INSTRUCTION MANUAL

276-5XX SERIES 4-20MA TRANSMITTERS

276-515 4 Phase (210 Meters) Amphenol
276-525 4 Phase (210 Meters) Weather-Tight, Explosion proof (UL, CSA)
276-517 7 Phase (220/240 Meters) Amphenol
276-527 7 Phase (220/240 Meters) Weather-Tight, Explosion proof (UL, CSA)

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  D276-515-200
  D276-517-200

Max Machinery, Inc. reserves the right to make changes to the product in this Instruction Manual to improve performance, reliability, or manufacturability. Consequently, contact *MMI* for the latest available specifications and performance data.

Although every effort has been made to ensure accuracy of the information contained in this Instruction Manual, *MMI* assumes no responsibility for inadvertent errors.

General Description: The Max 276 Series Transmitters are 4-20mA output devices available in two versions: One for the Max 210 Series Flowmeters and one for the 220/240 Series. Each is available with either amphenol connectors or in a weather-tight, explosion proof version for use with conduit.

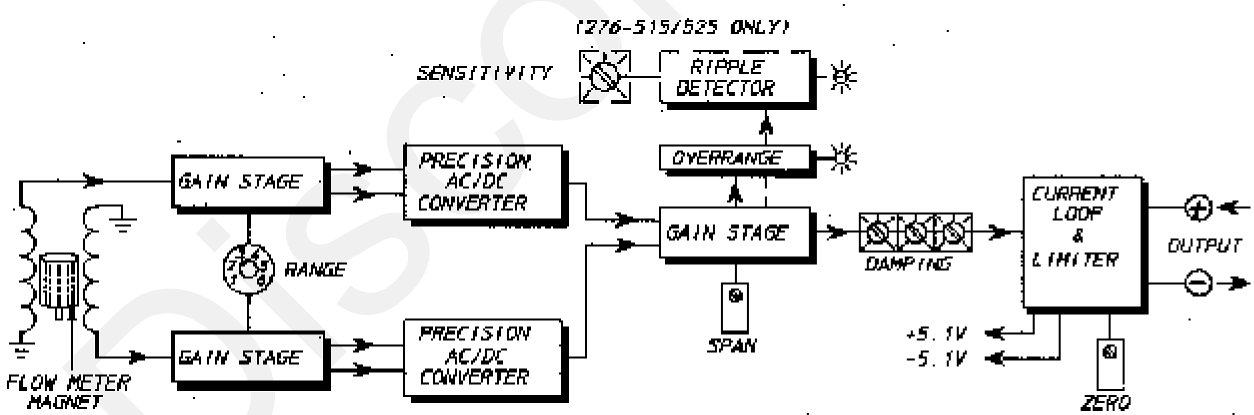
The transmitter uses a stator coil to sense the motion of a rotating magnet contained within the flow meter. This generates a two phase AC signal with a voltage proportional to the flow rate. The Transmitter electronics convert this signal to a DC voltage and then into the 4-20mA flow proportional output.

The 276 transmitter is a two wire, loop powered device that uses about 3.5mA of the 4-20mA which normally flows through the Transmitter. It will operate correctly with a minimum voltage of 11.5 V and up to a maximum of 35 V.

On board controls include a Zero adjustment, Range and Span settings, and a three pole damping filter. An LED indicates over range conditions which can cause a loss of accuracy.

When used with the *Max 210 Series Flowmeters*, the 276 Transmitter can be adjusted to electronically demodulate the nonlinear rotational rate of the crankshaft. This effect is inherent in piston type flow meters.

The *Max 276 Series Transmitters* generally provide faster response to flow rate changes than pulse type Transmitters. This is particularly true with the 210 series meters at low flow rates.



Specifications:

Range *(Flowmeter RPM)*

For a 4-20mA Output	
276-515 and 276-525	21 RPM Minimum 3600 RPM Maximum
276-517 and 276-527	18 RPM Minimum 3600 RPM Maximum

Accuracy

Linearity *(Input RPM vs Output Voltage)*	
Typical	± 0.05% or ± 0.01mA *(whichever is larger)*
Maximum	± 0.1% or ± 0.01mA *(whichever is larger)*
Zero Stability	± 0.01mA

Temperature Range *(See Temperature Considerations)*

Electronics:	
Operating	-10°C to 65°C
Storage	-40°C to 70°C
Stator	-40°C to 130°C

