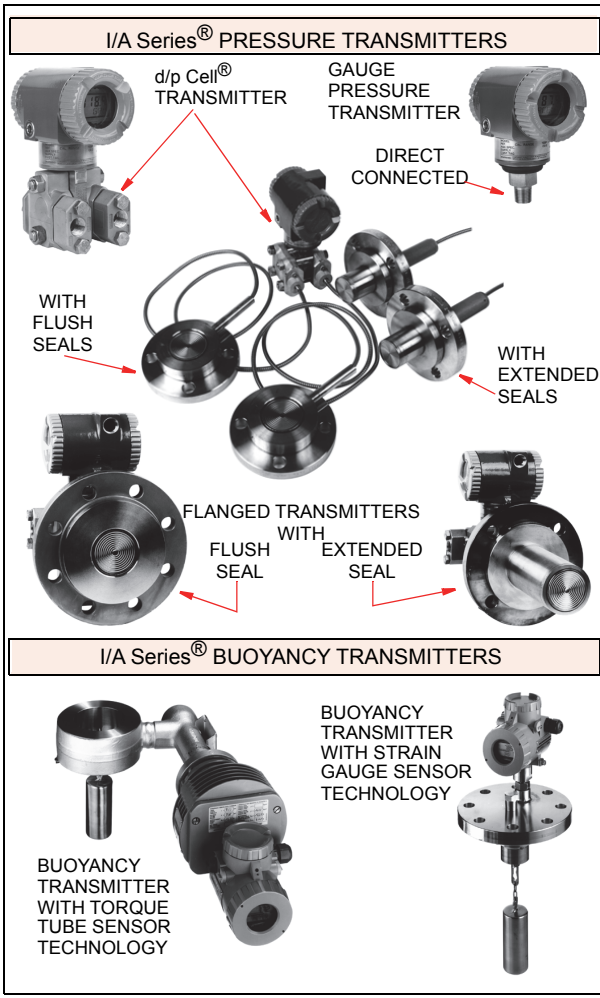
Ensuring Premium Performance with Foxboro Intelligent Level Transmitters

INTELLIGENT TRANSMITTERS FOR LIQUID LEVEL MEASUREMENT



Foxboro®

by Schneider Electric

INTRODUCTION

The I/A Series Intelligent Pressure Transmitters and 144LD and 144LVD Series Intelligent Buoyancy Transmitters are durable, high accuracy instruments that provide premium performance. To ensure premium performance, carefully follow the recommendations made in this brochure, in addition to the information contained in the instruction manual shipped with your transmitter (also available on our electronic documentation offering called **"FoxDoc"**).

If you have any questions or problems before, during, or after installation, contact Global Customer Support.

APPLICATION

Each level measurement requires a transmitter and sensor technology best suited to the process application. The proper transmitter and accessories selections play a vital role toward ensuring a premium transmitter performance. The table below provides some valuable experience-tested tips in selecting the proper transmitter for a given level measurement application.

Transm. Desc.	Vessel Type		Head Pressure		Process Temp.		Cross-Application		
	Open	Closed	Vac	High	High	Cyclic	Liq.	Slurry	I'face
Gauge Press.	√	NO	NO	NO	N/R (a)	N/R (a)	√	NO	NO
Gauge Press. w/Seal	√	NO	NO	NO	N/R	NO	√	√	NO
Gauge Press. w/Bubble Tube	√	NO	NO	NO	N/R	NO	√	NO	NO
Gauge Press. w/Purge Connection	√	NO	NO	NO	NO	NO	√	√	NO
Differential Pressure	√	√	√	√	√	√	√	NO	NO
Diff. Press. w/Seal	√	√	N/R	N/R	N/R	√	N-A	√	NO
Flanged Level (d/p)	√	√	√	√	√	N/R	√	√	NO
Buoyancy w/Torque Tube	√	√	√	√	√	√	√	√	√
Buoyancy w/Strain Gauge	√	√	√	√	√	√	√	√	√

NOTE: √ = YES, Recommended Application
N/R= NOT Recommended for this Application
NO= Do NOT use for this Application
(a)= But can be used with an Extended Sampling Line.

