

# G series

## Flow Metering Systems

### Operational Manual



For Models G004 thru G240

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Additional technical documents regarding transmitter performance and advanced operation are available at: <http://www.maxmachinery.com/>

Max Machinery, Inc. reserves the right to make changes to the product in this instruction manual to improve performance, reliability, or manufacturability. Contact Max Machinery Inc. for the latest available specifications and performance data. Although every effort has been made to ensure accuracy of the information in this instruction manual, Max Machinery Inc assumes no responsibility for inadvertent errors.

## General Description

The G-Series flow metering systems are the combination of a high pressure gear meter and a high resolution, microprocessor based transmitter. While gear meters are traditionally based on a design similar to a conventional hydraulic pump, the G Series of flow meters has been engineered to increase signal resolution, prevent internal cavitation and greatly reduce the pressure drop required to move fluid through the gears.

The G-Series transmitter uses modern sensor technology coupled with advanced signal processing to deliver new levels of performance and reliability. Solid state sensors are used to detect the position of a driven magnet inside the Max flow meter. Changes in position are tracked by a microprocessor, which generates an output frequency proportional to the flow rate. Advanced signal processing provides both fine angular resolution (0.36 degrees rotation per pulse) and rapid response (output updated every 1 ms).

The flow meter and transmitter are calibrated at the factory as a matched set. This ensures the highest accuracy and allows for quick setup in the field. For field installations where the transmitter has not been setup with a meter at the factory, an optional serial interface kit is available to provide full access to all configuration options and parameters.

### Flow Meter Features

- Capable of operating at high pressures (425 bar/6000 psi).
- Compatible with a wide range of fluid types and viscosities.
- Can operate at high temperatures with a suitable high temperature transmitter.

### Transmitter Features

High resolution measurement - Available in four configurations: Frequency, Quadrature, Voltage or Current outputs. Linearization of up to 16 points to fully describe the flow meter's output curve and achieve the highest system linearity over the meter's entire operating range.

Compensation Algorithm - Compensates for variations in Hall sensor and flow meter characteristics to provide a stable, undamped output that accurately represents the instantaneous flow rate.

Adjustable Anti-Dither Pulse Buffer - Prevents undesired output which can occur at very low flow rates in the presence of vibration or hydraulic noise. If the meter reverses for less than the programmed fraction of a revolution and then resumes forward rotation, the output will represent only the total forward flow. Reverse flow which exceeds the buffered amount will result in an output proportional to reverse flow rate.



## Installation - Flow Meter

Prior to installing the flow meter remove the storage caps from the ports and look carefully into each port of the meter. Ensure that no dirt or foreign particles have gotten into the ports of the meter. Make sure that adequate filtration exists upstream of the flow meter and that no contaminants exist in the line between the filter and flow meter. It is recommended that the flow meter be connected to the circuit by means of unions close to the flow meter to allow easy removal. A by-pass valve should be installed between the inlet and outlet ports in parallel to the flow meter to allow flow through the system in the event that the flow meter becomes blocked by foreign material.

### Operation

Confirm that the following parameters of your flow metering system are within the specifications for the meter being used:

Maximum System Pressure	(Specification sheet)
Differential Pressure across meter	(Pressure Drop Curves)
Maximum Flow Rate	(Pressure Drop Curves)
Metered Fluid Temperature	(Specification sheet)

If the metered fluid is a solid at room temperature, it is critical that it be fully melted before applying pressure to the meter in order to avoid excessive loading on the bearings or potentially fracturing the sensor magnet. To determine melt times, measure the surface temperature as near as possible to the transmitter. Wait until the body temperature exceeds the melting point, allowing additional time if the fluid is a poor heat conductor.

Starting with the valving to the flow meter closed, slowly open the bypass valve to establish flow. Then slowly open the inlet and outlet valves at the flow meter. When the meter turns smoothly and you detect a flow signal, slowly close the bypass valve completely.