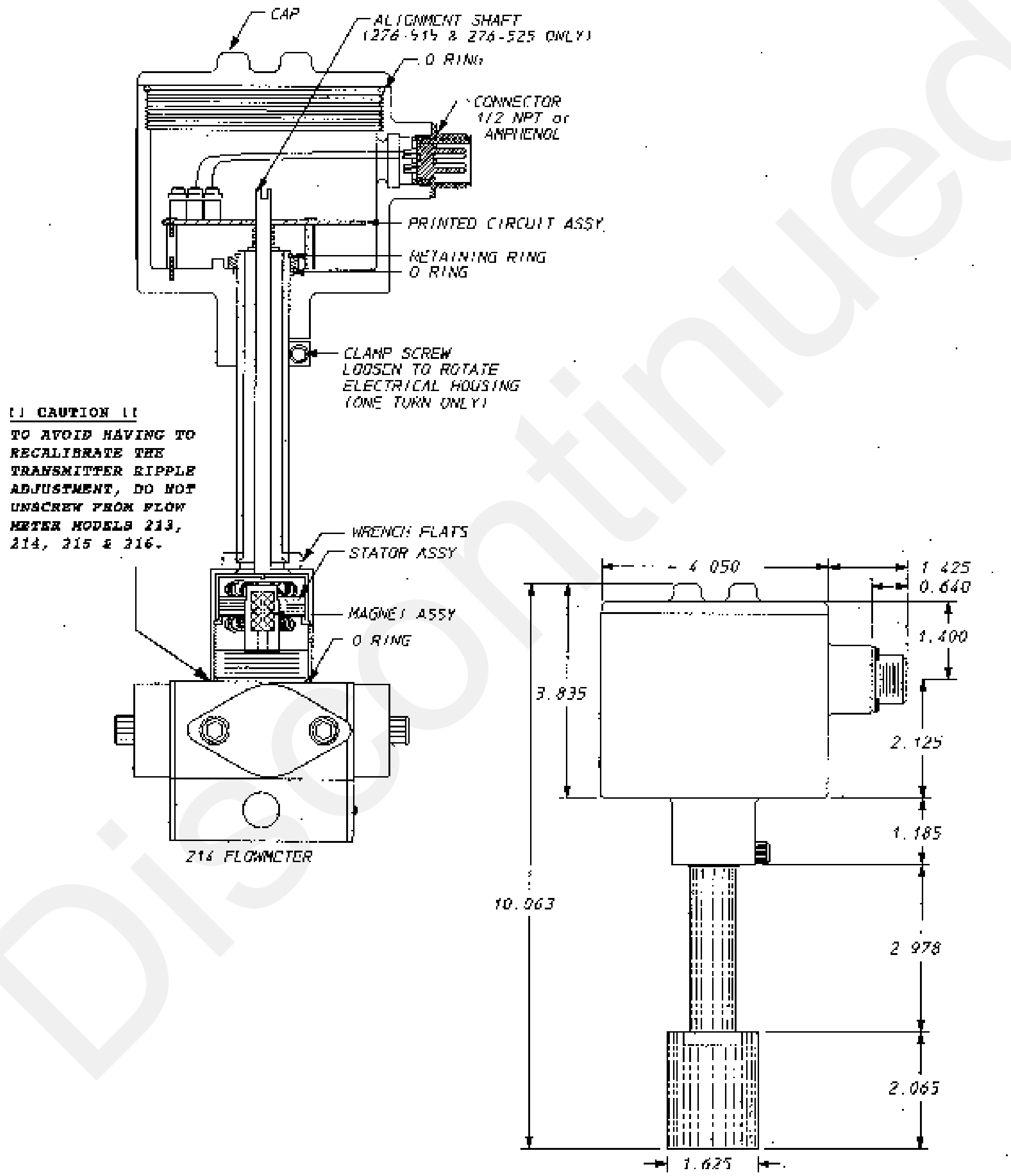
Temperature Coefficients

Flowmeter Magnet	± 0.5% per 100°C
Transmitter	
Span	± 0.2% per 100°C
Zero	+ 0.01mA per 100°C

Supply Voltage

Maximum at 25mA	35V *(Continuously)* 50V *(5 Sec or less)*
Minimum at 4mA	10.5 Volts
at 20mA	11.5 Volts

