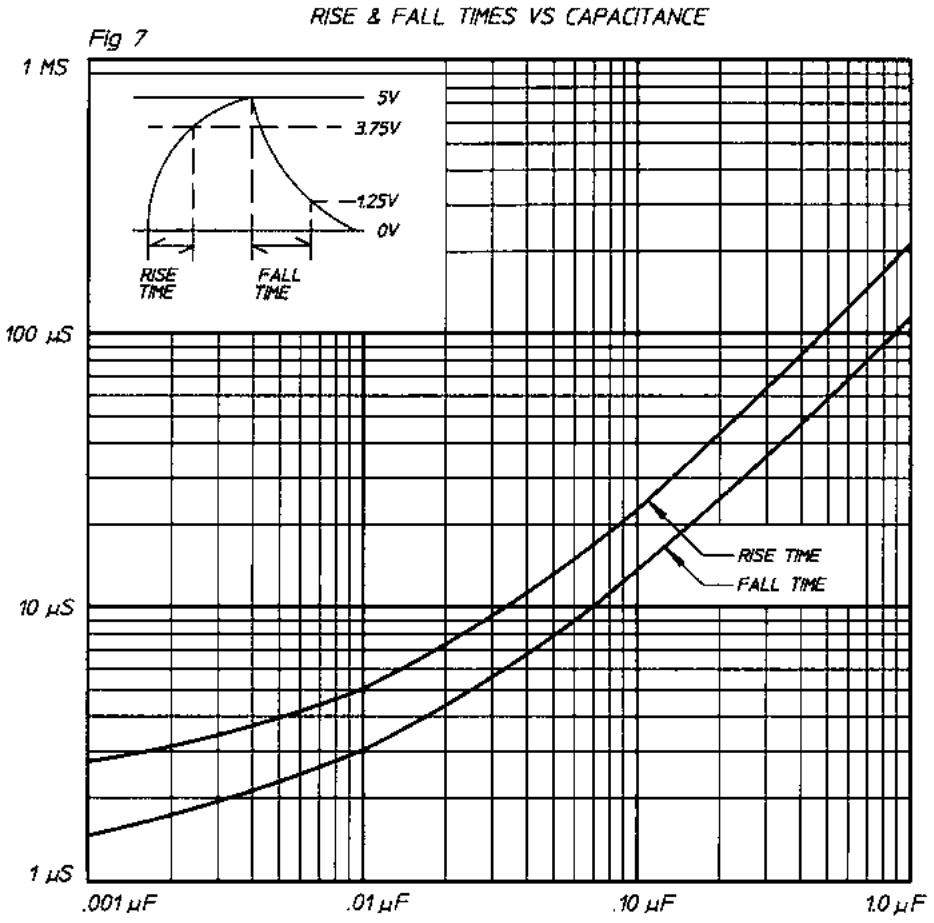
Maximum Transmission Distance

The graph below indicates typical conductor capacitance loads versus cable length for several types of cable. For instance, 1000 feet of 7 conductor #18 gauge stranded wire will put a 0.04 uF capacitive load on the output of the 234 Series Transmitters.



Maximum Transmission Distance (continued)

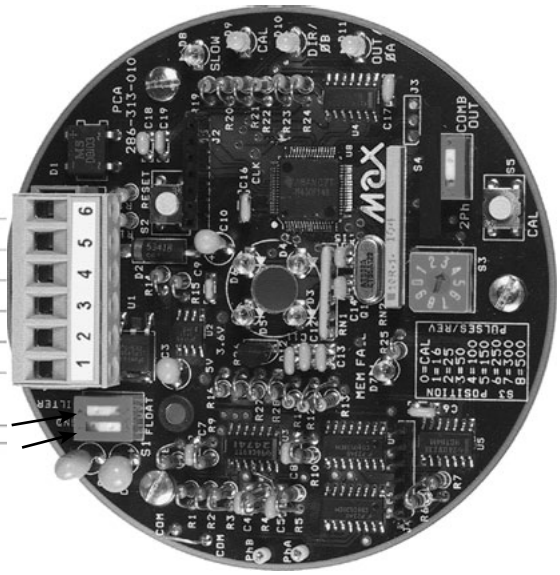
The graph below shows the relationship between output capacitance loading and rise and fall time for the Model 234 output signal. For instance, with 0.04uF load capacitance (1000 ft. shielded cable typ.) the rise/fall time is 10 uS. Consequently, the absolute maximum frequency the Model 234 could transmit would be 50 kHz (frequency = 1/time, where time includes the rise and fall times for one cycle).