If a bypass valve was not installed in the system, initiate flow in the system as gradually as possible. If you do not generate a flow signal, or the line pressure increases, stop the pump and allow more time for the material in the meter to liquefy.

No routine maintenance, cleaning, or lubrication of the flow meter is required. A routine filter cleaning schedule should be established. The system should be shut down if abnormal noises occur or if unusual differential pressures across the meter are encountered.

## INSTALLATION DO'S & DON'TS

DO: Read entire manual before installation. If you need further information, contact MAX and ask for Flow Meter Technical Service.

DO: Install proper filtration immediately upstream of the flow meter.

DO: Install the meter in the pressurized/upstream section of the circuit if the working fluid is prone to cavitation (thin fluids or low boiling points).

DO: Install bypass plumbing around the flow meter. Use the bypass during start-up while flushing the system to (1) remove dirt by filtration and (2) bleed air and vapor from the system. Open the meter valves slowly on start-up to avoid over-speeding the meter with entrapped air. The bypass also allows removal of the meter for service without disabling the system.

DO: Be very careful to keep all parts clean during installation or tear down. In particular, ensure that no metal shavings from inserting the pipe fittings end up in the meter. Particles larger than a few thousandths of an inch can cause significant damage to the meter.

DO: Add protective sealants to exposed socket head cap screws if meter is used in a highly corrosive environment.

DON'T: Ever apply more pressure to the meter than its pressure rating. In particular beware of sudden spikes, surges or hammering that may occur. If pressure limits are exceeded, return the meter to the factory for inspection and repair.

DON'T: Run water or aqueous solutions not approved by MAX through your flow meter as it may cause internal galling.

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

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

DON'T: Blow through the meter with compressed air, gas, etc., because it can easily be over-spiced and may result in damage to the meter.

DON'T: Turn on the pump if the meter is filled with material which is a solid at room temperature until the material has been melted completely. Use a bypass around the meter during start up.

DON'T: Apply excessive differential pressure across meter (see pressure drop graphs) as it will cause internal parts to fail prematurely.

DON'T: Exceed the maximum flow rates specified (see performance curves) as it will cause internal parts to fail prematurely.

DON'T: Operate the meter at a flow rate where the fluid is cavitating inside the meter.

# Troubleshooting

Trouble	Probable Cause	Corrective Action
No Flow thru meter or high pressure drop	Foreign particles or solidified matter in meter	Flush meter with suitable solvent. Return to Factory for repair if unsuccessful.
Flow but no transmitter output	Incorrect Wiring	Verify wiring.
	Failed transmitter	Remove cap on transmitter and observe flashing LED's. See page 10 for details.
	Defective Cable	Remove cap on transmitter. Repair or replace cable. Contact Factory.
Output is high compared to actual flow.	Incorrect scaling on analog output	Correct scaling on transmitter or display system
	Air in the lines	Purge lines or re plumb.
	Electrical Noise	Confirm proper grounding and shield cables.
	Magnetic Interference	Avoid placing near strong magnetic fields.
	Indicator out of calibration	See indicator manual.
Output is low compared to actual flow	Leaky bypass valve	Repair or replace valve
	Flow is below specified minimum rate	Increase flow or replace with appropriately sized meter
	Indicator out of calibration	See indicator manual
	Meter damaged from particulates in fluid	Contact Factory

## Repairs

The Max G-Series Meters are not designed for user repair and all such work should be done at the factory or under the direct supervision of the Max Technical Service Department. Unauthorized repair work may damage the meter and will void the product warranty. Please make note of model and serial numbers on the flow meter before calling the factory. A Return Material Authorization (or RMA) number will be issued if the flow meter has to be sent back for repair.