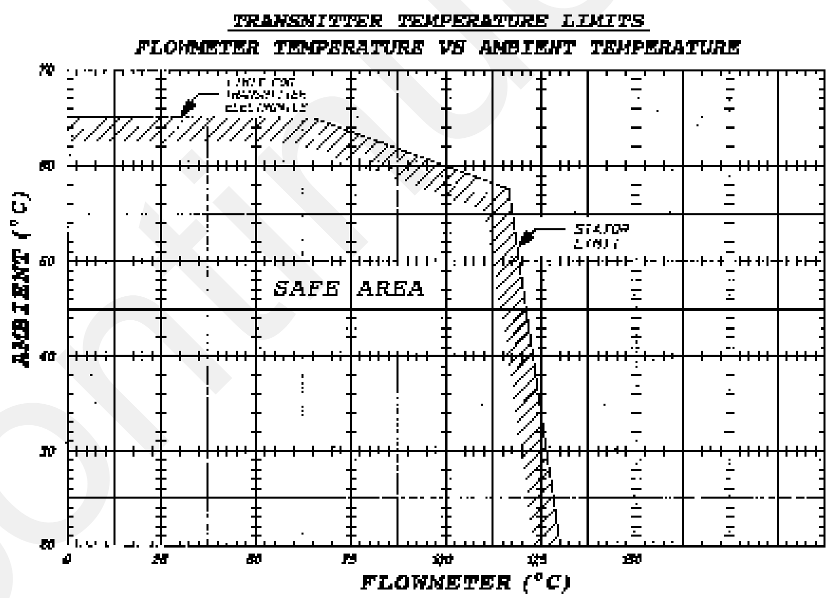
Mounting: The 276 Transmitter screws on and off of the Flowmeter. Because of the random location of the starting point of the threads, one Transmitter will probably not line up with the “in” and “out” ports of the Flowmeter like another will. The electrical outlet of the Transmitter can be rotated clockwise or counter clockwise **one turn** by loosening the clamping screw *at the base of the Transmitter housing* [shown below].



Two flats are provided for screwing the Transmitter on to the Flowmeter. **Care should be taken when slipping the Transmitter on and off**. The stator wire can be easily damaged.

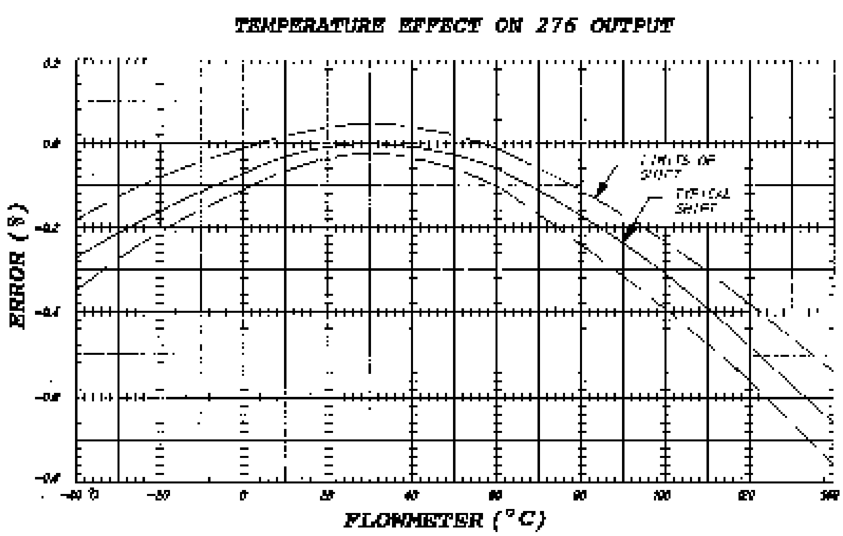
Moisture Protection: The weather-tight version of the Transmitter has it's electronic circuitry enclosed in a liquid and vapor tight enclosure. All joints are sealed by welding or by "O"-rings. If this sealed condition is to be maintained, the conduit connection to the enclosure should be made liquid and vapor tight by using pipe dope or a potting fitting. If a Transmitter is located outside and this precaution is not taken, moisture may form inside the housing. This will cause the circuitry to give an inaccurate output or possibly no output at all. In the long run it will cause corrosion and failure. The amphenol connector 276 Transmitter models offer moderate protection from moisture and dust, but are not totally sealed.

Temperature Considerations: High ambient temperatures (120°F/50°C) should be avoided if possible. It is a good idea to locate the Transmitter away from hot spots such as steam pipes, ovens and heaters. The electronics of the 276 Series Transmitters are rated for operation up to 65°C or 150°F. **Because some heat travels from the Flowmeter to the Transmitter electrical enclosure, the temperature of the electronics within is a function of both the Ambient and the Flowmeter temperature.** The figure [top, right] shows the relationship between the maximum ambient Transmitter temperature and the fluid temperature through the Flowmeter.