CALIBRATION VERIFICATION

Before installation, you should verify all calibration data and data label specification values must conform to actual process conditions and calibration procedures.

But which calibration standards should be applied? And what are the values? First and foremost, all relevant process, vessel, and other data must be used in calculating the calibration standards in accordance with the applicable process level measurements. Also, data and calibration specifications should be documented. Therefore these transmitters are provided with both calculation and data storage capabilities.

INSTALLATION

Upon checking/verifying all calibration specifications, the transmitter and all accessories (e.g., remote pressure seals) must then be properly installed.

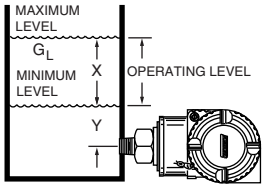
INTELLIGENT TRANSMITTER

The ability to remotely communicate with each transmitter greatly enhances sensor-to-process configuration. Being able to quickly obtain all primary and secondary sensor data is a key to remote and local troubleshooting. Also, at commissioning, all sensor data should be downloaded to a “floppy” or “hard drive.”

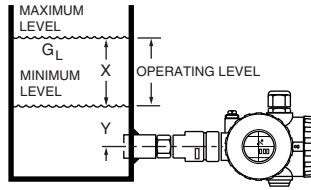
OPEN VESSEL APPLICATIONS

SINGLE, GAUGE PRESSURE TRANSMITTERS AND FLANGED LEVEL TRANSMITTERS

Single, Gauge Pressure Transmitters



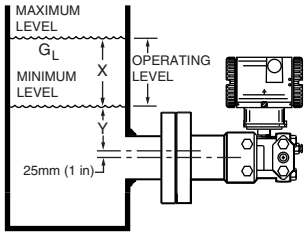
DIRECT CONNECTED TRANSMITTER



TRANSMITTER WITH INTEGRAL SEAL

APPLICATION TIPS • USE FOR CLEAN FLUIDS WITHOUT SOLIDS. INSTALLATION TIPS • PROVIDE ISOLATION VALVE. • PROVIDE DRAIN VALVE.	APPLICATION TIPS • AVOID APPLICATIONS WITH WIDE TEMPERATURE SWINGS. INSTALLATION TIPS • INSTALL SEAL DIAPHRAGM FLUSH WITH INSIDE SURFACE OF VESSEL.

Flanged Level Transmitter with Integral Diaphragm



APPLICATION TIPS

- ALWAYS KEEP SENSING DIAPHRAGM FULLY WETTED.
- HEAD PRESSURE REFERENCE LINE IS THE TOP EDGE OF DIAPHRAGM.

CALIBRATION TIPS

- FOR BENCH CALIBRATION, ALWAYS POSITION TRANSMITTER VERTICALLY TO ELIMINATE THE POSITION ZERO EFFECT.

Troubleshooting Considerations

- For Offline Calibration, Use Calibrated Range and Rezero in Field to Eliminate Position Effects.
- Avoid Rapid Temperature Shocks.
- Fluid Density Changes Will Offset Readings.

Calculations for Single, Gauge Pressure Transmitters and Flanged Level Transmitters

$$\begin{aligned} \text{SPAN} &= (X)(G_L) \\ H_{W,\,MIN} &= (Y)(G_L) \\ H_{W,\,MAX} &= (X+Y)(G_L) \\ \text{CAL. RANGE} &= H_{W,MIN} \text{ to } H_{W,\,MAX} \end{aligned}$$

where:

X = Liquid Level Span

Y = Zero Level Offset

H_W = Equivalent Head of Water on Transmitter

G_L = Specific Gravity of Liquid in Tank

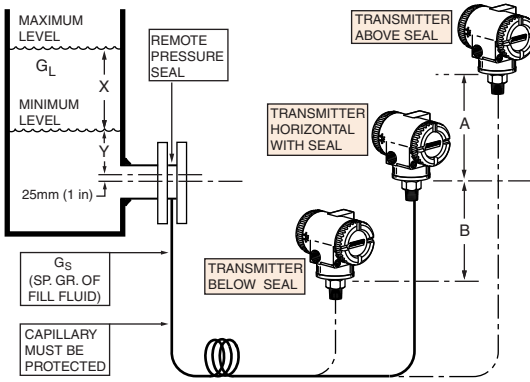
$H_{W,MIN}$ = H_W at Minimum Level; also Zero Suppression