# Flow meter Specifications

Model #	G004	G015	G045	G105	G240
Max Flow (1)	4 LPM (1 GPM)	15 LPM (4 GPM)	45 LPM (11.9 GPM)	105 LPM (28 GPM)	240 LPM (64 GPM)
Operating Pressure	425 bar (6000psi)	425 bar (6000psi)	425 bar (6000psi)	425 bar (6000psi)	see below
Filtration	10 micron	15 micron	20 micron	20 micron	30 micron
Max Temp (2)	155°C (310°F)	155°C (310°F)	155°C (310°F)	155°C (310°F)	155°C (310°F)
Weight	1.2 kg	1.8 kg	3.7kg	7.7kg	21 kg
Displacement cc/rev	1.8	4.2	13.5	38	133
Typical K-Factor (Pulses/cc)	500	200	70	25	7
NPT Port Size	1/8"	3/8"	1/2"	3/4"	1" to 280 bar (4000 psi)
SAE Port Size	#4	#6	#8	#10	#16 to 425 bar (6000psi)

(1) For fluids above 100cps fluid, flow rate must be derated. See graphs.

(2) Standard transmitter capable to 85°C (185°F).

# Transmitter Specifications

Supply Voltage & Current	Frequency output	5-26 Vdc @ 30 mA typical
	Analog output	12Vdc @ 90 mA typical
		24Vdc @ 45 mA typical

Analog Resolution	Adjustable without recalibration to any range of	
	+/- 20mA - Models ending in "A1" and "B1"	
	- or -	+/- 10 Vdc - Models ending in "C1" and "D1")

## FREQUENCY MODEL SPECIFICATIONS

Output (5.0 Volt Supply)	No Load	0.00 / 4.80 Volts
	2.5K Load to Common	0.00 / 4.60 Volts
	2.5K Load to +5 Volts	0.25 / 4.80 Volts

Short Circuit Current (1)	45 mA
Output Impedance	100 $\Omega$
Rise/Fall Time	0.2 $\mu$ Sec
Output Update Rate(2)	1 ms
Min/Max Frequency	0-60 kHz
Resolution	1 - 1000 pulses/rev

Ambient Temperature Range	Transmitter (Storage) -40°C to 85°C (-40°F to 185°F)	
	Transmitter (Operation) (3) -40°C to 80°C (-40°F to 175°F)	

Maximum Temp, Process Fluid (30°C Ambient, 5V supply)	(Standard Model)	90°C (195°F)
	(High Temp Model)	155°C (310°F)

Anti-dither Range Default	50% Revolution of Meter for unidirectional (software selectable from 1 - 100% of 1 revolution). 2% for bi-directional meters
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Signal Filtering	Software selectable from 1ms to 250ms time constant
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(1) Continuous Short Circuit is not recommended. The output current should not exceed 10 mA

(2) Events are seen as output transitions 1 ms after they occur

(3) Temperature of metered fluid will affect transmitter temperature, see graph



# Installation

## Transmitters – Mechanical Installation

1. The transmitter is attached to the flow meter's threaded magnet shield. Hand tighten only. (~ 3 ft-lb)
2. The transmitter lid has four thread paths. To realign the cable, remove the lid and rotate up to 180° and retighten using an alternate starting point. Tighten to compress the O-ring seal.

## Removal

1. Remove electrical connections
2. Unscrew transmitter, using a wrench if necessary.

**Removal note:** The transmitter does not need to be removed from the flow meter for any field servicing or adjustments. Normally, the flow meter and transmitter are shipped back to the factory for calibration or service as a unit. If the transmitter needs to be removed from the flow meter for installation, be sure to retighten the transmitter snugly in order to ensure proper sensor alignment.

## Moisture Protection

On all models, the housing is designed as a liquid and vapor-tight enclosure. There are O-ring seals at the lid and possibly also the base of the housing – these need to be fully seated. A properly sealed transmitter will prevent the formation of damaging moisture inside the housing.