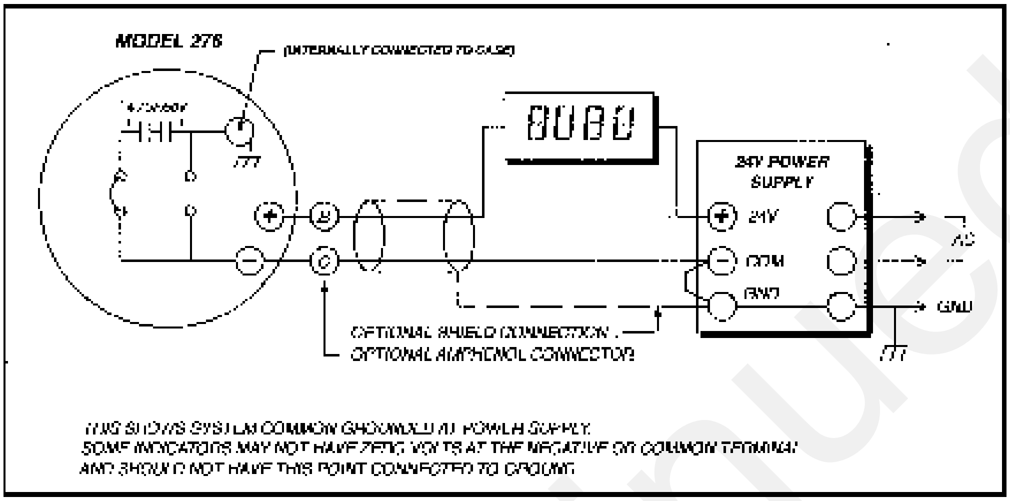
The stator of the 276 Transmitters is insulated with an epoxy that is rated to 130°C. This limits the maximum Flowmeter fluid temperature to about 130°C.

The output of the 276 Transmitter will be affected by changes in the temperature of the Flowmeter. This is because the magnet that generates the voltage in the stator is affected slightly by temperature. The figure [bottom, right] shows typical percentages of error.

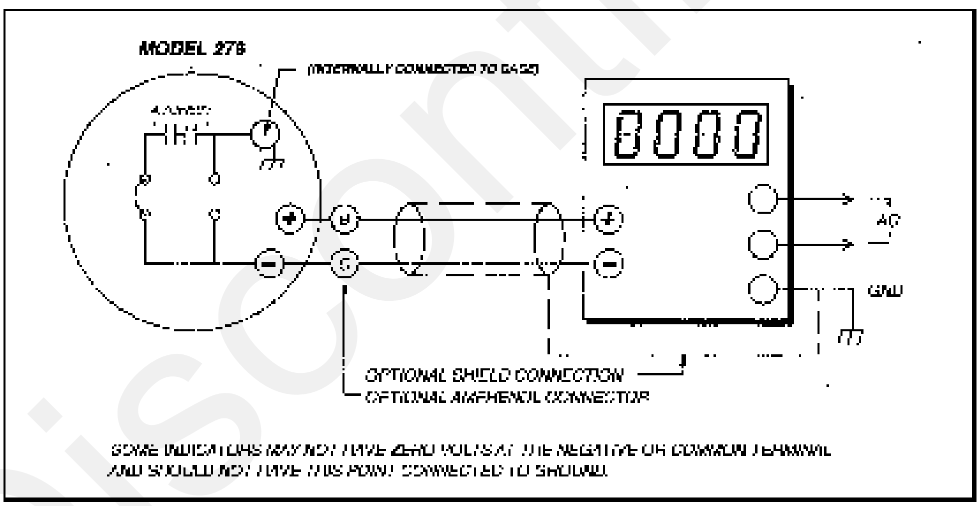


Grounding Jumpers: Two options are available for connecting the minus output to the case ground. These are shown schematically, below, in a ***typical wiring diagram***.

MODEL 276 AND CUSTOMER SUPPLIED INDICATOR (WITH SEPARATE POWER SUPPLY)



MODEL 276 AND CUSTOMER SUPPLIED SELF-POWERED INDICATOR



As supplied by the factory, a jumper is installed in the “filter” position, which capacitively couples minus and ground. This arrangement reduces possible electrical noise problems.

The “ground” jumper would connect minus and case ground directly together, and is supplied in an open condition. Some readout instruments do not have zero volts at the minus terminal, and a direct ground connection would not be advisable.

In a typical installation, the Transmitter case is grounded through the plumbing. An alternative is to make the ground connection at the “case” terminal on the printed circuit board.

Zero Adjustment: R52 (276-515/276-525) R64 (276-517/276-527) Adjust the output current to 4.000mA with zero flow through the Flowmeter.

Span Adjustment: S1 Coarse Range and R35 or R47 Fine Span Adjustment. **Table I** lists the approximate volumetric displacements of flow meters that can be used with the 276 transmitters. Use this table to calculate the RPM of the flow meter at maximum flow.

TABLE I.