$H_{W,MAX}$ = H_W at Maximum Level; also Zero Suppression plus Span

SINGLE, GAUGE PRESSURE TRANSMITTER WITH A REMOTE PRESSURE SEAL

Configuration

The figure that follows shows three transmitter locations – above the pressure seal, horizontal with the pressure seal, and below the pressure seal. When mounted above or below the pressure seal, the specific gravity of the seal fluid must be considered when calculating the "Equivalent Head of Water in Transmitter," as indicated in the equations that follow.



Calculations for Single, Gauge Pressure Transmitter with a Remote Pressure Seal

Transmitter **BELOW**, **HORIZONTAL**, or **ABOVE** Seal

SPAN = $(X)(G_L)$

CAL. RANGE = $H_{W,MIN}$ to $H_{W,MAX}$

Transmitter **BELOW** Seal

$H_{W,MIN} = (Y)(G_L) + (B)(G_S)$

$H_{W,MAX} = (X+Y)(G_L) + (B)(G_S)$

Transmitter **HORIZONTAL** with Seal

$H_{W,MIN} = (Y)(G_L)$

$H_{W,MAX} = (X+Y)(G_L)$

Transmitter **ABOVE** Seal

$H_{W,MIN} = (Y)(G_L) – (A)(G_S)$

$H_{W,MAX} = (X+Y)(G_L) – (A)(G_S)$

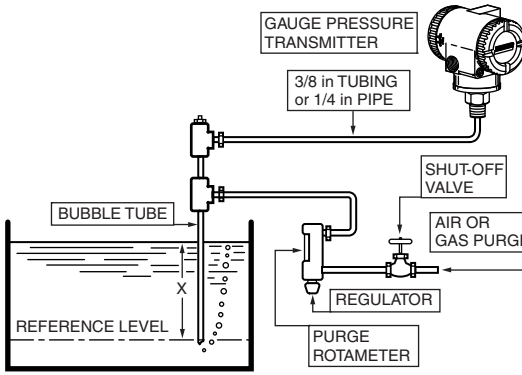
SINGLE, GAUGE PRESSURE TRANSMITTER WITH AIR, GAS, OR WATER PURGE

Air or Gas Purge in Bubble Tube Installations

Bubble Tube installations are low cost methods of measuring liquid level in an open tank. They are particularly applicable where:

- Process Liquid Could Crystallize in Transmitter Lines.
- Process Temperature Exceeds Temperature Limit of Flanged Transmitter.
- Vessel Has No Side Connections for Flanged Transmitter.
- Liquid Too Corrosive for Transmitter's Wetted Parts.

A typical bubble tube installation using an air or gas purge is shown in the figure below. Also, refer to Instruction MI 020-328 for installation details and other information relating to bubble tube applications.

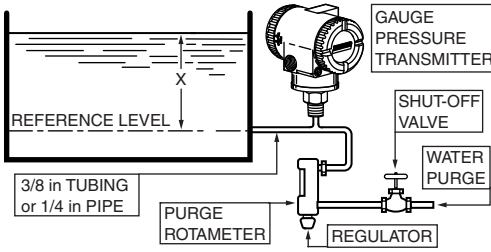


TROUBLESHOOTING TIPS

- PROVIDE CONSTANT FLOW RATE AND AIR/GAS PRESSURE.
- PROCESS DENSITY SHOULD BE CONSTANT.
- SHOULD BE A MINIMUM OF 75 mm (3 in) OR CLEAR LIQUID (NO SEDIMENT) BELOW BOTTOM OF BUBBLE TUBE.
- FLUSH OUT INSIDE OF BUBBLE TUBE IF SOLIDS OR DIRT TEND TO

Water Purge Installation

Water Purge installations are used for the same reasons as bubble tube installations (see previous section) except that slurries may also be measured. Refer to the figure below for a typical water purge installation.