**Turck connector Model:** The connector is sealed to the lid at the factory and is ready for use.

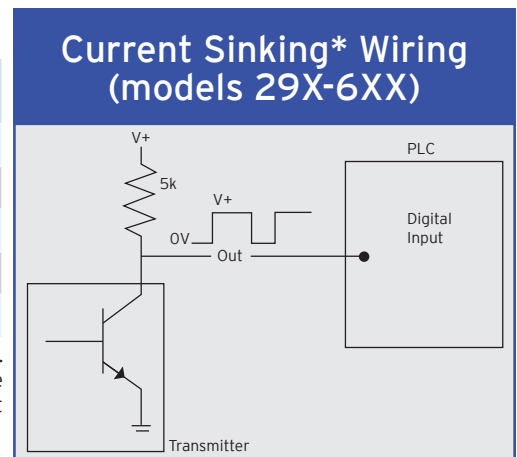
**NPT Model:** To ensure a moisture-tight seal, apply appropriate sealant to the threads at installation.

## ELECTRICAL INSTALLATION: WIRING

The electrical connector versions are pre-wired inside the transmitter and ready to accept a mating cable (available from the factory). The liquid-tight, NPT models need to be wired during installation as shown in the tables below:

Frequency Single Phase	290 Series	All Other Models	Mating Cable Wire Color	Turck Pin #
Case Ground	In-lid	Case	Blue	3
Common	1	Com	Black	4
Power 5-26 Vdc	2	V+	Brown	1
Pulse Output	3	Ph A	White	2
N/A		NC	Grey	5

\* A current sinking device produces an output pulse which is the opposite of a sourcing device. A positive DC voltage must be applied to the wire running between PhA and your PLC. When the output is triggered, this voltage will be grounded to zero volts. Note: use a 5k ohms resistor to limit the current flow in the signal line.



# Installation

## ELECTRICAL INSTALLATION: WIRING

Frequency Quadrature	290 Series	All Other Models	Mating Cable Wire Color	Turck Pin #
Case Ground	In-lid	Case	Blue	3
Common	1	Com	Black	4
Power 5-26 Vdc	2	V+	Brown	1
Output Phase A	3	Ph A	White	2
Output Phase B	4	Ph B	Grey	5

Analog	290 Series	All Other Models	Mating Cable Wire Color	Turck Pin #
Case Ground	In-lid	Case	Blue	3
Common	1	Com	Black	4
Power **	2	V+	Brown	1
Signal Output (+)	3	Sig	Grey	5
Signal Output (-)***	4	Ret	White	2

### Rotation/Output Indicators

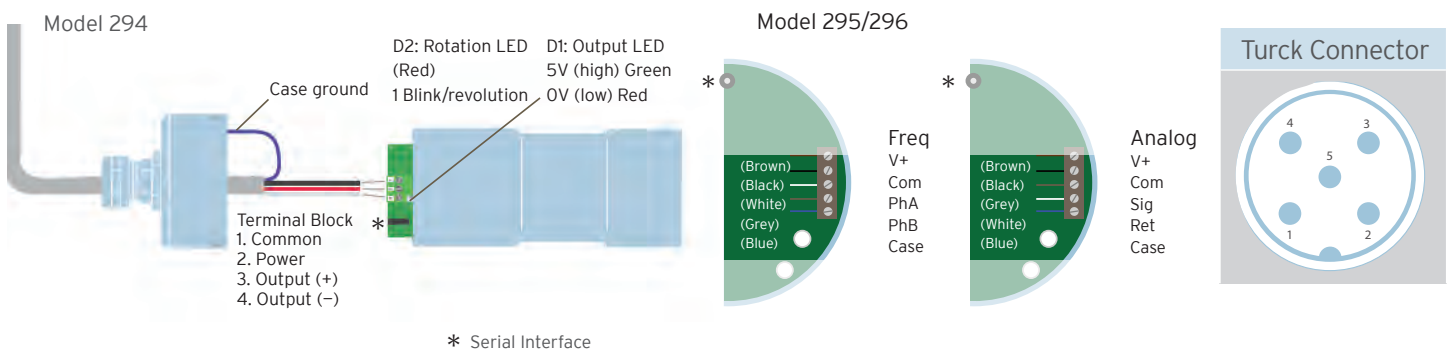
With power supplied, the output LED will be always illuminated (red or green). The red rotation indication LED may be on or off if the flow meter is stationary, depending on what position the meter has stopped in.