METER MAXIMUM FLOW AND DISPLACEMENT

FLOWMETER	MAXIMUM FLOW		DISPLACEMENT PER REVOLUTION	
	CC/MIN	GAL/MIN	CC	GALLONS
213	1,800	0.48	0.870	.00023
214	10,000	2.64	10.5	.00285
215	40,000	10.6	47.6	.0128
216	100,000	26.4	169.5	.0446
220	10,000	2.64	9.12	.0024
221	55,000	14.5	23.5	.0062
222	75,000	19.8	47.4	.0125
241	189,000	50.0	62.1	.0164
251	189,000	50.0	62.1	.0164
242	540,000	143.0	182.0	.0480
243	1,400,000	370.0	574.0	.152
244	3,500,000	925.0	1700.0	.456
245	8,000,000	2114.0	6060.0	1.60

(FOR EXAMPLE: THE 213 MAX RPM IS: 1800 CC/MIN ÷ 0.870 CC/REV = 2069 RPM.)

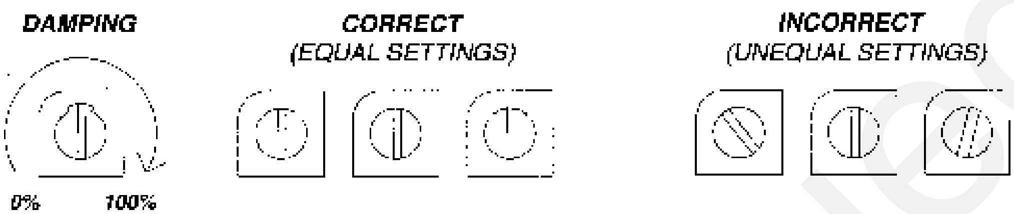
Table II lists the RPM range of each Range Switch setting for both 276 transmitters. Use this table to estimate the correct range position.

TABLE II.

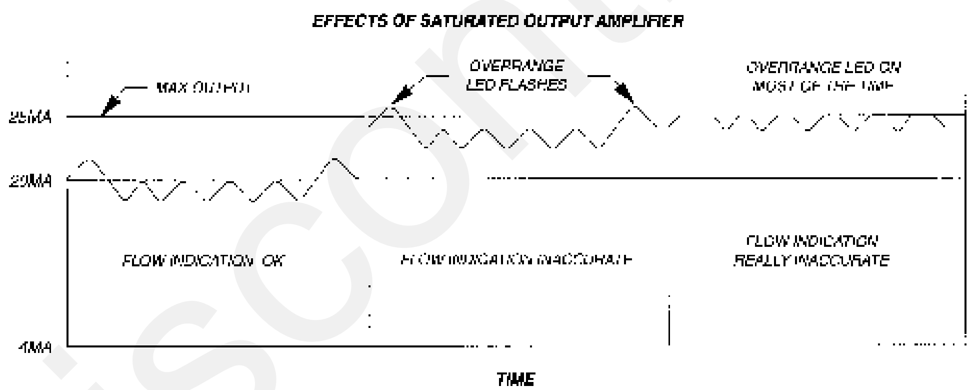
RPM RANGE VS SWITCH POSITION (RPM AT 20mA OUT)

SWITCH POSITION	276-5X5 MAX GAIN	276-5X5 MIN GAIN	276-5X7 MAX GAIN	276-5X7 MIN GAIN
1	1294	3620	1290	3612
2	568	1589	549	1537
3	249	697	233.6	654
4	109	306	99.4	278.3
5	48	134	42.3	118.4
6	21	59	18	50.4

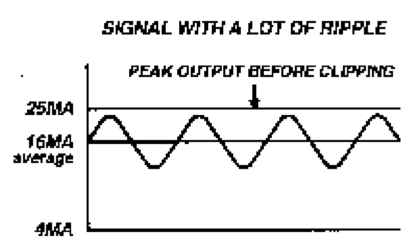
Damping: R37/38/39 or R49/50/51. The 276 Transmitter has a damping network which is used to average out meaningless variations in the output current which can result from system layout, pump noise, or Flowmeter design. To adjust the damping, set the flow rate to the lowest flow that will typically be used. Increase the setting of the three damping potentiometers equally until the indicated flow rate shows the desired stability. Increasing the damping will also slow the response to actual flow rate changes, so use the minimum damping necessary.