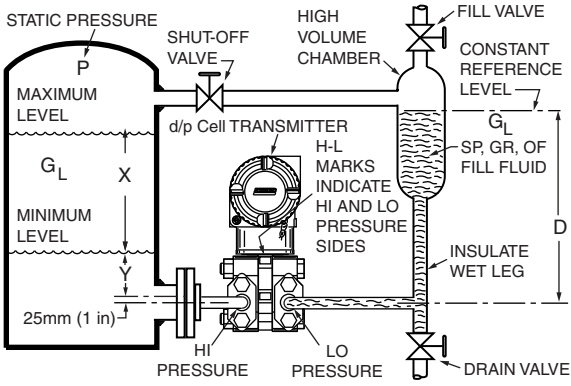


TROUBLESHOOTING TIPS

- PROVIDE CONSTANT FLOW RATE AND WATER PRESSURE
- PROCESS DENSITY SHOULD BE CONSTANT

CLOSED VESSEL APPLICATIONS

CLOSED VESSEL WITH WET LEG



APPLICATION TIPS

- AVOID VACUUM APPLICATIONS.
- AVOID PROCESSORS WITH PRESSURE SURGES.
- FILL FLUID CAN BE PROCESS FLUID.
- PROCESS SHOULD NOT FLOOD WET LEG.

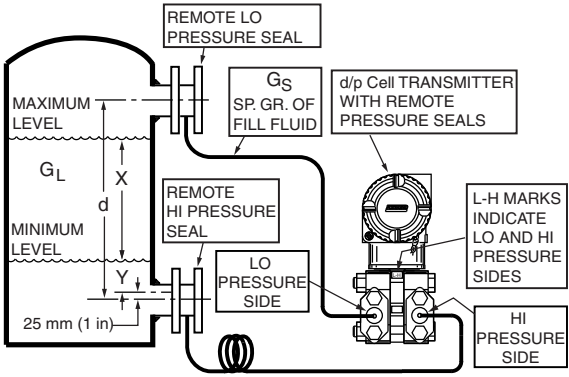
$$\text{SPAN} = (X)(G_L)$$
$$H_{W,\,MIN} = (Y)(G_L) - (D)(G_S)$$
$$H_{W,\,MAX} = (X+Y)(G_L) - (D)(G_S)$$
$$\text{CAL. RANGE} = H_{W,MIN} \text{ to } H_{W,\,MAX}$$

where:

X = Liquid Level Span
Y = Zero Level Offset
D = Wet Leg Height
G_L = Specific Gravity of Liquid in Tank
G_S = Specific Gravity of Fill Fluid
H_W = Equivalent Head of Water on Transmitter
$H_{W,MIN}$ = H_W at Minimum Level; also Zero Elevation
$H_{W,MAX}$ = H_W at Maximum Level; also Zero Elevation plus Span

CLOSED VESSEL WITH REMOTE SEALS

Installation and Calculations



INSTALLATION GUIDELINES	AVOID APPLICATIONS WITH
• HANDLE SEALS WITH CARE. • INSULATE CAPILLARY FROM LARGE SWINGS IN AMBIENT TEMPERATURE. • PROTECT CAPILLARY FROM MECHANICAL DAMAGE. • DOCUMENT PRESSURE SEAL SPECIFICATIONS.	• LONG CAPILLARY EXTENSIONS. • LEVELS WITH NARROW SPANS. • VERY TALL VESSELS. • WIDE PROCESS OR AMBIENT TEMPERATURE SWINGS. • WIDE OSCILLATIONS IN HEAD PRESSURE.

