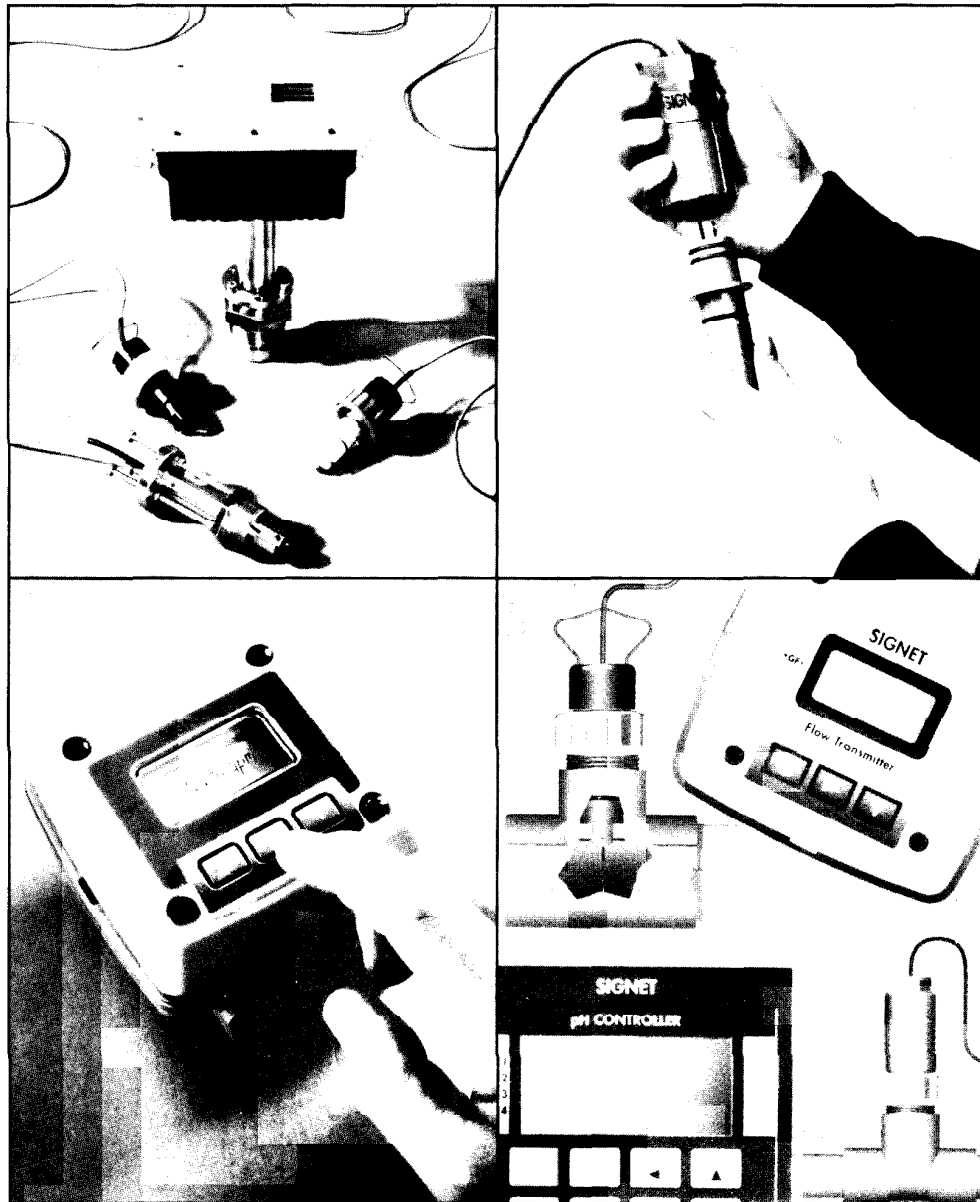


SIGNET Engineering Handbook



A Technical Guide for:

- Application Assistance
- Installation Guidelines
- Recommended Scale Ranges
- Conversion Data
- Chemical Resistance



GEORGE FISCHER +GF+

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Application Assistance Form

SIGNET Flow Application Assistance Form

DIST NAME: _____ CONTACT: _____ DATE: _____

CUST. NAME: _____ TITLE: _____

COMPANY: _____

ADDRESS: _____

CITY: _____ STATE: _____ ZIP: _____

TELEPHONE: () - _____ EXT: _____ FAX: () - _____

NAME OF PROJECT: _____

PRIORITY: IMMEDIATE: _____ FUTURE: _____ ROUTINE: _____

DESCRIPTION OF APPLICATION:(including piping description 50 diameters upstream & 5 diameters downstream of sensor): _____

PIPING MATERIAL: _____ SIZE: _____ SCHEDULE: _____

FLUID TEMP.: MIN: _____ MAX: _____ NOMINAL: _____

LINE PRESS.: MIN: _____ MAX: _____ NOMINAL: _____

FLUID TO BE MEASURED: _____ CONCENTRATION: _____ %

FLUID VISCOSITY: _____ SPECIFIC GRAVITY: _____

PERCENT SOLIDS: _____ SIZE OF SOLIDS: _____

DESCRIPTION OF SOLIDS: _____

FLOW RATE: MIN: _____ MAX: _____ NOMINAL: _____

REQUIRED ACCURACY: _____ UNIT OF MEASUREMENT: _____

DISTANCE FROM SENSOR TO INSTRUMENT: _____

AVAILABLE PWR: 110VAC: _____ 220VAC: _____ 24VDC: _____ NONE: _____

SPECIFIC FLOW INSTRUMENTATION NEEDS: (Check appropriate spaces)

FLOW RATE: _____ ANALOG: _____ DIGITAL: _____

ACCUMULATOR: _____ ONE ALARM: _____ TWO ALARM: _____

BATCH CONTROL: _____ PULSE OUT: _____ PUMP PULSER: _____

ISO 4-20mA: _____ NON-ISO 4-20mA: _____ 0-5VDC: _____

OTHER : _____

Application Assistance Form

SIGNET Analytical Application Assistance Form

DIST. NAME: _____ **CONTACT:** _____ **DATE:** _____

CUST. NAME: _____ **TITLE:** _____

COMPANY: _____

ADDRESS: _____

CITY: _____ **STATE:** _____ **ZIP:** _____

TELEPHONE: () - _____ **EXT:** _____ **FAX:** () - _____

NAME OF PROJECT: _____

PRIORITY: IMMEDIATE: _____ **FUTURE:** _____ **ROUTINE:** _____

DESCRIPTION OF APPLICATION:(sketch if possible): _____

SYSTEM RANGE: MIN: _____ **MAX:** _____ **NOMINAL:** _____

SENSOR MOUNTING REQUIREMENT: _____

SUBMERSION: _____ **INSERTION:** _____

TANK SIZE: _____ **LINE SIZE:** _____ **MATERIAL:** _____

RETENTION TIME OR GPM INFLUENT FLOW RATE: _____

MIN: _____ **MAX:** _____ **NOM:** _____

MIXING: YES: _____ **NO:** _____

FLUID TEMP.: MIN: _____ **MAX:** _____ **NOMINAL:** _____

LINE PRESS.: MIN: _____ **MAX:** _____ **NOMINAL:** _____

FLUID TO BE MEASURED: _____ **CONCENTRATION:** _____ %

REQUIRED ACCURACY: _____ **UNIT OF MEASUREMENT:** _____

DISTANCE FROM SENSOR TO INSTRUMENT: _____

ANY PRESENCE OF THE FOLLOWING IN SOLUTION: SOLIDS: _____

AIR BUBBLES: _____ **HYDROFLUORIC ACID:** _____ **SULFIDES:** _____

COATING SUBSTANCES: _____ **OTHER FLUORIDES:** _____

AVAILABLE PWR: 110VAC: _____ **220VAC:** _____ **24VDC:** _____ **NONE:** _____

SPECIFIC INSTRUMENTATION NEEDS: (Check appropriate spaces) _____

MONITOR: _____ **TRANSMITTER:** _____ **ONE ALARM:** _____

TWO ALARM: _____ **ISO 4-20mA:** _____ **NON-ISO:** _____

4-20mA: _____ **0-5/0-10VDC:** _____ **FOUR ALARM:** _____

PROPORTIONAL CONTROL (PULSE): _____

OTHER: _____

Quick Reference Indicator Feature Matrix

Flow Indicator Feature Matrix

● Standard Features

◐ Optional Features

		509	514	575	576	578	579	584	585-1	585-2	586	8510	8511	9010	9020	9520
Frequency Input	0 to 500 Hz	●	●	●	●	●	●	●	●	●	●	●				
	0 to 10000 Hz												●	●	●	●
Analog Input	0 to 20 mA													◐		
	4 to 20 mA													◐		
	0 to 5 VDC													◐		
	0 to 10 VDC													◐		
Power Input	110/220 VAC								●	●				●	●	
	12 VDC nominal		●	●		●	●	●								
	24 VDC nominal											●	●	●	●	●
	Battery				●						●					
None	●						●									
Flow Rate, Display	Analog	●	●	●					●	●						
	Digital					●		●			●	●	●	●	●	●
Pulse Output			●	●			●		●	●	●	●	●	●	●	●
Totalizer	1		●	●		●						●	●	●	●	
	2											●	●			
Counter Output			●	●		●	●							●	◐	●
Batch Relay																
Pump Pulsar														◐		◐
Alarm Relay	1								●	●				◐	●	
	2													◐		
Alarm Annunciators									●	●				●	●	
Security Code																
Analog Output	1		●						●			●	●			
	2									●				◐		
Non-Iso Analog Output	0 to 20 mA													◐		◐
	4 to 20 mA		●						●	●				◐		◐
	0 to 5 VDC		◐						◐	◐				◐		◐
	0 to 10 VDC													◐		◐
Iso Analog Output	0 to 20 mA											●	●	◐		
	4 to 20 mA									●		●		◐		
	0 to 5 VDC													◐		
	0 to 10 VDC													◐		

The data provided in this matrix is for product comparison. For specific details please refer to the appropriate page of this SIGNET flow catalog and SIGNET specification sheets.

Quick Reference Indicator Feature Matrix

pH/ORP Indicator Feature Matrix

● Standard Features

◐ Optional Features

Bold indicates current product

		9030	9040	9750	9750	9759	9769	8700	8701	8710
mV Input	0 to 14 pH	●		●		▲		●		●
	+/- 1000 mV's		●		●		●		●	●
Analog Input	0 to 20 mA	◐	◐							
	4 to 20 mA	◐	◐							
	0 to 5 VDC	◐	◐							
	0 to 10 VDC	◐	◐							
Power Input	110/220 VAC	●	●	●	●	●	●			
	24 VDC nominal	●	●					●	●	●
mV Display	None					●		●		
	Analog						●			
	Digital	●	●	●	●				●	●
pH Display	None		●		●		●		●	
	Analog					●				
	Digital	●		●				●		●
Temp Display	None		●		●	●	●	●	●	
	Analog									
	Digital	●		●						●
*Alarm Relays		◐	◐	●	●	●	●			
Pump Pulsers		◐	◐	◐	◐					
Alarm Annunciators		●	●	●	●	●	●			
Security Code		◐	◐	◐	◐					●
Analog Output	1			●	●			●	●	●
	2	◐	◐			●	●			
Non-Iso Analog Outputs	0 to 20 mA	◐	◐	●	●					
	4 to 20 mA	◐	◐	●	●	●	●			
	0 to 5 VDC	◐	◐	●	●	●	●			
	0 to 10 VDC	◐	◐							
Iso Analog Outputs	0 to 20 mA	◐	◐					●	●	●
	4 to 20 mA	◐	◐	◐	◐					
	0 to 5 VDC	◐	◐							
	0 to 10 VDC	◐	◐							

* Standard relay amount is 2.