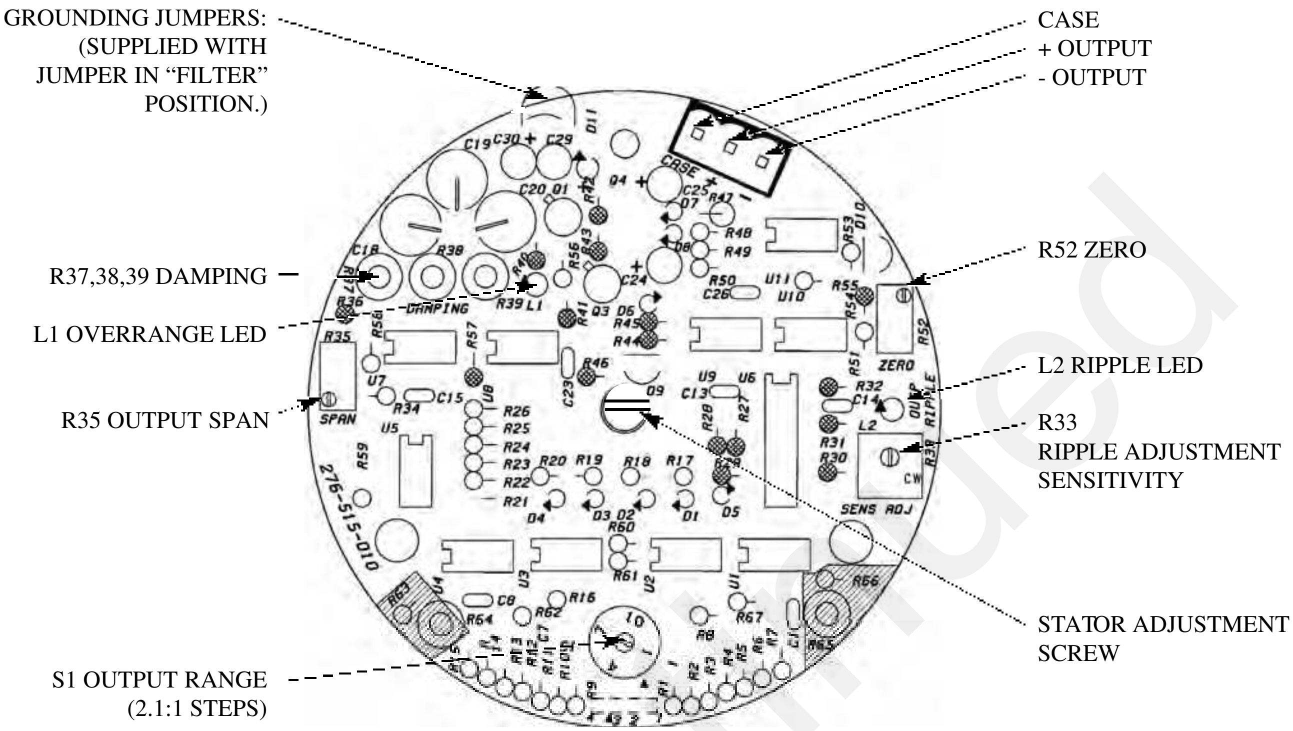
Output Over Range LED: This LED will start to blink if the Transmitter output amplifier begins to saturate (clip). This happens when the flow rate or gain is too high. Clipping will cause the output current to be less than it should be and not a true indication of flow rate. The figure below shows what happens as the flow rate is increased to the point at which the output is saturated.



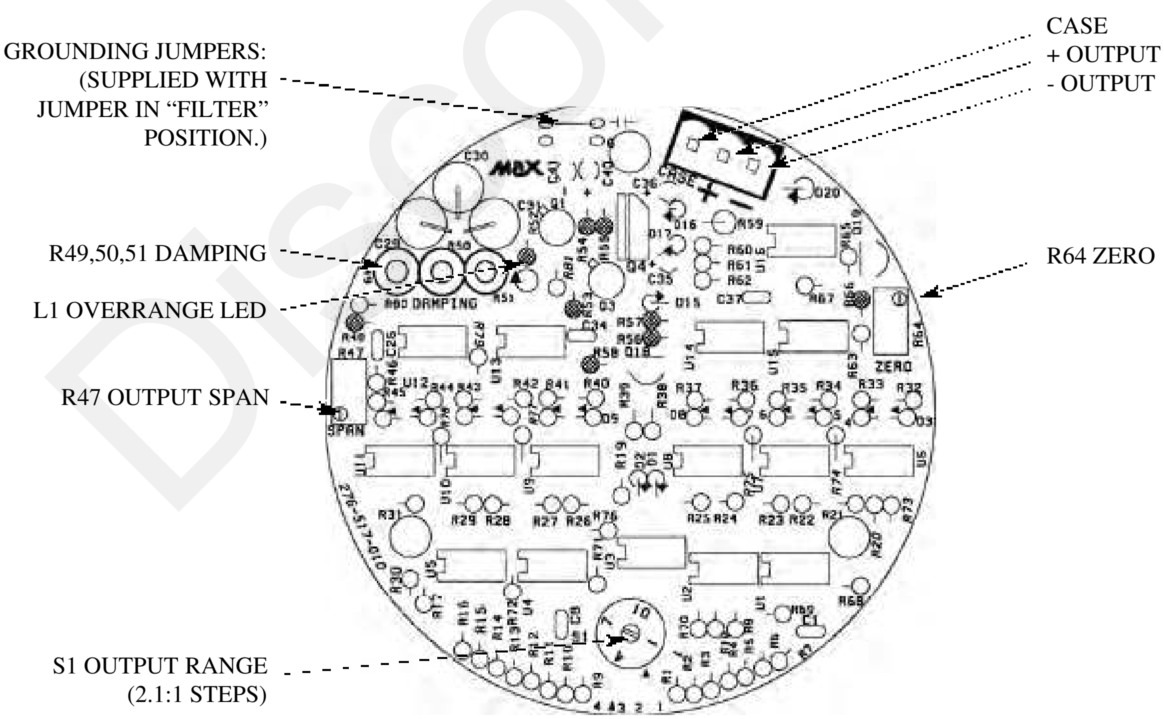
The flow rate in a system may have as much as 50% to 100% ripple. This may be caused by the pump, by air in the line, or a slightly sticky Flowmeter. The maximum output current of the 276 Transmitter must be kept low enough so that the output is not saturated. This may mean that the average full scale output current will have to be less than 20mA to avoid clipping the peaks in the output signal, as indicated in the figure below.