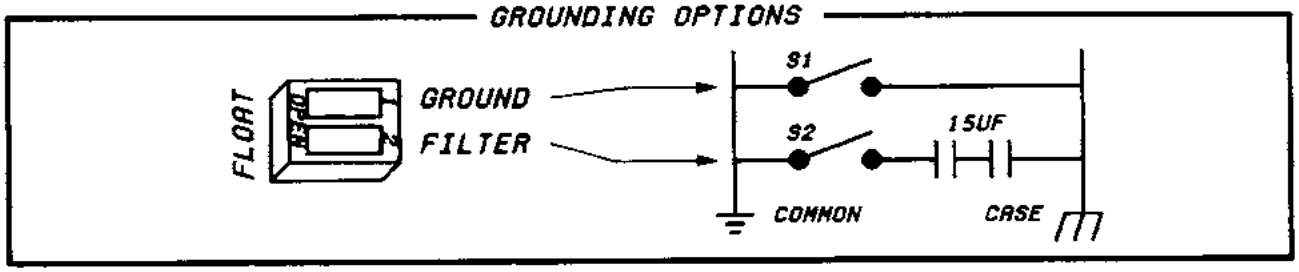


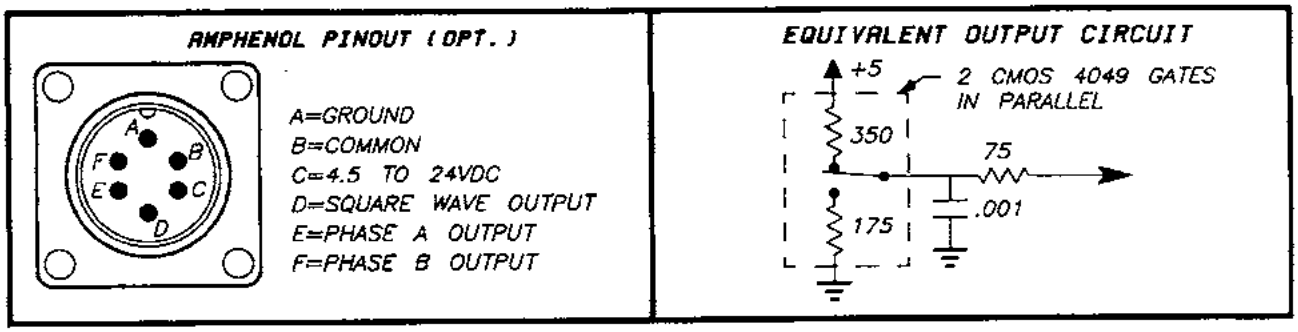
AMPHENOL CONNECTOR
PIN DESIGNATIONS

(F)	PHASE "B" *	BLUE
(E)	PHASE "A" *	ORANGE
(D)	OUTPUT	WHITE
(C)	POWER (4.5-24VDC @ 15mA)	RED
(B)	COMMON	BLACK
(A)	GROUND	GREEN

S1 Ground
S2 Filter
(S1,S2 OPEN=FLOAT)







Do's and Don'ts

DO: Install bypass plumbing around the flow meter. This is useful during start-up for removing dirt and air from the plumbing or when metering high temperature materials. It also allows removing the flow meter for service without disabling the system.

DO: Be very careful to keep parts clean during installation or a teardown. A little dirt can look like a truckload compared to the 10 micron filtration requirement.

DO: Clean the filter on a regular basis.

DO: Use the flow meter with liquids that will not harm the mechanism. Contact Max Technical Service if in doubt.

DON'T: Steam clean the meter (bypass or remove the meter if necessary).

DON'T: Blow down the meter with compressed air or gas because it may overspeed and damage the meter.

DON'T: Disassemble the flow meter. These are precision devices which require special tools and techniques.