9030/9040 have optional 2 or 4 relay output

▲ The 9759 has optional dial ranges of:
2 - 12 pH
4 - 10 pH

Quick Reference Indicator Feature Matrix

Conductivity Indicator Feature Matrix

● Standard Features

◐ Optional Features

★ Specify (See Ranges)

Bold indicates current product

		9850	811	812	821	822	9859	8800	9050
Cell Constant	0.05	★	◐	◐	●	●	★	●	●
	0.1						★	●	●
	1.0						★	●	●
	2.0	★	●	●			★	●	●
	10.0	★					★	●	●
	20.0						★	●	●
Power Input	110/220 VAC	●	●	●	●	●	●	●	●
	24 VDC nominal							●	●
μS/mS Display	None				●	●			
	Analog						●		
	Digital	●	●	●				◐	●
KΩ/MΩ Display	None	●	●	●			●	●	●
	Digital				●	●			
Temp Display	None						●	●	
	Digital	●	●	●	●	●			●
Temperature Compensation		A	F	A	F	F	F	F	A
* Alarm Relays		●	●	●	●	●	●	●	◐
Alarm Annunciators		●	●	●	●	●	●	●	●
Security Code		●							●
Non-Iso Analog Outputs	4 to 20 mA	●	●	●	●	●	●	●	◐
	0 to 5 VDC	◐					●		◐
Iso Output	4 to 20 mA	◐	◐	◐	◐	◐	●	◐	●

A = Adjustable
F = Fixed

*Standard alarm relay amount is 2.
9050 has optional 2 or 4 relay output.

Instrument Ranges

9050

0.1 cell 1 - 1,000 μs
1.0 cell 10 - 10,000 μs
10.0 cell 100 - 100,000 μs
20.0 cell 200 - 200,000 μs

9859

0.1 cell 1 - 5,000 μs
1.0 cell 50 - 50,000 μs
10.0 cell 500 - 500,000 μs
20.0 cell 1000 - 1,000,000 μs

8800

0 - 20 mS/cm (-1)
0 - 200 mS/cm (-2)
0 - 2,000 mS/cm (-3)
0 - 10,000 mS/cm (-4)

Quick Reference Compatibility Matrix

Flow Sensor/Indicator Compatibility Matrix

● Compatible

◆ Compatible - system cannot exceed 0.8 gpm (3000 ml/min)

■ Compatible - system can utilize sensor pulse or 4 to 20 mA output

▲ Compatible - system can utilize "K" factors up to 19999, cannot be calibrated in gpm units

○ Contact factory for low flow ranges

	515 8510-XX	525	508 2535 2540 8510-XX	2502	2507	2550
509	●					
514	●	●	●	◆	●	●
575	●	●	●	◆	●	●
576	●	○				
578	●	●	●	◆	●	●
579	●	●	●	◆	●	●
584	●	●	●	◆	●	●
585	●	●			●	
586	●	○				
8510	●	●				
8511	●	●	●	●	●	
9010	●	●	●	▲	●	■
9020	●	●	●	▲	●	●
9520	●	●	●	●	●	●

Quick Reference Compatibility Matrix

Analytical Sensor/Indicator Compatibility Matrix

Digital

	3-2710.103-12	3-2710.103-32	3-2712.103	2711.103	3-2720
9030	●	●	●		●
9040				●	●
9750	●	●	●		*
9760				●	*

Analog

	2710.104-12	2710.104-32	2712.391-3	2711.103	3-2720
9759.100	●	●			
9769.100			●	●	
9759.101					●
9769.101					●

* Requires installation of 3-2710.420 pre-amp board

Bold indicates current product

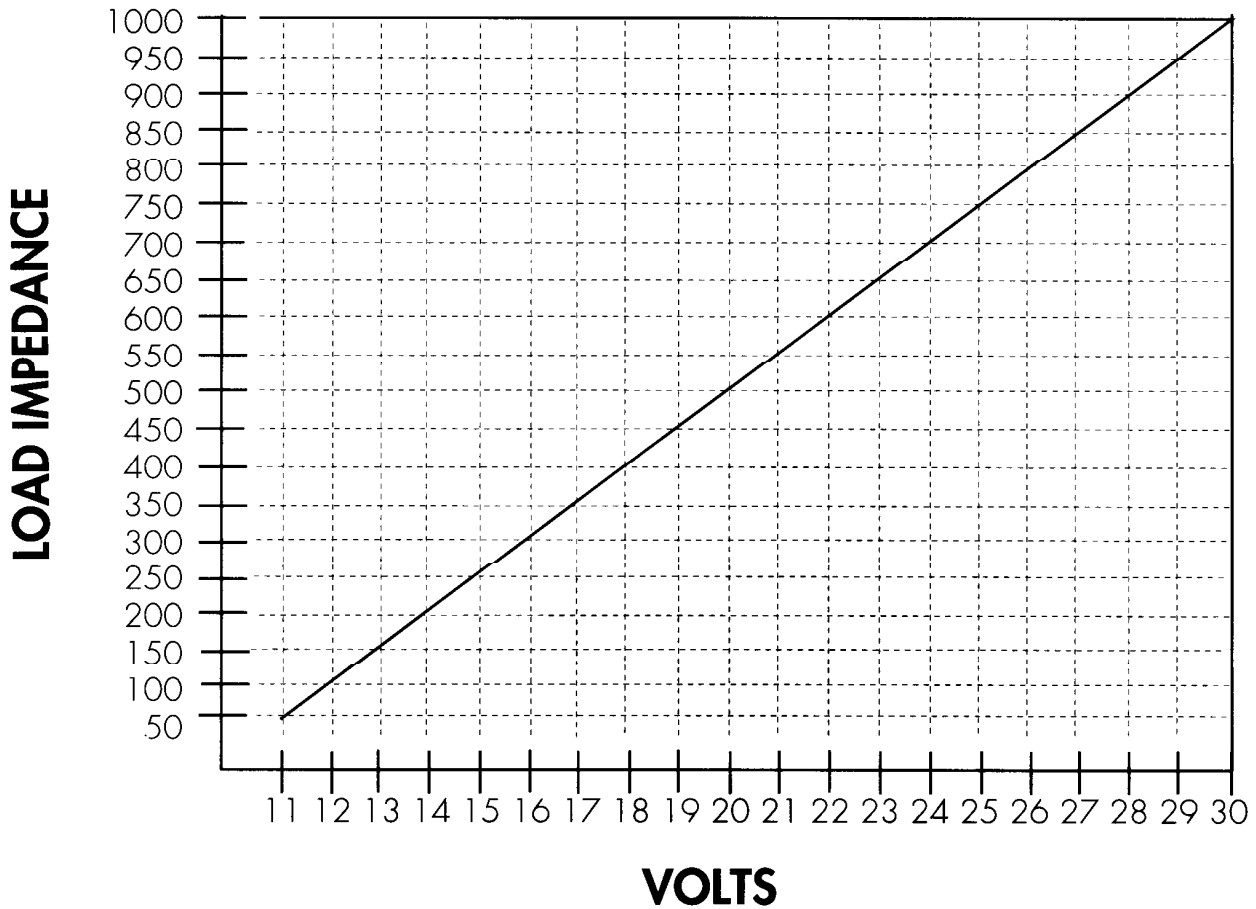
	2800.103-X1	2801.103-X1	2800.103-X3	2801.103-X3	2800.103-X4	2801.103-X4	P84533-5	P84533-3	P84533-4	2820-1	2820-2	2821-1	2821-2	2822-1	2822-2	2823-1	2823-2	3-8800.300-P	3-8801.300-P
9850					●	●			●										
811	●	●					●												
812	●	●					●												
821		●					●												
822		●					●												
9050										●		●		●		●			
9859			●	●				●			●		●		●		●		
8800-1,2																			●
8800-3,4																		●	

Bold indicates current product

"X" Denotes Sensor Type -1 = In Line -2 = Submersible

Transmitter Load Capability

Transmitter Power Versus Load



Signet transmitters can operate on voltages as low as 10 volts dc. However, this does not take into account the amount of electrical load that the transmitter can handle. "Load" refers to the total resistance of the circuit the 4 - 20 milliamp output is connected to. Things to consider that would add to the amount of load would include computers, read outs, recorders, cables, etc. Knowing the amount of electrical load can help you to size the proper power supply for your application. Looking at the chart above, if you had a system with 700 ohms of impedance (resistance) you would require a power supply of at least 24 volts dc. You can also calculate the amount of load your system can handle by using the following formula:

$$\frac{\text{Voltage Supply} - 10}{0.02} = \text{Impedance in ohms}$$

Flow Indicator Scale Ranges

Recommended Scale Ranges

(In gallons per minute)

Recommended full scale calibration ranges for individual pipe size installations are shown in the chart below. Average flow rate should be approximately 50% of the scale.

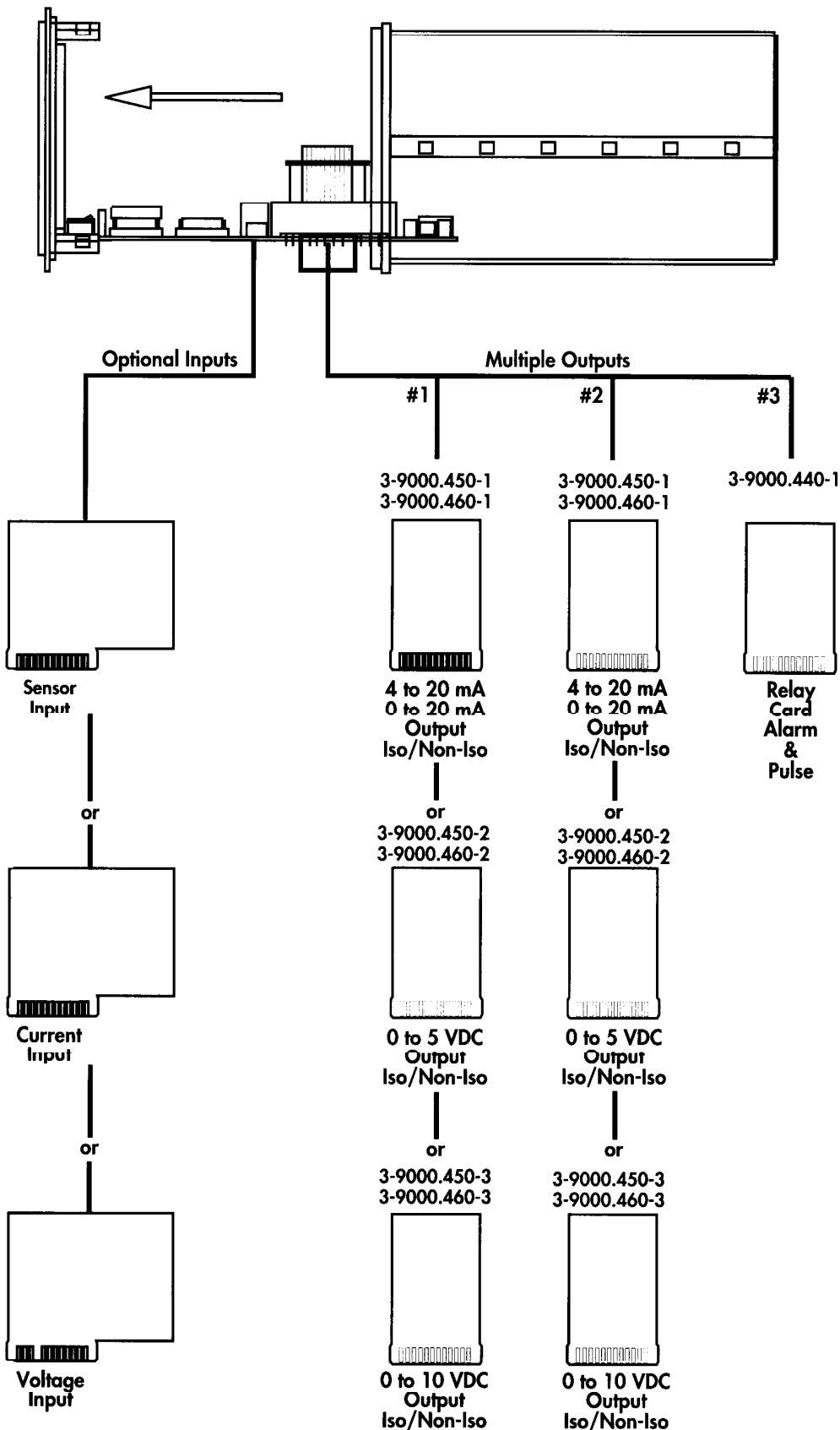
Although systems are normally calibrated in gallons per minute (GPM), virtually any volumetric unit is available for use in a specific system calibration.