$$\text{SPAN} = (X)(G_L)$$

$$\text{CAL. RANGE} = H_{W,MIN} \text{ to } H_{W,MAX}$$

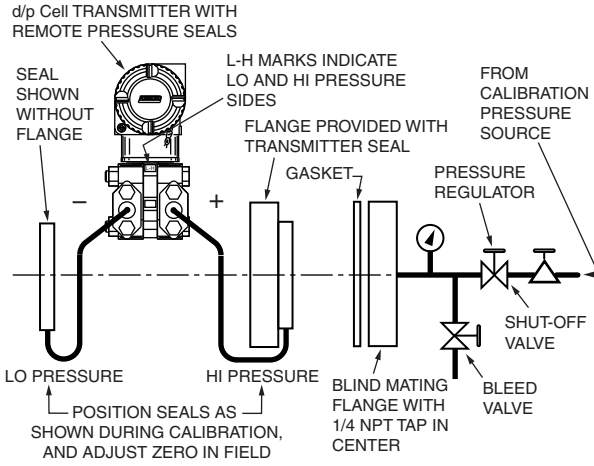
$$H_{W,MIN} = (Y)(G_L) - (d)(G_S)$$

$$H_{W,MAX} = (X+Y)(G_L) - (d)(G_S)$$

where:

X = Liquid Level Span
Y = Zero Level Offset
d = Distance between Seals
G_L = Specific Gravity of Liquid in Tank
G_S = Specific Gravity of Fill Fluid
H_W = Equivalent Head of Water on Transmitter
$H_{W,MIN}$ = H_W at Minimum Level; also Zero Suppression
$H_{W,MAX}$ = H_W at Maximum Level; also Zero Suppression plus Span

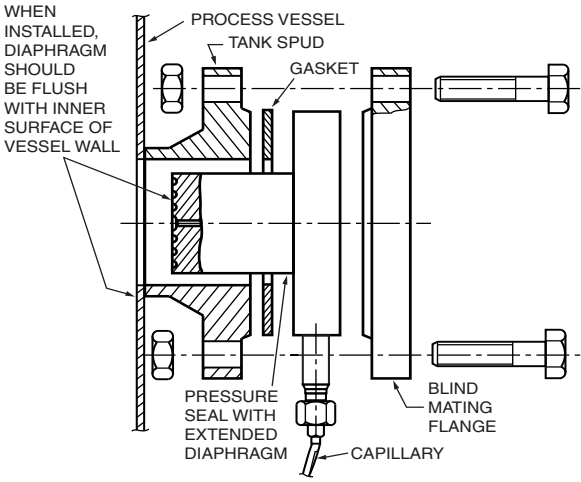
Bench Calibration



BENCH CALIBRATION TIPS

- LOW (–) PRESSURE SIDE IS EXPOSED TO ATMOSPHERIC PRESSURE.
- HI AND LO PRESSURE SEALS TO BE AT SAME (EQUAL) ELEVATION.

Remote Seal with Extended Diaphragm



BUOYANCY TRANSMITTERS

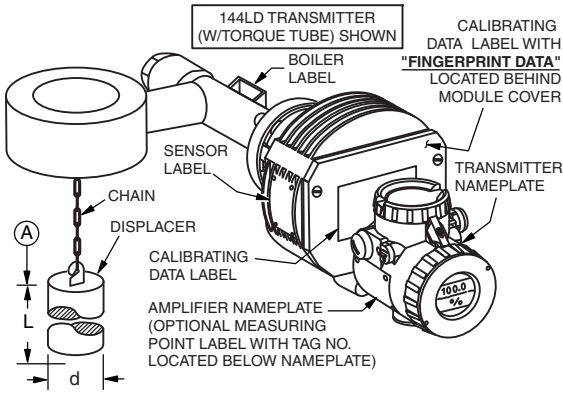
BUOYANCY TRANSMITTER APPLICATIONS

The 144LD and 144LVD Series Intelligent Buoyancy Transmitters measure the change in buoyant force on a displacer suspended in a liquid. The output can represent liquid level, density, or interface level between two liquids. They are generally applied where optimum accuracy is required in wide measurement ranges, or when sensor shutoff is required without draining the vessel. These transmitters are ideally suited for use with corrosive liquids, low and very high temperature liquids, liquids with foam buildup, low or medium viscosity liquids, high static pressure and vacuum service processes, or where settling solids are likely to occur. Avoid using with liquids having varying densities. The sensors are designed using either torque tube or strain gauge sensor technology.