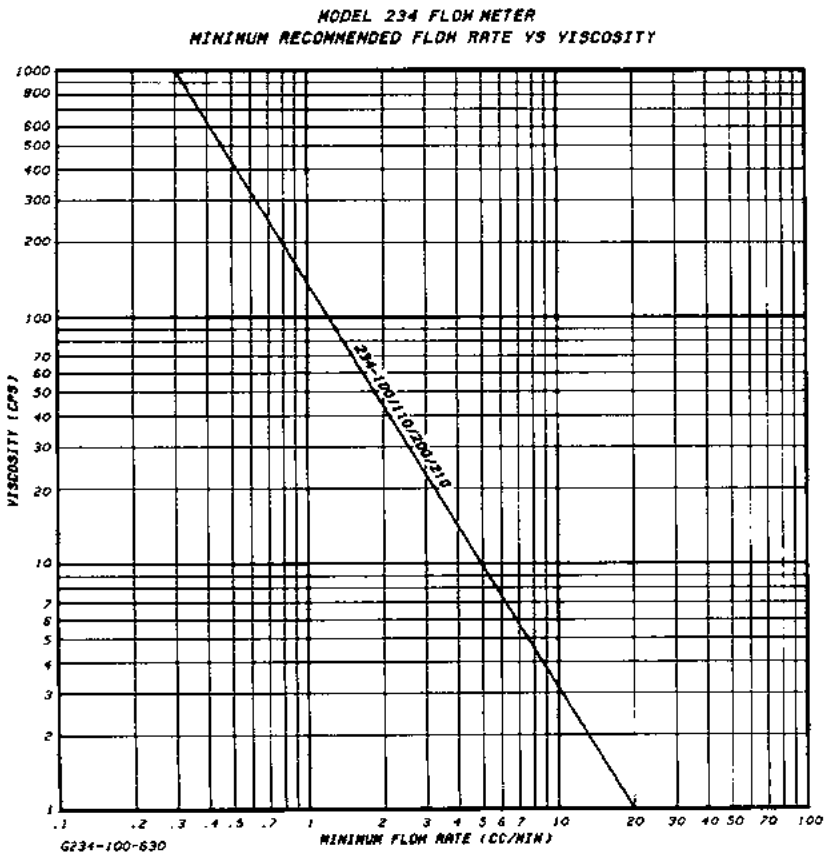
DON'T: Apply excessive differential pressure across the meter or exceed the maximum pressure specification.

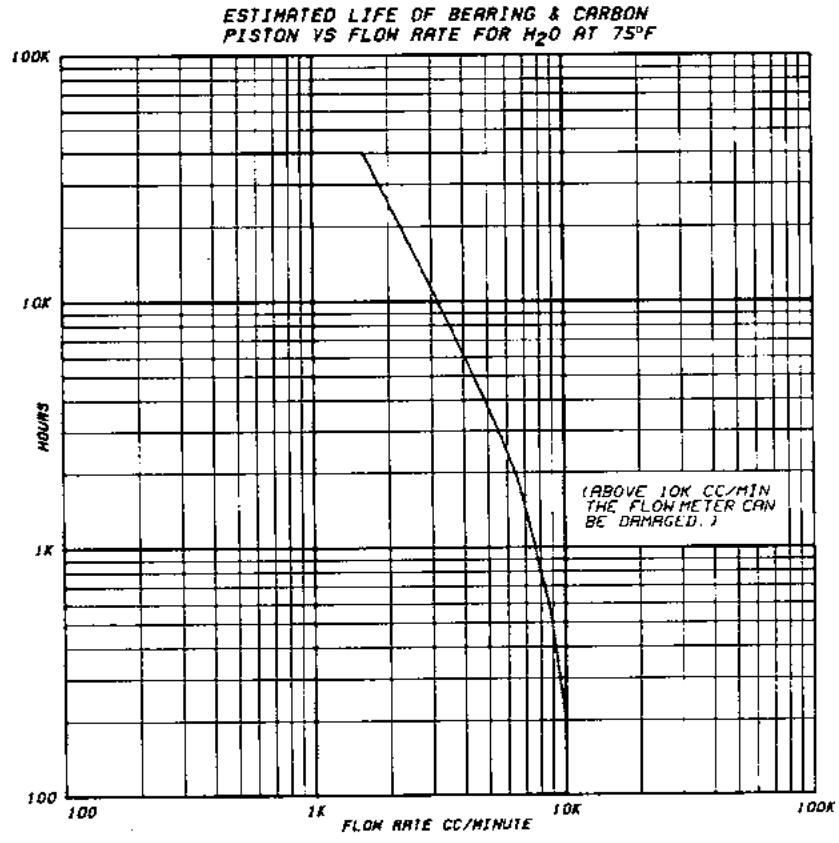
DON'T: Exceed the maximum flow rates for the material viscosity.

DON'T: Exceed the maximum fluid or transmitter housing temperatures.

DON'T: Allow materials which solidify in air to set-up in the flow meter. These may be impossible to remove. If the meter needs to be removed for repair and cannot be completely cleaned, plug the inlet and outlet ports at once.

DON'T: Turn on the pump in a system filled with solidified material. Wait until the material is completely melted and use the flow meter bypass valve during start-up.





Performance Curves