For use with SIGNET analog indicators and the SIGNET 515, 525, 2535.

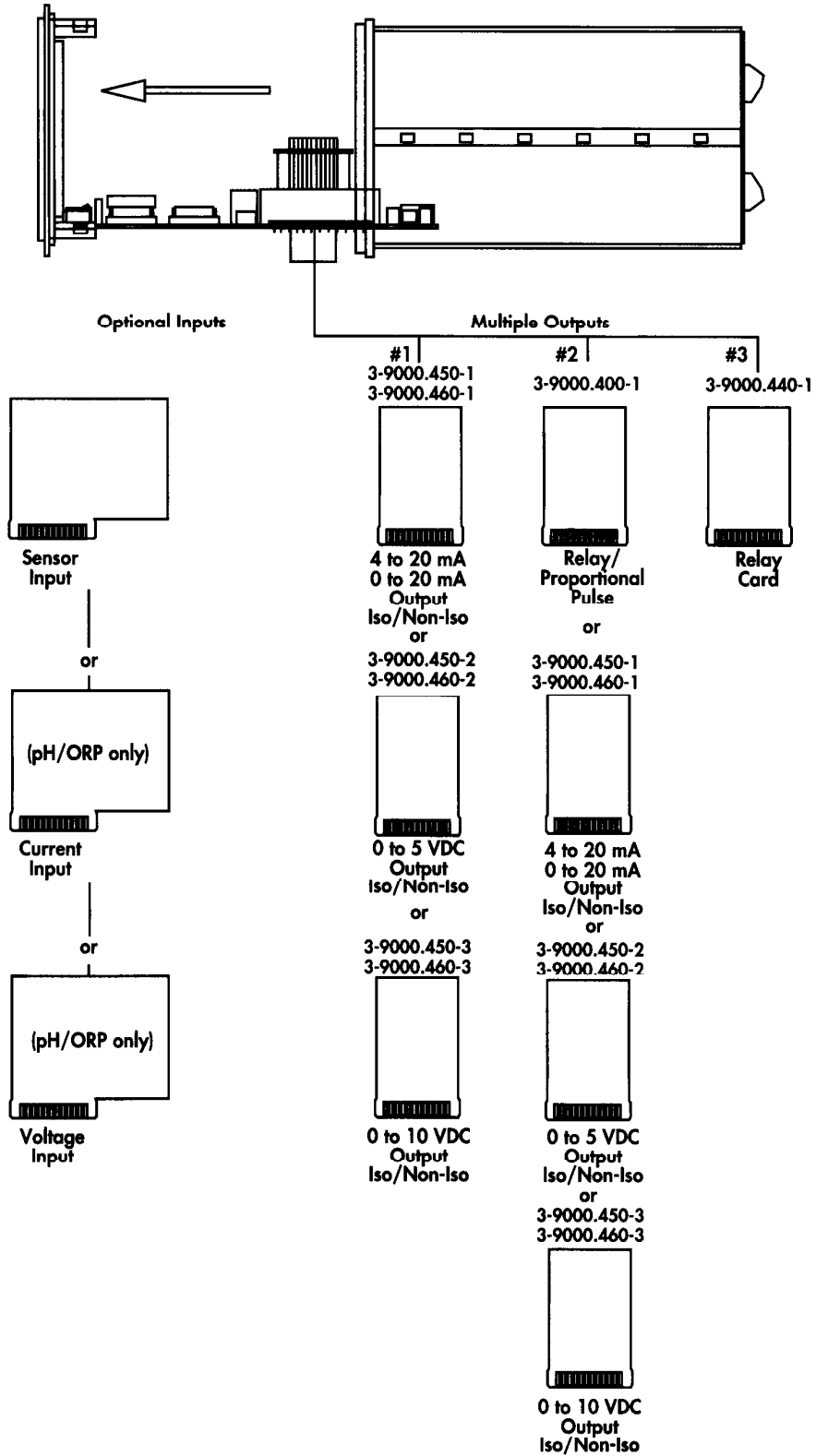
*Min not available on 509 indicator.

<u>Pipe Size (in.)</u>	<u>Std.</u>	<u>Opt.</u>	<u>*Min.</u>	<u>Total</u>
0.50	0-18	0-12	0-8	X 1
0.75	0-30	0-18	0-12	X 1
1	0-50	0-30	0-18	X 1
1.25	0-80	0-50	0-30	X 10
1.50	0-120	0-80	0-50	X 10
2	0-180	0-120	0-80	X 10
2.50	0-300	0-180	0-120	X 10
3	0-500	0-300	0-180	X 10
4	0-800	0-500	0-300	X 100
5	0-1200	0-800	0-500	X 100
6	0-1800	0-1200	0-800	X 100
8	0-3000	0-1800	0-1200	X 100
10	0-5000	0-3000	0-1800	X 100
12	0-8000	0-5000	0-3000	X 1000
14	0-12000	0-8000	0-5000	X 1000
16	0-12000	0-8000	0-5000	X 1000
18	0-18000	0-12000	0-8000	X 10000

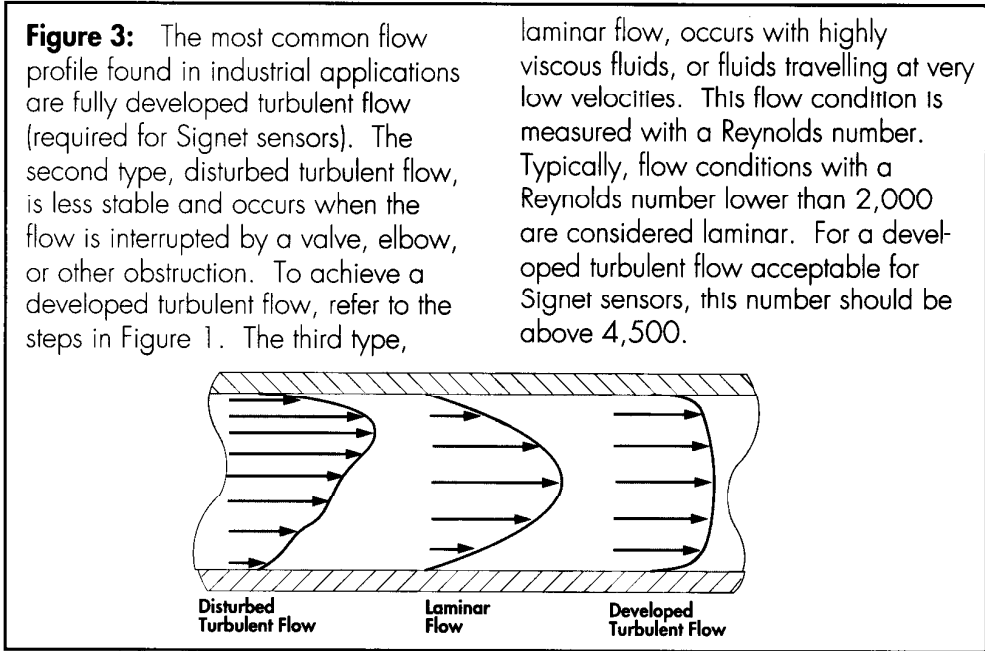
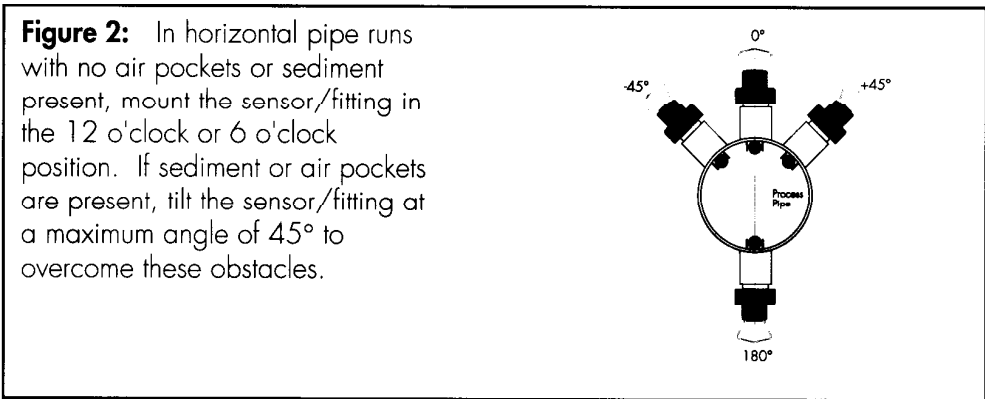
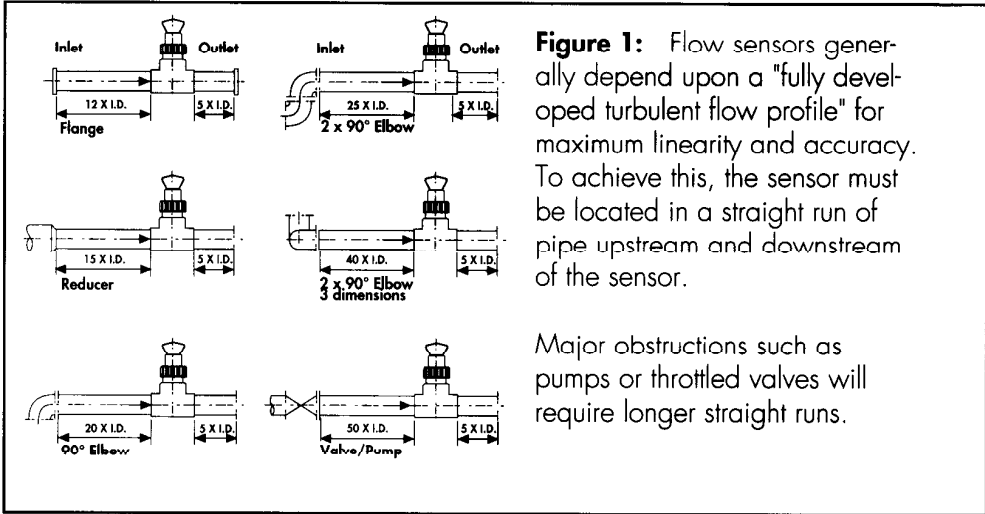
SIGNET Intelek-Pro™ Modular Flow Controller



SIGNET Intelek-Pro™ Modular pH, ORP, and Conductivity Controllers



Flow Sensor Installation Guidelines



pH Sensor Installation Guidelines

Submersible Applications:

For optimum control in a well mixed tank, the sensor should be placed near the outlet of the tank (see Figure 1). The waste and reagent inlet should enter on the opposite side. If the tank is agitated violently, protect the sensor using a half pipe baffle.