Note: There are no selections or adjustments to be made on the circuit board. The only method of altering the setup parameters is through the Serial Interface Program.

\*\* Pulse output versions, 5 to 26 Vdc, Analog output versions ending in A/1 or C/1, 24Vdc, ending in B/1 or D1, 12Vdc

\*\*\* Signal output is fully isolated: If using a true differential input a 10K Ohm pulldown resistor should be installed between (-) and common at the receiving end.

## WIRING DIAGRAM



## Rotation/Output Indicators

All of the microprocessor based transmitters incorporate a LED to indicate that they are detecting magnet rotation in the meter.

An alternating red/green or blue/green LED indicates that the circuit is detecting a rotating magnet and should provide an output. Additional LED's are present for setup, programming and troubleshooting and are not intended for general use.

Note: There are no selections or adjustments to be made on the circuit board. The only method of altering the setup parameters is through the serial interface program. Contact the factory regarding P/N 294-100-050, user interface software.

## Field Compensation of transmitter

When a new transmitter is attached to a flow meter, the compensation routine should be performed to optimize the performance of the system. This routine requires a steady flow rate which turns the meter at between 15 and 1000 RPM. If you are using the interface software, please consult the "software Interface" manual for instructions. For the 290 Series, the sequence is as follows:

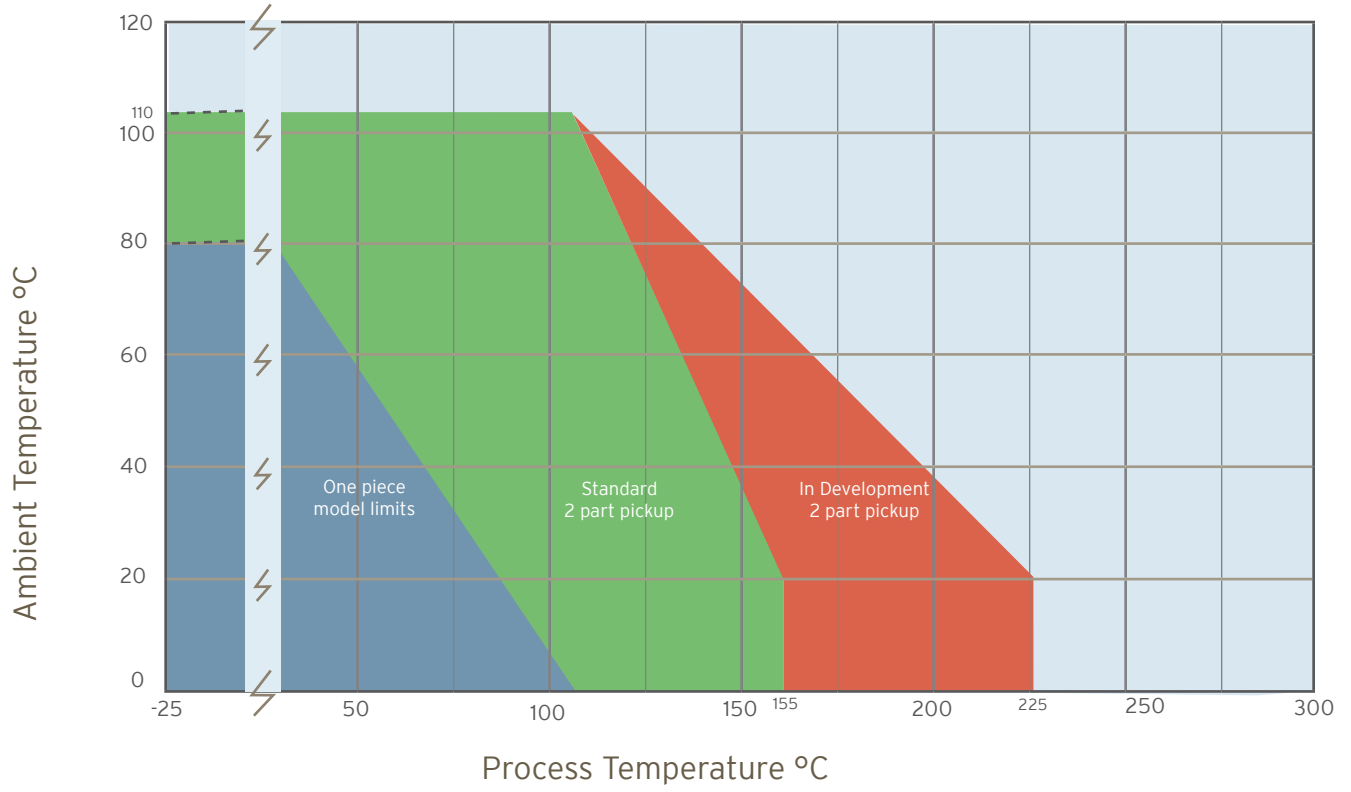
1. Stabilize the flow rate
2. Push the compensation button on the PCA
3. The blue/green LED will change to solid blue for 6 to 8 revolutions of the meter
4. A green indicator light indicates a successful update of the compensation, a red indicator light indicates that the previous compensation has been retained.