TRANSMITTER NAMEPLATES AND LABELS

- TRANSMITTER NAMEPLATE: Shows Model Number of transmitter; and special version number (ECEP), and revision number.
- AMPLIFIER NAMEPLATE: Contains electrical data (e.g., output, power, voltage, etc.), area classification code, and serial number.
- MEASURING POINT LABEL (OPTIONAL): Below amplifier nameplate or hung on earth (ground) terminal. Indicates Tag No., e.g., LIT 100 .
- BOILER LABEL: Contains nominal pressure, material, permissible pressure and load, serial number, etc.
- SENSOR TRIM LABEL: When replacing amplifier, the sensor data must be determined per the applicable transmitter instruction manual, and new data entered on the Sensor Trim Label.
- SENSOR LABEL: Required on transmitter approved or certified for use in explosionproof applications.
- CALIBRATION DATA LABELS: Transmitter and displacer must be correctly matched. Calibration is performed in factory based on customer's process and measuring requirements. Each displacer is marked with a Tag Number (if not known, then the last three digits of the transmitter serial number are used). One label with adjustment data is located on outside of sensor housing, and one label (with "Fingerprint" data) is located on inside of sensor housing.

See figure below for location of nameplates and labels.



USE OF CALIBRATION DATA

A Model 144LD Calibrating Data Label

VERDRANGER / IMMERS. BODY / PLONGEUR			EINGESTELLT AUF / ADJUSTED TO / ADJUSTEE A:			
(A) LANGE / LENGTH / LONGUEUR	L=	1000 mm	DICHTE OBEN / DENSITY ABOVE / DENSITE HAUT	ρ_2	___ kg/m³	(E)
(B) VOLUMEN / VOLUME / VOLUME	V=	707 cm^3	DICHTE UNTEN / DENSITY BELOW / DENSITE BAS	ρ_1	1000 kg/m³	(F)
(C) GEWICHTSKRAFT / WEIGHT / POIDS	F_G=	14.71 N	MESSANFANG / MIN. INPUT VALUE / DEBUT DE MESURE	F_0	14.71 N	(G)
(D) MAX. DRUCK / MAX. PRESSURE / PRESSION MAXI.		ATM bar	MESSENDE / MAX. INPUT VALUE / FIN DE MESURE	F_{100}	7.78 N	(H)
AUSGANG / OUTPUT / SORTIE 4-20 mA						

Calibrating Data Label Descriptions

- (A) = Displacer Length for this Application is 1000 mm.
- (B) = Displacer above has a Volume of 707 cm^3.
- (C) = Displacer Weight Force is 14.71 N (Newtons); and Displacer Weight is:
  F_G/"g" = 14.71 N/9.81 m/s^2 = 1.5 kg.
- (D) = Displacer is exposed to ATM (Atmospheric) Pressure.
- (E) = Density Above Liquid Level is 0 (i.e., Air).
- (F) = Density Below Liquid Level is 1000 kg/m^3 (i.e., Water).
- (G) = Displacer Weight Force at 0% Level is 14.71 N.
- (H) = Displacer Weight Force at 100% Level is 7.78 N.

Calibrating Data Label Symbology Definitions

L = Displacer Length, mm
d = Displacer Diameter, mm
V = Displacer Volume, cm^3
or V = $(L)(\pi d^2/4)(1/1000)cm^3$
F_G = Displacer Weight Force, N (Newtons)
F_0 = Displacer Weight Force at 0% Level
F_{100} = Displacer Weight Force at 100% Level
ρ_1 = Density Below Liquid Level, kg/m^3
ρ_2 = Density Above Liquid Level, kg/m^3