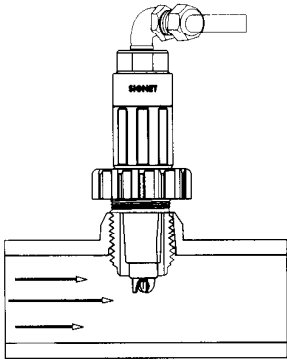


Figure 2:

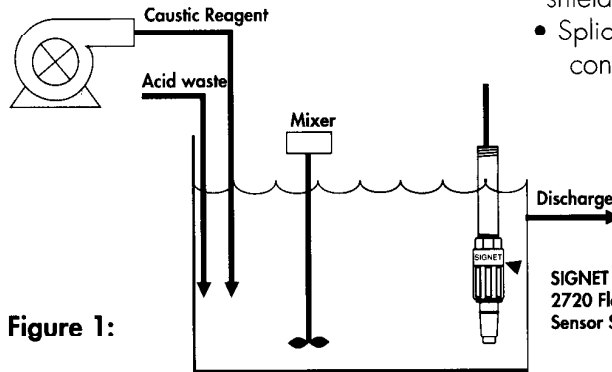


Figure 1:

Concerns:

- The sensor must remain in solution. Ensure that the tank will not be drained and left empty on a regular basis or for any extended period of time.
- Mixing is best done using a standard impeller mixer. Mixing via pump recirculation or air sparging has proven ineffective in many applications.

In-line Applications: For proper sampling and increased life for in-line installations, the flow rate past the electrode should be less than 4 ft/s for bulb and 5 ft/s for flat surface configurations (see Figure 2).

In order to maintain proper flow of electrolyte through the reference junction, and to prevent air from affecting the measuring element, pH electrodes should be mounted vertically $\pm 30^\circ$ (see Figure 3). Keep the electrode wet at all times. If necessary, pipe a low spot in the pipe for the sensor.

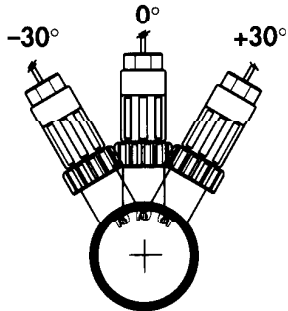


Figure 3:

Note: in-line installation is for monitoring purposes only. pH control should be done in a tank.

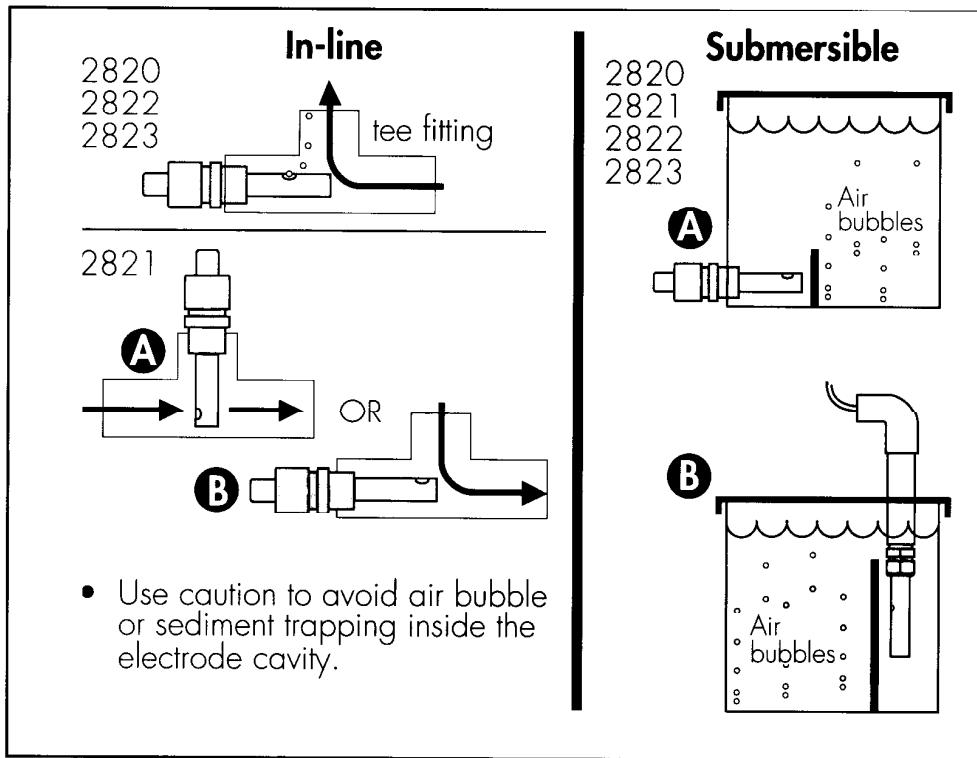
Proper pH Wiring Techniques

- Always use proper cable. SIGNET's 2720 preamplifiers have 15 feet of Belden #9355: 5 conductor with shield. Maximum length is 400 feet.
- Splices are best done with soldered connections, even if a terminal block is used. Connections without a terminal block should be shrink wrapped.
 - Care must be taken to maintain isolation. On SIGNET systems, the shield wire (isolated ground) must at no time come in contact with an earth ground, including conduit and junction boxes.
- All pH sensor cables should be run in individual conduit from the preamplifier to the controller. No other cables for 110 VAC power or other instrumentation should share the conduit.
- Keep all pH components (sensor, cable, controller) away from high voltage transformers and other components with high EMF's.

SIGNET's unique connection technology makes it easy to maintain a clean, dry contact between the probe and preamplifier. Contact surfaces should be protected from excessive exposure to dirt or spray during installation and maintenance. SIGNET pre-amplification allows for pH signal transmission up to 400 ft. Keep electrode clean and well maintained for a longer life.

Sensors can be installed in any SIGNET fitting up to and including 4" in diameter. For installations over 4", the P31515-OV200 pipe adapter may be used. Contact the factory for additional information.

Conductivity Sensor Installation Guidelines



In-line Sensor Installations

SIGNET 2820 Series Conductivity Sensors are easily mounted using standard female pipe fittings available at local hardware stores.

For optimum system performance, several mounting techniques must be observed. In-line applications require special considerations unlike most submersible types. Factors such as air bubbles, "dead zones", excessive flow rates, and sediment build-up are problems associated with pipeline installations.

Air bubbles around the sensor electrodes can cause the sensor to read lower conductivity values than actual. Pockets or "dead zones" may produce inaccurate reading since they isolate the sensor from the main process stream.

Oils or sediments in the system can coat or clog the sensor electrodes,

causing poor response or no response at all.

Mount the sensor in a location where the flow rate is moderate. Ideally, the sensor should be mounted where flow is directed into the sensor cavity (e.g. elbow, tee).

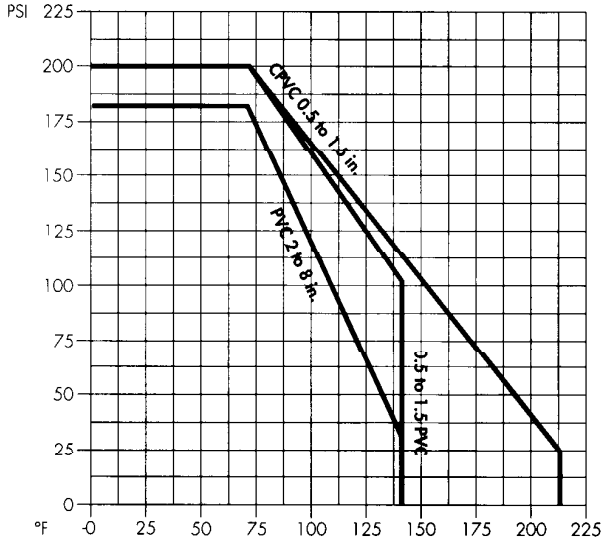
Refer to the following illustration for recommended mounting techniques.

- Refer to your conductivity sensor instruction manual for specific sensor assembly and mounting instructions.
- For other installations, contact your local SIGNET distributor for more information.
- After the sensor is first installed and the pipe is filled with fluid, firmly tap the sensor fitting several times to release any air bubbles trapped within the sensor cavity.