## High Temperature Operation Above 65°C (150°F)

The operating limit of the meter/transmitter is a function of both the ambient and the metered fluid temperature, as shown in the following graphs. Although the electronic components are rated to 80°C (175°F), additional heat can be conducted from the flow meter into the transmitter housing requiring a lower ambient temperature limit for high fluid temperatures.

To prolong the life of the transmitter and reduce the risk of component related failures over time, high ambient temperatures >65°C (150°F) 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. When working with elevated fluid temperatures >65°C (150°F), insulating the flow meter is recommended to reduce the risk of burns, and to reduce the heating of the electronics by convection of hot air off of the meter (especially for larger meters). The upper temperature limits shown in the curves rely on ambient convection to remove heat from the transmitter housing, cooling the electronics. For this reason, if operating near the upper temperature limit, the transmitter should not be insulated. At these elevated temperatures, the transmitter will be very hot – exercise appropriate caution.

# Temperature Limits Model 296 Transmitter Series



## INSTALLATION INSTRUCTIONS – HAZARDOUS LOCATIONS

Applies only to Max Model EX295 and EX296 Transmitters with explosion proof certification. These transmitters provide protection via a flame proof housing and through current limiting to the circuit board: Must wire with a class 2 power supply (See table for loads).

Meets US and Canadian Haz-Loc classifications, Class I, Div 1, Groups C and D, Tx  
As well as ATEX/IECEX II 2 G Ex d IIB Tx Gb  
Certification numbers Demko 11 ATEX 1013058X and IECEX UL 10.0048X

### Mechanical Installation

The outer housing freely rotates to align the conduit hole with your electrical connection point. If the transmitter is already attached to the meter skip to step 5:

1. To attach the transmitter to the flow meter, apply a small amount of low strength thread adhesive, such as Loctite™, on the threads and screw the transmitter into the threaded recess on top of the flow meter.
2. Locate the locking set screw below the conduit hole and remove it. Rotate the outer housing clockwise until the screw hole lines up with a hole in the inner housing. Inserting an Allen key into the threaded hole while rotating the housing can help in finding the point of alignment. Now re-insert the set screw and hand-tighten it to lock the inner and outer housing together.
3. Finish tightening the transmitter onto the meter by applying a torque of 2 to 5 ft.-lb. (2.7 to 6.78 N-m).
4. Now back out the locking screw until it is flush with the surface of the transmitter.
5. The housing can now be rotated to align the conduit port in the desired direction.
6. To open the housing for wiring, remove the locking screw at the edge of the lid and then remove the cap using a 3/8" socket drive.
7. Install conduit. Within 18" of the housing install a conduit stop and fully seal with potting compound.
8. Connect wires to terminal block as shown below.
9. A case ground terminal is provided internally, but if grounded metallic conduit is not used, then one of the external grounds below the conduit fitting must be used. For metric- use either a 6 or 8 mm long stainless steel M5 x 8.0 bolt. For inch measurement - use either a 1/4" or 5/16" long stainless steel #10-32 bolt.
10. Reattach cap and tighten to 40 in-lbs to seal enclosure. Install safety lock screw at the edge of the lid and hand tighten.