276-515/525



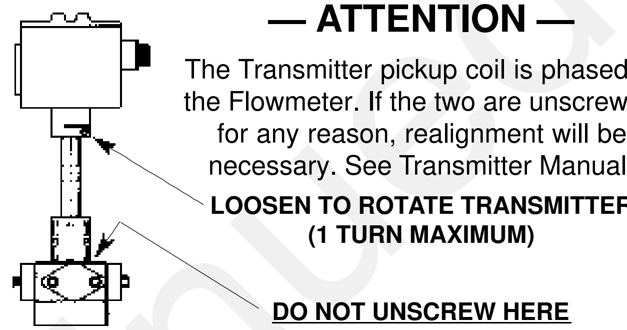
276-517/527



Ripple Adjustment: (276-515 and 276-525 Transmitters Only)

This adjustment will have to be made if the Transmitter is unscrewed from the Flowmeter.

The 276-515 and the 276-525 Transmitters are made to compensate for the non uniform rotational rate of the 210 series piston meters, which can cause as much as 50% ripple at the Transmitter output. To take advantage of this feature, the stator of the 276 Transmitter must be positioned correctly for each meter it is mated to.



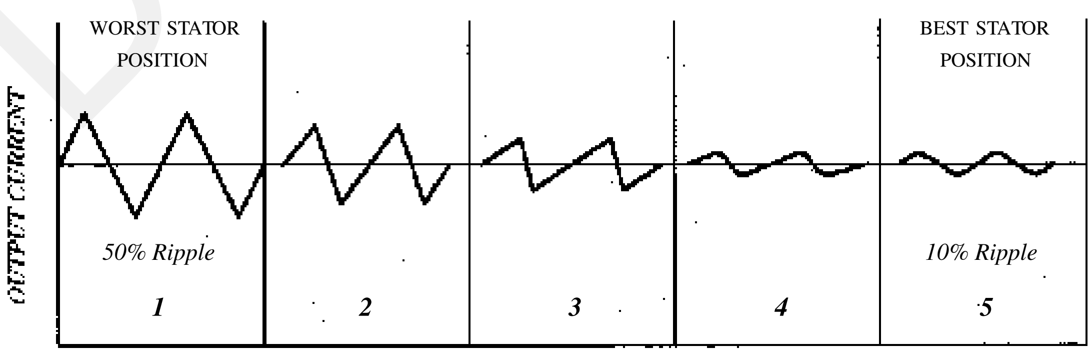
— ATTENTION —

The Transmitter pickup coil is phased to the Flowmeter. If the two are unscrewed for any reason, realignment will be necessary. See Transmitter Manual.

The Flowmeter must have a flow through it for this adjustment to be made. It is advisable to adjust the ripple at the lower end of the flow range; although if the flow rate is less than 5% of the Flowmeter's full scale capability, you may have problems with this procedure. Increase the Sensitivity Adjustment (R33) clockwise just until the Ripple LED (L2) next to it starts to turn on. Then turn the Stator Adjustment Screw in a direction that decreases the brightness or turns off the Ripple LED. Once again increase the Sensitivity Potentiometer until the LED just comes on and again turn the stator adjustment in a direction that minimizes the LED brightness. Repeat this process until any further change in the position of the stator screw causes the LED brightness to increase rather than decrease.