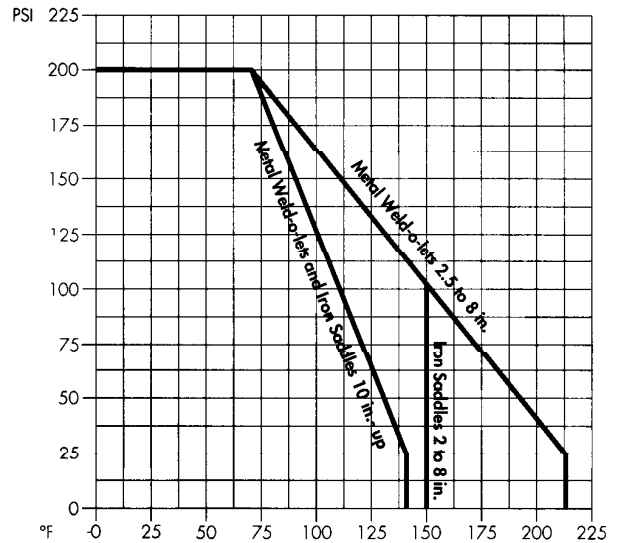
Pressure/Temperature Charts

Fitting Pressure/Temperature Charts

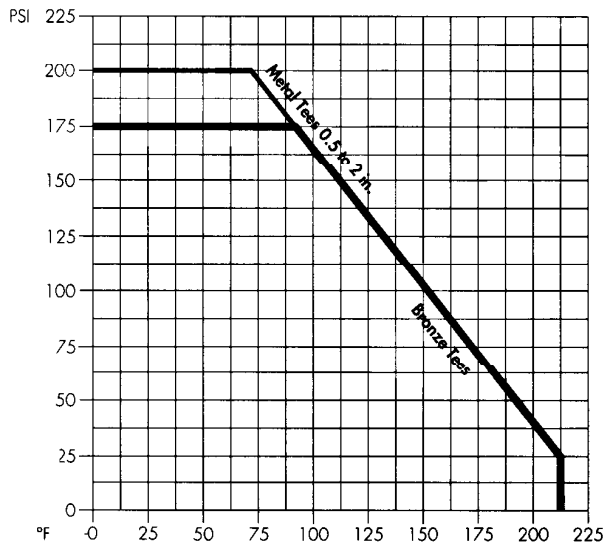
PVC CPVC Tees and Saddles



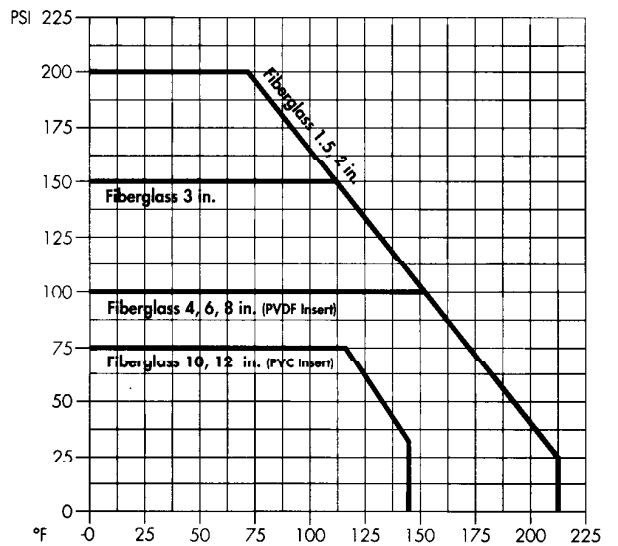
Metal Weld-o-lets and Saddle Fittings



Metal Tees



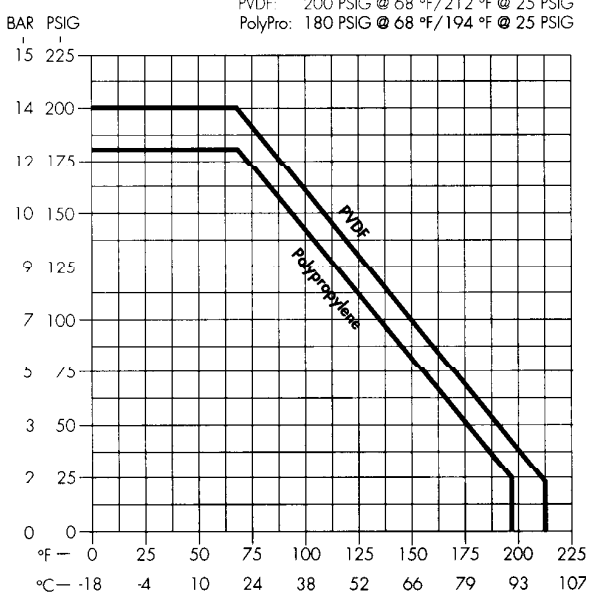
Fiberglass Tees and Saddles



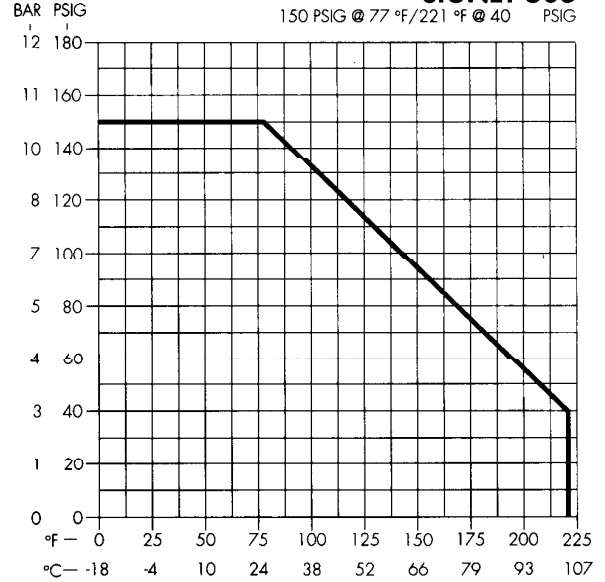
Pressure/Temperature Charts

Sensor Pressure/Temperature Charts

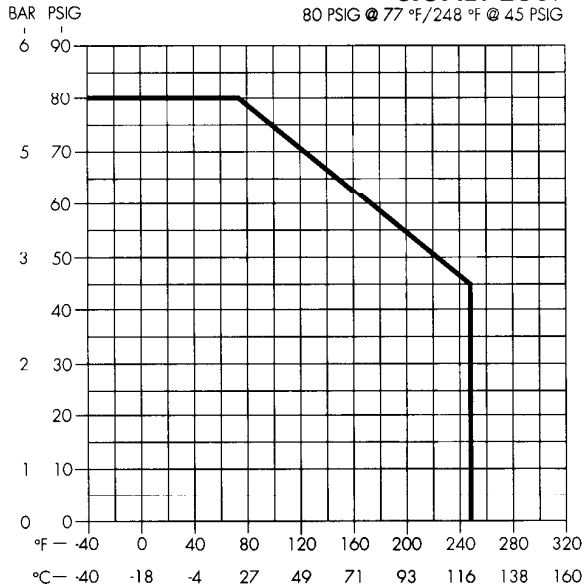
SIGNET 515, 2535, 8510-XX, 8511-XX



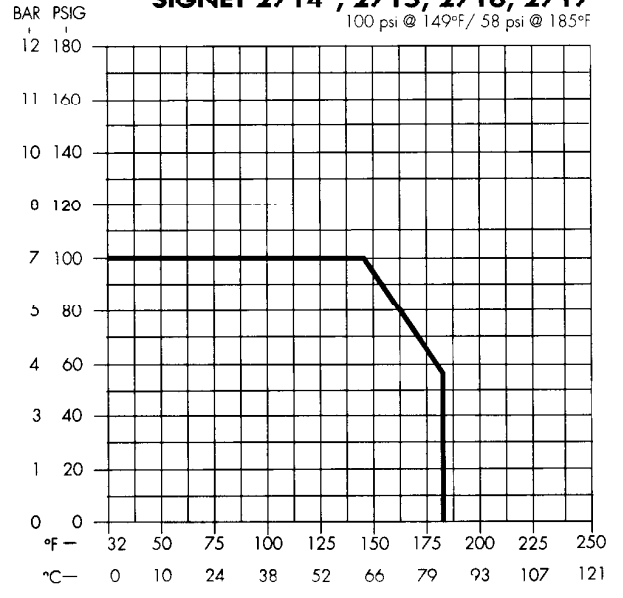
SIGNET 508



SIGNET 2507



SIGNET 2714*, 2715, 2716, 2717



*2714 minimum temperature is 50° F

Note: The above pressure/temperature curves are specifically for the SIGNET sensor. During system design specifications of all components must be considered. In the case of a metal piping system, a plastic sensor will reduce system specification. When using a PVDF sensor in a PVC piping system, the fitting will reduce the system specification.

SIGNET Cable Specifications

SIGNET Cables & Belden Equivalents

Sensor	SIGNET P/N	Belden P/N	Std. Length	Max. Length
515, 2517, 525, 1500	5523-0222 2 cond w/shld 22 AWG	8451	25'	200'
2535 2540	5523-0222 2 cond w/shld	8451 22 AWG	25'	1000'
2507	5523-0222	8451 2 cond w/shld	25' 22 AWG	500'
2530	5523-0222	8451 2 cond w/shld	00' 22 AWG	500'
2502	5523-0222	8451 2 cond w/shld	5' 22 AWG	200'
508	5523-0422	8723 4 cond w/shld	25' 22 AWG	200'
2720	5523-0524	9535 5 cond w/shld	15' 24 AWG	400'
3-2710.10x 3-2712.391	5523-0524 5 cond w/shld	9535 24 AWG	25'	400'
712	P81594 4 cond w/shld	9155 20 AWG	25'	1000'
282x-1	5523-0322	9770 3 cond w/shld	15' 22 AWG	100'
282x-2	5523-1422	8724 4 cond w/shld	15' 22 AWG	100'
2800 2801	5523-0422	8723 4 cond w/shld	25' 22 AWG	100'

Std. lengths refer to the amount of cable supplied by SIGNET. Any splices should be soldered and well insulated from each other & the environment (Be sure to maintain shielding through the splice). Cable splicing should be limited to one splice per sensor.

SIGNET O-Ring Specifications

SIGNET Sensor "O"-Rings

Sensor	Qty.	Material	SIGNET P/N	Mfg#
515	2	*Viton	1220 - 0021	ARP-568-021 Parker
2535	2	*Viton	1220 - 0021	ARP-568-021 Parker
8510-XX	2	*Viton	1220 - 0021	ARP-568-021 Parker
8511-XX	2	*Viton	1220 - 0021	ARP-568-021 Parker
2530	2	*Viton	1220 - 0021	ARP-568-021 Parker
2800	2	*Viton	1220 - 0021	ARP-568-021 Parker
2801	2	*Viton	1220 - 0021	ARP-568-021 Parker
4500	2	*Viton	1220 - 0021	ARP-568-021 Parker
8300	2	*Viton	1220 - 0021	ARP-568-021 Parker
8400	2	*Viton	1220 - 0021	ARP-568-021 Parker
8800	2	*Viton	1220 - 0021	ARP-568-021 Parker
2714	3	*Viton	1220 - 0021	ARP-568-021 Parker
2715	3	*Viton	1220 - 0021	ARP-568-021 Parker
2716	3	*Viton	1220 - 0021	ARP-568-021 Parker
2717	3	*Viton	1220 - 0021	ARP-568-021 Parker
2540-1	1	*Viton	1220 - 0021	ARP-568-021 Parker
2540-3	2	*Viton	1220 - 0021	ARP-568-021 Parker
3-1500	1	**Fluoromyte/Viton	3-1500.391-1	See ** below
3-2507	1	Viton	3-2507.080-3	Q4122-514AD All Seals
2517	2	Viton	1220 - 0020	ARP -568-020 Parker
2550	1	Viton	1220 - 0131	ARP -568-131 Parker

*Optional materials

1224 - 0021	EPR	ARP - 568-024 Parker
1228 - 0021	Kal Rez	Kal Rez 005 Dupont

** Optional materials

3-1500.391-2	Nitroxile/Nitrile	Paker#12501250
3-1500.391-3	Viton/Viton	Must call and specify
3-1500.391-4	EPR/EPR	material. Nuber is for
		seal size only.

Velocity Chart

Min/Max GPM Values for SIGNET Insertion Flow Sensors

The values provided in the chart below are for product comparison in schedule 40 metal pipe.

The minimum/maximum gpm values will differ depending on pipe size, schedule and pipe material.

Pipe Size (in.)	2535 3-8511-XX	2550	2540	515 3-8510-XX	525
Min FPS	.3	.3	.3	1	1.6
Max FPS	20	20	20	20	20
0.5	.3 19	- -	- -	1 19	1.6 19
0.75	.5 34	- -	- -	1.7 34	2.7 34
1	.8 54	- -	- -	2.7 54	4.7 54
1.25	1.4 94	- -	- -	4.7 94	7.4 94
1.5	1.9 127	- -	1.9 127	6.4 127	10.1 127
2	3.2 210	3.2 210	3.2 210	10.6 210	16.8 210
2.5	4.5 300	4.5 300	4.5 300	15 300	24 300
3	7 461	7 461	7 461	24 461	37 461
4	12 794	12 794	12 794	40 794	63 794
5	19 1247	19 1247	19 1247	63 1247	100 1247
6	27 1801	27 1801	27 1801	91 1801	144 1801
8	47 3119	47 3119	47 3119	156 3119	250 3119
10	74 4915	74 4915	74 4915	246 4915	393 4915
12	105 6977	105 6977	105 6977	349 6977	559 6977
14	127 8432	127 8432	127 8432	422 8432	- -
16	166 11015	166 11015	166 11015	551 11015	- -
18	210 13942	210 13942	210 13942	698 13942	- -

Glass pH Electrode mV Values

	← Acidic							Basic →							
pH	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
mV @ 25C	+414	+355	+296	+237	+177	+118	+59	00	-59	-118	-177	-237	-296	-355	-414

Sulfuric Acid: 0.3

Limes: 2.8 - 3.8

Wines: 3.0

Oranges: 3.0-4.0

Beer: 4.0 - 5.0

Blood (Human): 7.3-7.5

Eggwhites: 7.6-7.5

Sodium Bicarbonate: 8.4

Ammonia: 11.6

Sodium Hydroxide: 14.0

pH Electrode Failure

- **Dry reference junction**

Symptom: Probe is sluggish between buffers. Reads 4.3 in 4.0 buffer, and 9.7 in 10.0 buffer.

Action: Clean electrode. Soak in 2M KCl solution heated to 120 –150°F. Remove and quench in cool water.

- **Cracked electrode**

Symptom: mV value fixed between 60-75 mV. (5.8 to 6.0 pH).