## Removal from Flow Meter

Note: the transmitter does not need to be removed from the flow meter for any field servicing or adjustments. Normally, the flow meter and transmitter are shipped back to the factory for calibration as a unit.

1. Remove the locking screw at the edge of the lid and then remove the cap using a 3/8" socket drive.
2. Disconnect wires at the terminal block and remove wiring conduit from transmitter.
3. Locate the locking set screw below the conduit hole and remove it. Rotate the outer housing clockwise until the screw hole lines up with a hole in the inner housing. Inserting an Allen key into the threaded hole while rotating the housing can help in finding the point of alignment. Now re-insert the set screw and hand-tighten it. This will lock the inner and outer housing together.
4. Unscrew the transmitter, using a strap wrench if necessary.

## Moisture Protection

The housing is a liquid and vapor-tight enclosure certified to IP66. There is an O-ring seal at the lid of the housing – the seal needs to be fully seated to provide moisture protection and achieve flameproof specifications.

## About Explosion proof installations

For the Model 295 and 296 to fully adhere to the HazLoc certifications, the wiring must meet the appropriate codes. (Use of a wire conduit does not make the installation explosion proof - read below.) The transmitters which are certified for use in hazardous locations require the use of a 1/2" NPT conduit fitting. The wiring conduit must be sealed with a conduit stop within 18" of the device. If you choose to use exposed cables, cable seals must be used with sealing fittings and the wiring must be an approved armored cable. (For detailed information on the joint constructions used to achieve a flame proof housing, please contact Max Machinery.)

## Electrical Installation

Use wiring that is between 20 and 28 gauge and rated to at least 5°C above the maximum ambient temperature, and rated to at least 80% of the maximum fluid temperature.

Pulse Output Wiring	Circuit Board Label	Mating Cable Wire Color**	Analog Output Wiring	Two Part Transmitter	
				End Labels	Wire Color
Case ground	Case	Blue	Case	Com	Brown
Common	Com	Black	Com	Rb	Grey
Power*	V+	Brown	V+	Ra	White
Signal Output (+)	PHA	White	RET	5V	Black
(Quad only)	PHB	Grey	SIG	Case	Blue

\* Consult Table \*\* (Color codes are typical for Max Machinery wired devices)

## Electrical Requirements

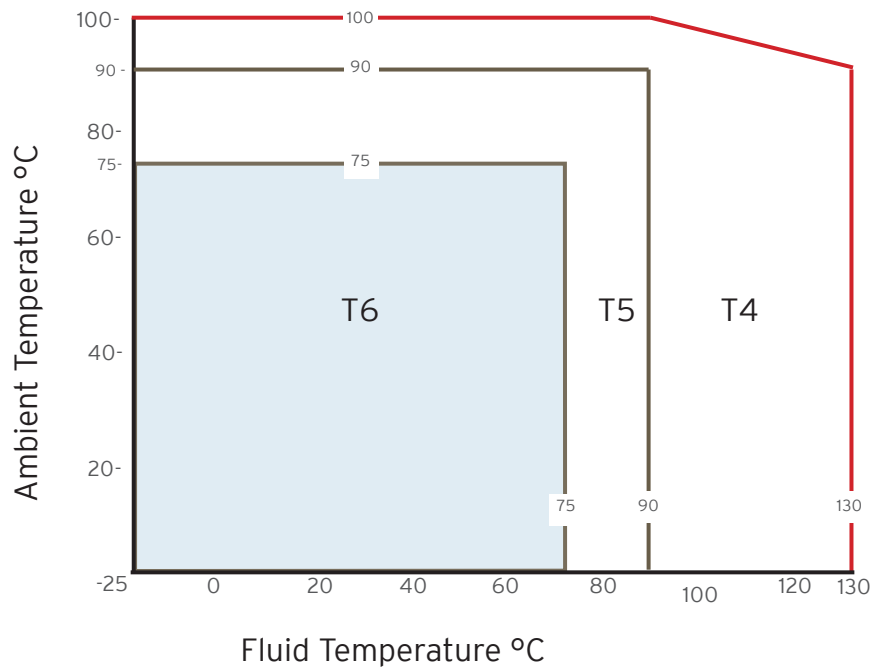
The device must be powered with a Class 2 power supply. Electrical loads are specific to model number's:

Part #'s	Transmitter Type	Electrical Input Requirements	Output Electrical Requirements
29x-0xx-0xx	Pulse Output Transmitter	5-28Vdc 40mA	Single Line 0-5V 10mA (500 ohm pulldown or greater)
29x-1xx-0xx	Quadrature Output Transmitter	5-28Vdc 50mA	2 Lines 0-5V 10mA each (500 ohm pulldown or greater)
29x-2xx-0xx	mA Output Transmitter (24Vdc)	24-28Vdc 50mA	Isolated current loop, max 500 ohms in line, 12Vdc max
29x-2xx-1xx	mA Output Transmitter (12Vdc)	12-15Vdc 100mA	Isolated current loop, max 500 ohms in line, 12Vdc max
29x-3xx-0xx	V Output Transmitter (24Vdc)	24-28Vdc 50mA	Isolated voltage loop, min 1000 ohms across line, 12Vdc max
29x-3xx-1xx	V Output Transmitter (12Vdc)	12-15Vdc 100mA	Isolated voltage loop, min 1000 ohms across line, 12Vdc max
29x-6xx-0xx	Level Shifter Pulse Output Transmitter	5-28Vdc 30mA	Single line, current sinking, max 28Vdc, max 25mA

## Temperature Classification

Temperature class is a function of fluid temperature used in the meter and ambient temperature. For hot fluids, meter must be insulated and transmitter must be left exposed. All transmitters are rated to operate within the BLUE region, but only the remote sender unit variants (295-x5x-xxx) can operate up to the maximum temperatures shown in the chart. Consult factory for installation details when operating near temperature limits.

Temperature class chart for all explosion proof variants:



Note: Consult factory to determine the functional temperature limit of your transmitter variant. Temperature class ratings do not correspond with the continuous duty area for the electronics within the transmitter. A complete description of your transmitter may be found on the Max Machinery web site ([www.maxmachinery.com](http://www.maxmachinery.com)). Individual specification sheets and product family manuals are also available for viewing or downloading.

# EC Declaration of Conformity

We, Max Machinery Inc. declare as manufacturer under our sole responsibility that the product series 295/296 Explosion Proof Flow Transmitter is in conformity with the provisions of the European Community Directives as shown below.

Applicable Series: Part numbers of the format 295-xx1-x00 and 296-xx1-x00 where 'x' does not affect conformity to the standards.

Low Voltage Directive 2006/95/EC

EMC Directive 2004/108/EC

EN 61000-6-2:2005 Electromagnetic Immunity

EN 61000-6-4:2007 Electromagnetic Emission

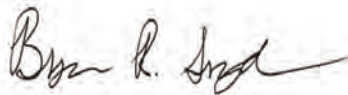
ATEX Directive 94/9/EC designed and manufactured in accordance with Annex II of the ATEX Directive EN 60079-0:2009 Explosive atmospheres general requirements  
(Note: no routine verification and tests are required by clause 27)  
EN 60079-1:2007 Protection by flameproof enclosures type d"

Designation:  539  II 2 G Ex d IIB Tx Gb

EC Type examination certificate DEMKO 11 ATEX 1013058X provided by  
UL International DEMKO A/S NB Number: 0539  
P.O. Box 514, Lyskaer 8, DK-2730 Herlev, Denmark

Product quality assurance notification #11 ATEX Q1116140 provided by UL Demko

Production control done to ISO 9001:2008, certificate #C2010-01864



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