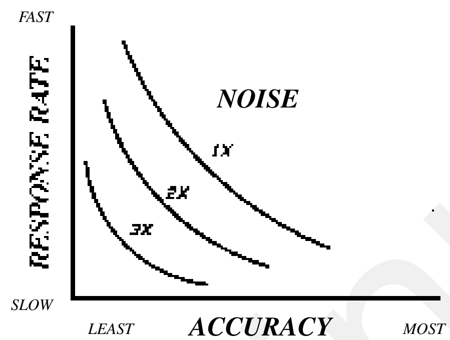
Shown below is the effect of the stator position on output ripple. There are four best and four worst positions for the stator per revolution. This means that it will take a maximum of 45° on the Stator Adjustment Screw to find the best location.

OUTPUT RIPPLE VS STATOR POSITION



Response Rate, Accuracy & Noise: There is always a trade off in a metering system between response rate, accuracy and noise. The three are related such that their product equals a constant. If any one of them is made smaller, the others can be made larger.

In most metering systems, response rate and accuracy are desirable characteristics. To maximize one or both of these parameters, noise should be reduced to a minimum. Once noise has been minimized, there is a trade off between accuracy and response rate.



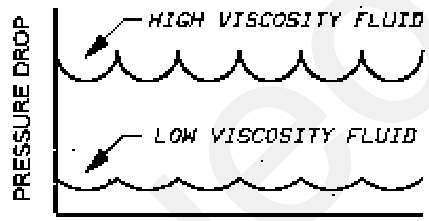
Response Rate: When discussing response rate there are three facets to consider. They are: the response of the flow to a change in the system set point, the correction of the flow to an error induced in it, and the response of the flow rate display to a change in flow rates. These responses are all purposely slowed down by filtering or damping so the system only reacts to meaningful flow changes and not to such things as pump pulsations or Flowmeter ripple. More damping means slower response.

Accuracy: There are three topics to consider when looking at accuracy. The first being the display; which can typically have anywhere from two digits (1 to 99) to 4-1/2 digits (19,999) of information. This equals a resolution of 1% to a maximum of 0.005%, respectively. The display steadiness is also directly related to it's accuracy. For instance, a display that jitters from 95 to 105 in a meaningless way is not accurate to one part in 100 (1%) but only to about 10 parts in 100 (10%).

The basic accuracy of the Flowmeter is a prime consideration. Typically, the accuracy of a positive displacement meter is not as good for a fraction of its cycle as it is for one or more complete cycles. If a system is dampened so that the response rate is longer than the period of one revolution of the meter, the accuracy of the display is increased. The accuracy of the system can never be better than that of the Flowmeter.

Noise: Noise can be defined as any change in either the fluid flow or the electrical system that is not a meaningful change in the flow rate. For instance, the ripple induced in the flow by a gear or piston pump is noise. The system will typically have to be dampened so that its' response time is longer than the tooth to tooth period of the pump. Piston pumps with fewer than three pistons create a particularly large amount of bothersome ripple and result in a system that is very slow to respond.

PRESSURE DROP VS TIME
(210 SERIES PISTON METER)

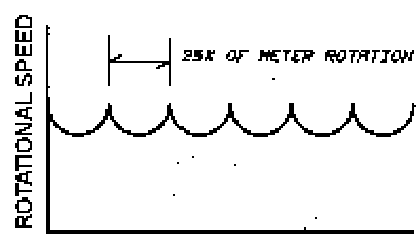


All positive displacement Flowmeters add noise to a Flowmetering system. The noise is typically of two origins. As the elements of the meter rotate, they require varying amounts of pressure to move (As shown in illustration, right).

This induces pressure fluctuations between the pump (or control valve) and the Flowmeter. If there is any air trapped in the line, the fluid flow will vary as the air compresses and expands. This will be sensed as a changing flow by the Flowmeter and the output will contain unwanted ripple or noise. Plumbing in a flow system should be sized and laid out to avoid air being trapped between the Flowmeter and the flow controlling device (a pump or valve).

The second type of noise that must be considered is a result of Flowmeter geometry and design. Because of features such as an oval gear, or a piston/crankshaft configuration, or due to manufacturing tolerances, the rotation of the metering elements is not completely uniform. For example, the 210 series meters utilize four pistons connected to a crankshaft. The varying rotational speed of the crankshaft is shown in the figure to the right.

ROTATIONAL SPEED
(OF 210 CRANKSHAFT)



To obtain the smoothest output signal, the Transmitter (276-515 or 276-525) for these meters can be adjusted to minimize this characteristic. Additionally, some amount of damping is usually necessary at the indicator.

The electronic converter of any meter will add its share of noise. For instance, DC Transmitters produce some ripple in their output due to the sinusoidal nature of the induced voltage in the armature coils.