Action: Replace electrode.

- **Depleted reference**

Symptom: mV value in 7.0 buffer greater than ± 50 mV.

Action: Replace electrode.

- **Dirty glass and/or plugged reference junction**

Symptom: poor response from buffer to buffer, or output is unstable.

Action: Clean electrode, replace if necessary.

Flow/Analytical Formulas

Flow Formulas

<p>K = Pulses per engineering unit, i.e. Pulses per gallon</p> <p>A = Engineering units per minute per Hertz, i.e. GPM/Hz</p> <p>J = Maximum frequency at full scale or span</p> <p>F = Frequency</p>	<p>FS = Full scale value, i.e. maximum reading on an analog display</p> <p>mA = Milliamps</p> <p>ml = Milliliter</p> <p>FPS = Feet/Second</p> <p>ID = Inner diameter in inches</p> <p>RN = Reynolds number</p> <p>SG = Specific gravity</p>		
$\frac{60}{\text{"K"}} = \text{"A"}$	$\frac{60}{\text{"A"}} = \text{"K"}$	$\frac{\text{FS}}{\text{"A"}} = \text{"J"}$	<p>"A" x Freq. = flow rate</p> <p>Flow rate ÷ A = Freq</p>
<p>Gallon "K" x 7.48 = Cubic Foot "K"</p> <p>Gallon "K" x 264.2 = Cubic Meter "K"</p> <p>Gallon "K" ÷ lbs/gal = lb "K"</p>	<p>3785 x "K" / ml = "K" / gallon</p> <p>Gallons x 3.785 = Litres</p>		
$\frac{\text{Input "F"}}{\text{J}} \times 16 + 4 = \text{mA out (4 - 20mA)}$	$\frac{\text{Input "F"}}{\text{J}} \times 20 = \text{mA out (0 - 20mA)}$		
$\frac{\text{Input "F"}}{\text{J}} \times 5 + 1 = \text{Volts out (1 - 5volts)}$	$\frac{\text{Input "F"}}{\text{J}} \times 5 = \text{Volts out (0 - 5volts)}$		
<h2>Analytical Formulas</h2>			
<p>For a range of 0 - 14pH :</p> $\frac{\text{pH value}}{14} \times 16 + 4 = \text{mA}$			
<p>For a shortened span:</p> $\left[\frac{\text{pH value} - 4 \text{ mA}}{\text{pH value} - 4 \text{ mA}} \right] \times 16 + 4 = \text{mA out}$			
<p>Theoretical pH millivolt values = 59.16mv per pH unit. (+) mv below 7pH & (-) mv above 7pH.</p> <p>millivolts @ 7pH = 0mv</p> <p>millivolts @ 6pH = +59.16mv</p> <p>millivolts @ 8pH = - 59.16mv</p>	<p>millivolts @ 4pH = +177.48 mv</p> <p>millivolts @ 10pH = -177.48 mv</p>		
<p>To simulate conductivity values @ 25°C:</p>			
$\left[\frac{\text{Cell constant}}{\text{Desired conductivity in } \mu\text{s}} \right] \times 1 \text{ Million} = \text{Simulation resistance in ohms}$			
$\left[\frac{\text{Cell constant}}{\text{Resistance in ohms}} \right] \times 1 \text{ Million} = \text{Conductivity in } \mu\text{s/cm}$			

Conversion Data

Conversion Constants

To Change	To	Multiply by
Inches	Feet	0.0833
Inches	Millimeters	25.4
Feet	Inches	12
Feet	Yards	0.3333
Yards	Feet	3
Square Inches	Square Feet	0.00694
Square Feet	Square Inches	144
Square Feet	Square Yards	0.11111
Square Yards	Square Feet	9
Cubic Inches	Cubic Feet	0.00058
Cubic Feet	Cubic Inches	1728
Cubic Feet	Cubic Yards	0.03703
Cubic Yards	Cubic Feet	27
Cubic Inches	Gallons	0.00433
Cubic Feet	Gallons	7.48
Gallons	Cubic Inches	231
Gallons	Cubic Feet	0.1337
Gallons	Pounds of Water	8.33
Pounds of Water	Gallons	0.12004
Ounces	Pounds	0.0625
Pounds	Ounces	16
Pounds per Sq. In.	Inches of Water	27.72
Pounds per Sq. In.	Feet of Water	2.310
Pounds per Sq. In.	Inches of Mercury	2.04
Pounds per Sq. In.	Atmospheres	0.0681

Capacity or Flow

1 Gallon per Minute (g.p.m.)	0.134 c.f.m.
1 Cubic Ft. per Minute (c.f.m.)	449 g.p.h.
1 Cubic Ft. per Second (c.f.s.)	449 g.p.m.
1 Acre Foot per Day	227 g.p.m.
1 Acre Inch per Hour	453 g.p.m.
1 Cubic Meter per Minute	264.2 g.p.m.
1,000,000 Gallons per Day	696 g.p.m.
1 Gallon per Minute	3.79 l.p.m.
1 Litre per Minute (l.p.m.)	0.264 g.p.m.

Volume

Volume of a pipe is computed by
 $V = ID^2 \times \pi \times L \times 3$

Where: V = volume (in cubic inches)

ID = inside diameter (in inches)

π = 3.14159

L = length of pipe (in feet)

1 U.S. Gallon	128 fl. oz (U.S.)
	231 cu. in.
	0.134 cu. ft.
	3.785 litres
	0.00379 cu. meters
	0.833 Imp. gal
	0.0238 42 gal. barrel
1 Imperial Gallon	1.2 U.S. gal.
1 Cubic Foot	7.48 U.S. gal.
	0.0283 cu. meter
1 Litre	0.2642 U.S. gal.
1 Cubic Meter	35.314 cu. ft.
	264.2 U.S. gal.
1 Acre Foot	43,560 cu. ft.
	325,829 U.S. gal.
1 Acre Inch	3,630 cu. ft.
	27,100 U.S. gal.

Weight

1 U.S. Gallon @ 50°F	8.33 lb. x sp. gr.
1 Cubic Foot	62.35 lb. x sp. gr.
	7.48 gal. (U.S.)
1 Cubic Ft. of Water @ 50°F	62.41 lb.
1 Cubic Ft. of Water @ 39.2°F (39.2°F is water temperature at its greatest density)	62.43 lb.
1 Kilogram	2.2 lb

Temperature

°C	(°F - 32) x 5/9
°F	(°C x 9/5) + 32

Conversion Data

Viscosity Conversion

Poise = c.g.s. unit of absolute viscosity

Stoke = c.g.s. unit of kinematic viscosity

Centipoise = 0.01 poise

Centistoke = 0.01 stoke

Centipoises = centistokes x density (at temperature under consideration)

Reyn (1 lb. sec. per sq. in.) = 69×10^5 centipoises

Viscous Liquids

Viscosity Measures a Liquid's Resistance to Flow

Saybolt Universal SSU	Stokes	Centistokes	Poises*	Centipoises*	Engler Seconds	Redwood No. 1 Seconds	Typical Liquids At 70°F
31	0.10	1.00	.008	.8	54	29	Water
35	.025	2.56	.020	2.05	59	32.1	Kerosene
50	.074	7.40	.059	5.92	80	44.3	No. 2 Fuel Oil
80	1.57	15.7	.126	12.6	125	69.2	No. 4 Fuel Oil
100	202	20.2	.162	16.2	150	85.6	Transformer Oil
200	432	43.2	.346	34.6	295	170	Hydraulic Oil
300	.654	65.	.522	52.2	470	254	SAE 10W Oil
500	1.10	110	.88	88.0	760	423	SAE 10 Oil
1,000	2.16	220	1.73	173	1,500	896	SAE 20 Oil
2,000	4.40	440	3.52	352	3,000	1,690	SAE 30 Oil
5,000	10.8	1,080	8.80	880	7,500	4,230	SAE 50 Oil
10,000	21.6	2,160	17.0	1,760	15,000	8,460	SAE 60-70 Oil
50,000	108	10,800	88	8,800	75,000	43,660	Molasses B
100,000	216	21,600	173	17,300	150,000	88,160	Molasses C

*Poises and centipoises are given for oil of .8 specific gravity, Relationship: centistokes x specific gravity = centipoises.

Kinematic Viscosity (in centistokes) =

$$\frac{\text{Absolute Viscosity (in centipoise)}}{\text{Density}}$$

Density

Reynolds Number, R

Reynolds Number, R , is a dimensionless number or ratio of velocity in ft. per sec. times the internal diameter of the pipe in feet times the density in slugs per cu. ft. divided by the absolute viscosity in lb. sec. per sq. ft.

$$R = \frac{VD\rho}{\mu}$$

This is equivalent to $R = VD/\nu$ (VD divided by the kinematic viscosity). Reynolds Number is of great significance because it determines the type of flow, either laminar or turbulent, which will occur in any pipe line, the only exception being a critical zone roughly between an R of 2000 to 3500.

For those who prefer the greater precision of an algebraic equation, Reynolds Number for a pipe line may also be computed from the following formula:

$$R = \frac{Q}{29.4 \, dv}$$

where Q is in Gpm, d is inside diameter of pipe in inches, and r is kinematic viscosity in ft. ²/sec.

The most common flow profile found in industrial applications are fully developed turbulent flow (required for Signet sensors). The second type, disturbed turbulent flow, is less stable and occurs when the flow is interrupted by a valve, elbow, or other obstruction. The third type, laminar flow, occurs with highly viscous fluids, or fluids travelling at very low velocities. Typically, flow conditions with a Reynolds number lower than 2,000 are considered laminar. For a developed turbulent flow acceptable for Signet sensors, this number should be above 4,500.

Conversion Data

Conversion of Thermometer Readings

Degrees Centigrade to Degrees Fahrenheit

C	F	C	F	C	F	C	F
-40	-40.0	+5	+41.0	+40	+104.0	+175	+347
-38	-36.4	6	42.8	41	105.8	180	356
-36	-32.8	7	44.6	42	107.6	185	365
-34	-29.2	8	46.4	43	109.4	190	374
-32	-25.6	9	48.2	44	111.2	195	383
-30	-22.0	10	50.0	45	113.0	200	392
-28	-18.4	11	51.8	46	114.8	205	401
-26	-14.8	12	53.6	47	116.6	210	410
-24	-11.2	13	55.4	48	118.4	215	419
-22	-7.6	14	57.2	49	120.2	220	428
-20	-4.0	15	59.0	50	122.0	225	437
-19	-2.2	16	60.8	55	131.0	230	446
-18	-0.4	17	62.6	60	140.0	235	455
-17	+1.4	18	64.4	65	149.0	240	464
-16	3.2	19	66.2	70	158.0	245	473
-15	5.0	20	68.0	75	167.0	250	482
-14	6.8	21	69.8	80	176.0	255	491
-13	8.6	22	71.6	85	185.0	260	500
-12	10.4	23	73.4	90	194.0	265	509
-11	12.2	24	75.2	95	203.0	270	518
-10	14.0	25	77.0	100	212.0	275	527
-9	15.8	26	78.8	105	221.0	280	536
-8	17.6	27	80.6	110	230.0	285	545
-7	19.4	28	82.4	115	239.0	290	554
-6	21.2	29	84.2	120	248.0	295	563
-5	23.0	30	86.0	125	257.0	300	572
-4	24.8	31	87.8	130	266.0	305	581
-3	26.6	32	89.6	135	275.0	310	590
-2	28.4	33	91.4	140	284.0	315	599
-1	30.2	34	93.2	145	293.0	320	608
0	32.0	35	95.0	150	302.0	325	617
+1	33.8	36	96.8	155	311.0	330	626
2	35.6	37	98.6	160	320.0	335	635
3	37.4	38	100.4	165	329.0	340	644
4	39.2	39	102.2	170		345	

Glossary of Technical Terms

Accumulator: A digital display or electro-mechanical device that records and displays the total volume of fluid detected by a flow sensor. Often referred to as a totalizer. Accumulators are available in resettable and non-resettable styles

Analyzer: An analog instrument (with pointer) capable of displaying the measured value (pH, ORP, or conductivity), with limited output features.

Buffer: A standard solution (generally purchased as certified) for calibrating pH systems (also used during ORP calibration). The buffering capability of the solution enables it to resist changes in pH that might occur from contamination from the sensor during calibration.

Controller: An instrument with a digital readout capable of displaying the measured value with various user adjustable output options. E.g., alarm relays, proportional pulsing, and analog outputs.

Deviation: Used for the proportional pulse output on pH and ORP controllers. This represents the span (number of pH/ORP units) from pulse start (0 pulses per minute) to maximum pulse rate (as programmed up to 120 pulses per minute).

Electrode: The specific component of a sensor that is sensitive to and detects raw changes within the process. The term electrode is used when referring to pH, ORP and magmeter sensors.

Hysteresis: A deadband on an alarm set point to prevent oscillation of relays, valves, pumps, or alarms. E.g., on a low alarm, the alarm will activate when the measured variable goes below the set point. This alarm will stay activated until the measured variable rises above the set point, plus the amount of hysteresis.

With a programmable hysteresis the user determines when the alarm turns on and then off providing a more flexible alarm function.

Load: The total electrical resistance (measured in ohms) of each device connected to an analog output, including wiring. E.g., if a strip chart recorder had an input impedance of 250 ohms and the wiring used was another 10 ohms the total electrical load would be 260 ohms.

ORP: Measurement of the oxidation reduction potential of a solution. This is a measurement of the activity of electrons in the solution, i.e. the solution's ability to oxidize or reduce other species. The raw electrode signal (mV) is the unit of measurement, but is standardized to known solutions to compensate for electrode degradation. It is measured with a platinum band electrode.

pH: Measurement of Hydrogen Ion (H⁺) concentration (activity) in a solution. pH is equal to the negative log of the H⁺ ion concentration (activity). It is measured with a sensitive glass membrane electrode.

Pre-amp: A device that reduces the high signal impedance generated by pH and ORP electrodes and adds gain to the signal enabling a stable, noise free transmission up to 400 feet from the electrode to the transmitter, analyzer, or controller.

Proportional Pulse: A momentary contact closure (relay output) that is proportional to the process variable relative to the set point. E.g., for pH it is typically used to speed up and slow down proportional metering pumps for adding acid or caustic. In flow mea-

(continued)

Glossary of Terms

surement it is typically used for injecting chemicals proportional to flow rate by controlling the pulsing rate of a proportional metering pump.

Range: 1. The total sensing capability (from minimum to maximum) of a sensor. E.g., pH, flow, temperature, or pressure range, etc. 2. The total span (from minimum to maximum) in engineering units of an analog dial face. E.g., dial face = 2-12 pH, thus the dial range is 2-12 pH. 3. The total span (from minimum to maximum) in engineering units of an analog output. E.g., 4-20 mA = 0-120 gpm, thus the 4-20 mA range is 0-120 gpm.

Relay SPDT: A Single Pole, Double Throw relay that has the following electrical connections. Common, Normally Open, and Normally Closed (Com, N/O, and N/C). Making and breaking contacts for turning multiple devices on and off such as a red light/green light, pump on valve closed, two-way valves, mixer off valve open, etc.

Relay SPST: A Single Pole, Single Throw relay that has the following electrical connections. Common, and Normally Open (Com, and N/O). Making and breaking contact for turning a device on and off such as a valve, pump, alarm, etc.

Scale (Full): The maximum obtainable value displayed on the dial face of an analog instrument. E.g., 2-12 pH, full scale is 12 pH, or 0-180 gpm, full scale is 180 gpm.

Sensor: A device in its entirety that is inserted into a fluid for the purpose of accurately detecting process changes. E.g., paddlewheel flow sensor, mag sensor, or a combination of electrode (pH or ORP) with a preamplifier.

Set Point: The point (process value) at which an alarm activates. A high alarm activates when the measured variable is above the set point value. A low alarm is activated when the measured variable is below the set point value.

Slope: A second calibration point for pH and ORP that enables accurate linearization of the electrode output. In pH calibration, this is generally done in a pH 4.0 or 10.0 buffer which enables diagnosis of the state of the measuring (glass) side of the electrode (theoretically 59 mV/pH unit, positive for acids, negative for bases).

Standardize: Calibration of the pH or ORP electrode to a known value solution. In pH calibration, this is generally done in a pH 7.0 buffer which enables diagnosis of the state of the reference side of the electrode (theoretically 0 mV)

Totalizer: A digital display or electromechanical device that records and displays the total volume of fluid detected by a flow sensor. Often referred to as an accumulator. Totalizers are available in resettable and non-resettable styles.

Transmitter (two-wire): A fully isolated, loop powered device (24 VDC nominal) used in conjunction with a sensor for 4-20 mA transmission of measured process variable (pH, flow, ORP, conductivity, temperature, or pressure.) Often connected directly to computers, recorders, valves, metering pumps, controllers, etc.

Parts and Accessories

Parts and Accessories (see page 21 for O-Ring information)

Part Number	Product Description	Where Used	Additional Comments
M1538-2	Rotor Replacement - PVDF (black)	515-P, 8510-P	To be used with PolyPro sensor
M1538-3	Rotor Replacement - PVDF (natural)	515-V/T, 8510-V	To be used with PVDF sensors
M1538-4	Rotor Replacement - Tefzel	515, 8510	For additional chemical compatibility with PolyPro sensors.
P51546	Rotor Replacement w/Teflon Sleeve Bearing	515, 8510	For increased abrasion resistance
P51550-3	Rotor Replacement Kit - PVDF Rotor (natural), PVDF Pin	515-T	Optional replacement for other 515 and 8510 sensors.
3-2535.321	Rotor Replacement Kit - PVDF Rotor (natural), PVDF Pin	option only	Optional replacement for 2535 and 8511 sensors.
3-2535-320-1	Rotor Replacement - PVDF (black)	2535-P	To be used with PolyPro sensor
3-2535-320-2	Rotor Replacement - PVDF (natural)	2535-V	To be used with PVDF sensors
P52509	Rotor Replacement Kit - rotor, pin, retainers, & bearings.	525, 1500	
P52509-1	Rotor Replacement Kit - rotor, pin retainers, & bearings.	2517	
3-2540.320	Rotor Replacement Kit - rotor, & bearings.	2540	
M1546-1	Rotor Pin Replacement - Titanium	515-P, 2535-P, 8510-P	Optional replacement for other 515, 2535, & 8510 sensors.
M1546-2	Rotor Pin Replacement - Hastelloy C	515-V, 2535-V, 8510-V	Optional replacement for other 515, 2535, & 8510 sensors.
M1546-3	Rotor Pin Replacement - Tantalum	515, 2535, 8510	Option for additional chemical compatibility.
M1546-4	Rotor Pin Replacement - PVDF	515-T	Optional replacement for other 515, 2535, & 8510 sensors.
P31536	PolyPro Plug	SIGNET Installation Pipe Fittings.	Do not use with Metalex or PVDF fittings.
P31536-2	PVDF Plug	SIGNET PVDF Installation Fittings	
P31542	Sensor Replacement Cap - Red	515	
P31542-2	Sensor Replacement Cap - Yellow	2535	
P50060	Instrument Mounting "L" Bracket	500, 700, 800, 9700, & 9800 series	Optional method for instrument mounting, pipe, or shelf.
P50078	Instrument Back Cover Kit (NEMA-4X)	500, 700, 800, 9700, & 9800 series	To protect wiring connections. Use w/conduit/liquid tight conn.
3-9000.395	Instrument Back Cover Kit (NEMA-4X)	Intelek-Pro	To protect wiring connections. Use w/conduit/liquid tight conn.
3-9000.399	Mounting Adapter	Intelek-Pro	Used to adapt Intelek-Pro to existing 5.1" x 5.1" cut out.

Instructions for Use of the Chemical Resistant Guide

The Chemical Resistance chart shown on the following pages is only intended as a guide. Changes in the composition of the medium or special working conditions could lead to deviations. If there is any doubt, it is advisable to test the behavior of the material under the specific working conditions, by means of a pilot installation. No guarantees can be given in respect to the information contained in this booklet. The data shown is based upon information available at the time of printing, but it may, however, be revised from time to time in the light of subsequent research and experience.

Classification

The customary classifications: **resistant**, **conditionally resistant** and **not recommended** are depicted by the signs +, 0 and —, which allow simple presentation and application. These classifications are defined as:

Resistant: +

Within the acceptable limits of pressure and temperature the material is unaffected or only insignificantly affected.

Conditionally resistant: 0

The medium can attack the material or cause swelling. Restrictions must be made with regards to pressure and/or temperature, taking the expected service life into account. The service life of the installation can be noticeably shortened. Further consultations with George Fischer are recommended.

Not recommended: —

The material cannot be used with the medium at all, or only under special conditions.

Chemical Resistance Chart

Aggressive Media				Chemical Resistance											
Medium	Formula	Concentration	Temperature C°	PVC	PP	PVDF (SYGEEF®)	IIR EPDM	FPM	316 SS	Hastelloy C	Titanium	Alumina Ceramic	Tefzel		
Ammonium hydroxide	NH ₄ OH	aqueous, cold saturated	20	+	+	0	+	+	+	0	+	+	+		
			40	+	+	0	+	+	+	+	+	+	+		
			60	0	+		+	+	+	+	+	+	+		
			80				+	+	+	+	+	+	+	+	
			100				0	0	0	+	+	+	+	+	
120												+			
Boric acid	H ₃ BO ₃	aqueous, all	20	+	+	+	+	+	U	+	+	+	+		
			40	+	+	+	+	+	+	+	+	+	+		
			60	0	+	+	+	+	+	+	+	+	+		
			80		+	+	+	+	+	+	+	+	+	+	
			100		+	+	+	+	+	+	+	+	+	+	
120												+			
Caustic soda solution	NaOH	up to 10% aqueous	20	+	+	0	+	0	+	0	+	—	+		
			40	+	+	0	+	0	+	+	+	+	+		
			60	0	+	0	+	0	+	+	+	+	+		
			80		+		+	+	+	+	+	+	+	+	
			100		+	—	—	+	+	+	+	+	+	+	
		120												+	
		up to 40% aqueous	20	+	+	0	+	0	+	—	0	0	+	—	+
			40	+	+	0	+	—	+	—	0	0	+	—	+
			60	0	+	0	+	—	+	—	0	0	+	—	+
			80		+	—	—	—	—	—	—	—	—	—	—
			100		+	+	—	—	—	—	—	—	—	—	—
		120												+	
		50% aqueous	20	+	+	0	+	—	+	—	0	0	+	—	+
			40	+	+	0	+	—	+	—	0	0	+	—	+
			60	+	+	0	+	—	0	—	0	0	+	—	+
80			+	—	—	—	—	—	—	—	—	—	—		
100			+	+	—	—	—	—	—	—	—	—	—		
120												+			
Chlorine	Cl ₂	moist, 97% gaseous	20	0	—	+	0	+	0	0	0	+	0		
			40			+								0	
			60			+								0	
			80			+								0	
			100			0								0	
		120												0	
		anhydrous, technically pure	20	0	—	+	0	+	0	+	0	+	+	+	0
			40			+						+	+	+	0
			60			+						+	+	+	0
			80			+						+	+	+	0
			100			0						0	+	+	0
		120												0	
		liquid, technically pure	20	—	—	+	—	0	—	0	0	+	0	+	0
			40			+						+	+	+	0
			60			+						+	+	+	0
80				+						+	+	+	0		
100				+						+	+	+	0		
120									+	+	+	0			
Chromic Acid	CrO ₃ +H ₂ O	up to 50% aqueous	20	+	0	+	0	+	+	+	+	+	+		
			40	+	—	+	0	+	+	+	+	+	+		
			60	0		+	0	+	+	+	+	+	+		
			80			+	0	+	+	+	+	+	+	+	
			100			0	0	+	+	+	+	+	+	+	
		120			0	0	0	0	0	0	0	0	0		
		all, aqueous	20	+	0	+	0	+	+	+	+	+	+	+	
			40			+		+	+	+	+	+	+	+	
			60			+		+	+	+	+	+	+	+	
			80			0		0	0	0	0	0	0	0	
100				0		0	0	0	0	0	0	0			
120												+			
Chromic acid + sulfuric acid + water	CrO ₃ H ₂ SO ₄ H ₂ O	50 g 15 g 35 g	20	+	—	+	0	+	+	+	+	+	+		
			40	+		+	0	+	+	+	+	+	+		
			60	0		+	0	+	+	+	+	+	+		
			80			+		+	+	+	+	+	+	+	
			100			0		0	0	0	0	0	0	0	
120												+			

Chemical Resistance Chart

Aggressive Media				Chemical Resistance										
Medium	Formula	Concentration	Temperature C°	PVC	PP	PVDF (SYGEF®)	IIR EPDM	FPM	316 SS	Hastelloy C	Titanium	Alumina Ceramic	Tefzel	
Copper salts		all, aqueous	20	+	+	+	+	+	0	+	+	+	+	
			40	0	—	+	+	+	+	+	+	+	+	
			60	+	—	+	+	+	+	+	+	+	+	
			80	+	—	+	+	+	+	+	+	+	+	
			100	+	—	+	+	+	+	+	+	+	+	
Formic acid		technically pure	20	+	+	+	+	—	0	+	0	+	+	
			40	0	—	+	+	—	+	+	+	+		
			60	—	—	+	+	0	+	+	+	+		
			80	+	—	+	+	+	+	+	+	+		
			100	+	—	+	+	+	+	+	+	+		
Hydrochloric acid	HCl	5% aqueous	20	+	+	+	+	+	0	+	0	+	+	
			40	+	+	+	+	+	+	+	+	+		
			60	0	+	+	+	+	+	+	+	+		
			80	+	+	+	+	+	+	+	+	+		
			100	+	+	+	+	+	+	+	+	+		
		10% aqueous	20	+	+	+	+	+	+	0	+	0	+	+
			40	+	+	+	+	+	+	+	+	+	+	+
			60	0	0	+	+	+	+	+	+	+	+	+
			80	+	0	+	+	+	+	+	+	+	+	+
			100	+	0	+	+	+	+	+	+	+	+	+
		up to 30% aqueous	20	+	+	+	+	+	+	0	0	—	+	+
			40	+	0	+	+	+	+	0	0	—	+	+
			60	0	—	+	+	+	0	0	0	—	+	+
			80	+	—	+	+	+	0	0	0	—	+	+
			100	+	—	+	+	+	0	0	0	—	+	+
36% aqueous	20	+	+	+	+	+	+	0	0	—	+	+		
	40	+	0	+	+	+	0	0	0	—	+	+		
	60	0	—	+	+	+	—	—	0	—	+	+		
	80	+	—	+	+	+	—	—	0	—	+	+		
	100	+	—	+	+	+	—	—	0	—	+	+		
Hydrofluoric acid	HF	up to 40% aqueous	20	+	+	+	—	+	—	+	—	—	+	
			40	0	+	+	—	+	—	+	—	—	+	
			60	0	+	+	—	+	—	+	—	—	+	
			80	+	+	+	—	+	—	+	—	—	+	
			100	+	+	+	—	+	—	+	—	—	+	
		50% aqueous	20	+	+	+	—	+	—	—	0	—	—	+
			40	+	+	+	—	+	—	—	0	—	—	+
			60	+	+	+	—	+	—	—	0	—	—	+
			80	+	+	+	—	+	—	—	0	—	—	+
			100	+	+	+	—	+	—	—	0	—	—	+
		70% aqueous	20	+	+	+	—	+	—	—	0	—	—	+
			40	+	+	+	—	+	—	—	0	—	—	+
			60	+	+	+	—	+	—	—	0	—	—	+
			80	+	+	+	—	+	—	—	0	—	—	+
			100	+	+	+	—	+	—	—	0	—	—	+
Mixed acids (sulfuric, nitric, water)	H ₂ SO ₄ HNO ₃ H ₂ O	48%	20	+	—	+	0	—	—	—	—	—	+	
			40	0	—	+	0	—	—	—	—	—	+	
		49% 3%	60	—	—	+	0	—	—	—	—	—	—	+
			80	—	—	+	0	—	—	—	—	—	—	+
			100	—	—	+	0	—	—	—	—	—	—	+
	50% 50% 0%	20	0	—	+	0	—	—	—	—	—	—	+	
		40	—	—	+	0	—	—	—	—	—	—	+	
		60	—	—	+	0	—	—	—	—	—	—	+	
		80	—	—	+	0	—	—	—	—	—	—	+	
		100	—	—	+	0	—	—	—	—	—	—	+	

Chemical Resistance Chart

Aggressive Media				Chemical Resistance											
Medium	Formula	Concentration	Temperature C°	PVC	PP	PVDF (SYGEF®)	IIR EPDM	FPM	316 SS	Hcstelloy C	Titanium	Alumina Ceramic	Tetzel		
Mixed acids (con't) (sulfuric, nitric, water)	H ₂ SO ₄ HNO ₃ H ₂ O	10% 87% 3%	20	0	—	0	—	—							
			40												
			60												
			80												
			100												
	120														
	H ₂ SO ₄ HNO ₃ H ₂ O	50% 31% 19%	20	+	—	+	0	+							
			40												
			60												
			80												
			100												
	120														
	H ₂ SO ₄ HNO ₃ H ₂ O	50% 33% 17%	20	+	—	+	0	+							
			40	0											
			60												
			80												
100															
120															
H ₂ SO ₄ HNO ₃ H ₂ O	10% 20% 70%	20	+	—	+	+	+	+							
		40	+		+	+	+	+							
		60			+	+	+	+							
		80			+	+	+	+							
		100			+	+	+	+							
120															
Mixed acids (nitric hydrofluoric sulfuric)	15% pure HNO ₃ 5% pure HF 18% pure H ₂ SO ₄	3 parts 1 part 2 parts	20	0	—	+	+	+							
			40			+	0	0							
			60			+									
			80			+									
			100			+									
120															
Mixed acids (sulfuric, phosphoric, water)	H ₂ SO ₄ H ₃ PO ₄ H ₂ O	30% 60% 10%	20	+	0	+	+	+							
			40	+		+	+	+							
			60			+	+	+							
			80			+	+	+							
			100			+	+	+							
120															
Nickel salts		cold saturated, aqueous	20	+	+	+	+	+	0	0	0	+	+		
			40	+	+	+	+	+	+						
			60	0	+	+	+	+	+						
			80			+	+	+	+						
			100			+	+	+	+						
120			+	+	+	+									
Nitric acid	HNO ₃	6.3%, aqueous	20	+	+	+	+	+	0	+	+	+			
			40	+		+	+	+	0						
			60	+	0	+	+	0	0						
			80			+	+	+							
			100			+	+	+							
			120			+	+	+							
			up to 40%, aqueous	20	+	0	+	+	+	+	+	+	+	+	
				40	+		+	+	+	+	+	+	+	+	
		60		0	—	+	+	0	+	+	+	0	+		
		80				+	+	+	+	0	—	0	+		
		100			+	+	+								
		120													
		65%, aqueous	20	0	—	+	—	+	—	+	+	+	+	+	
			40	0		+		+		0	+	+	+	+	
			60	—		+		+		—	+	0	+	+	
			80			+		+			0	0	+	+	
100			+		+			0							
120															
100%, aqueous	20	—	—	—	—	—	—	—	+	+	+	+			
	40								+	—					
	60								+						
	80								+						
100								+							
120								+							

Technical — Material Compatibility

Aggressive Media				Chemical Resistance										
Medium	Formula	Concentration	Temperature C°	PVC	PP	PVDF (SYGEF®)	IIR EPDM	FPM	316 SS	Hastelloy C	Titanium	Alumina Ceramic	Tefzel	
Oxalic acid	COOH COOH	cold saturated, aqueous	20	+	+	+	0	+	—	—	—	+	+	
			40	+	+	+	0	+	—	—	—	+	+	
			60	+	+	0	0	—	—	—	—	—	+	+
			80				—	—	—	—	—	—	+	+
			100										+	+
120											+	+		
Phosphoric acid	H ₃ PO ₄	up to 30%, aqueous	20	+	+	+	+	+	+	+	0	+	+	
			40	+	+	+	+	+	+	+	+	+	+	
			60	0	+	+	+	+	+	+	+	+	+	
			80		+	+	+	+	+	+	+	+	+	+
			100				0	+	+	0	+	+	+	+
		120							—	—	—	+	+	
		50%, aqueous	20	+	+	+	+	+	+	+	+	0	+	+
			40	+	+	+	+	+	+	+	+	+	+	+
			60	+	+	+	+	+	+	+	+	+	+	+
			80				0	+	+	+	+	+	+	+
			100							0	+	+	+	+
		120								—	—	+	+	
		85%, aqueous	20	+	+	+	+	+	+	+	+	0	+	+
			40	+	+	+	+	+	+	+	+	+	+	+
			60	+	+	+	+	+	+	+	+	+	+	+
80					0	+	+	+	+	+	+	+		
100								0	+	+	+	+		
120								—	—	+	+			
Sodium sulphite	Na ₂ SO ₃	cold saturated, aqueous	20	+	+	+	+	+	+	0	+	+	+	
			40	+	+	+	+	+	+	+	+	+	+	
			60	0	+	+	+	+	+	+	+	+	+	
			80				+	+	+	+	+	+	+	+
			100									+	+	+
120										+	+			
Sulfuric acid	H ₂ SO ₄	up to 40%, aqueous	20	+	+	+	+	+	—	—	—	+	+	
			40	+	+	+	+	+	—	—	—	+	+	
			60	0	+	+	+	+	—	—	—	+	+	
			80				+	+	—	—	—	+	+	
			100						—	—	—	+	+	
		120										+	+	
		up to 60%, aqueous	20	+	+	+	+	+	+	+	—	—	+	+
			40	+	+	+	+	+	+	+	—	—	+	+
			60	+	+	+	+	+	0	+	—	—	+	+
			80				+	+	—	0	—	—	+	+
			100							0	—	—	+	+
		120										+	+	
		up to 80%, aqueous	20	+	+	+	+	+	+	+	—	—	+	+
			40	+	+	+	+	+	0	+	—	—	+	+
			60	+	0	+	+	+	—	+	—	—	+	+
80					+	+	—	—	—	—	+	+		
100								0	—	—	+	+		
120										+	+			
90%, aqueous	20	+	0	+	+	+	0	+	—	—	+	+		
	40	+		+	+	+	—	+	—	—	+	+		
	60			+	+	+					+	+		
	80			+	+	+					+	+		
	100										+	+		
120											+			