Units Conversion Table

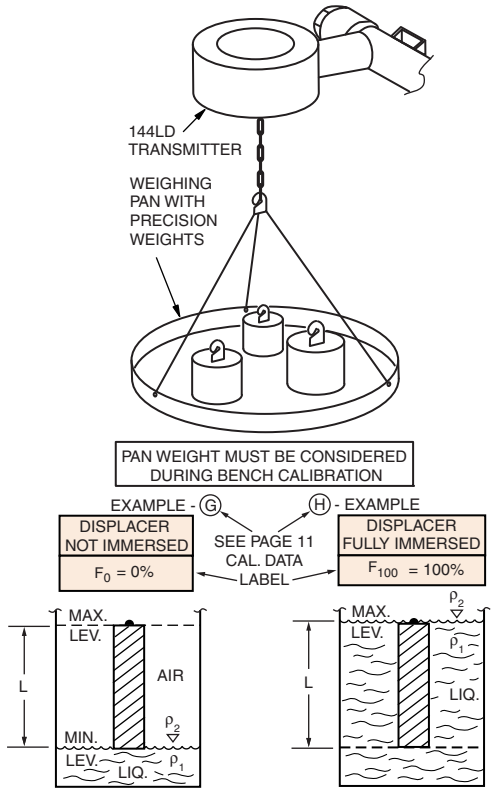
Multiply	By	To Get	Multiply	By	To Get
cm^3	10^{-3}	L (a)	N (a)	0.2248	lb
mm^3	10^{-6}	L (a)	N (a)	0.1020 (b)	kg
mm^3	10^{-3}	cm^3	kg	9.81 (b)	N (a)
L (a)	61.024	in^3	kg	2.2046	lb
L (a)	0.035315	ft^3	kg/m^3	10^{-3}	kg/cm^3
cm	0.3937	in	kg/m^3	$36.127x10^{-6}$	lb/in^3
mm	0.03937	in	kg/cm^3	$36.127x10^{-3}$	lb/in^3
in	0.0833	ft	lb/in^3	1728	lb/ft^3

(a) L = Liter; N = Newton
(b) 1N/"g" = 1N/(9.81 m/s^2) = 0.1020 kg

Examples Using Units Conversion Table

V = 707 cm^3, or $(707)(10^{-3})$ = 0.707 L
F_G = 14.71 N, or (14.71)(0.1020) = 1.5 kg
ρ_1 = 1000 kg/m^3, or $(1000)(36.127x10^{-6})$
= 0.036127 lb/in^3
also ρ_1 = 1000 kg/m^3, or 1000 x 10^{-3} = 1 kg/cm^3

BENCH CALIBRATION USING WEIGHTS

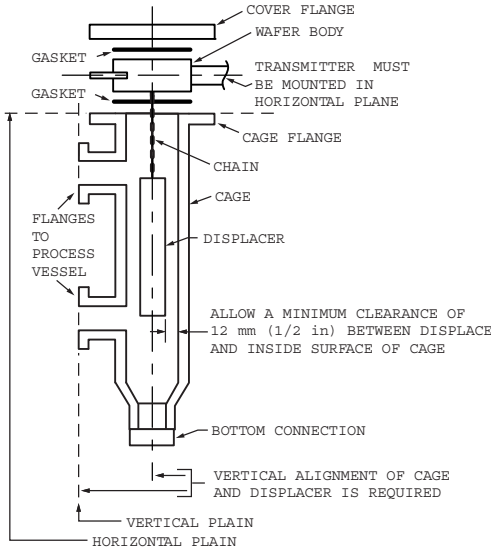


Calculation – Calibration Weights					
Level - Range	0%	25%	50%	75%	100%
Output Signal	4 mA	8 mA	12 mA	16 mA	20 mA
Weight-Force	F_0	F_{25}	F_{50}	F_{75}	F_{100}
Data in “N”	14.71	12.97 8	11.245	9.5125	7.78
Weights in “kg”	1.499	1.323	1.146	0.970	0.793

NOTES:
(a) Values for F_0 Ⓖ and F_{100} Ⓗ in “N”. Read from Calibration Data Label on page 12.
(b) For % Calibration, apply displacer suspended in air.
(c) Use linear interpolation to calculate “N” values for F_{25}, F_{50}, and F_{75} columns.
(d) Convert “N” Values to “kg” Values using Conversion Table.

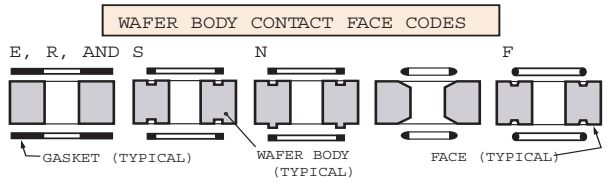
INSTALLATION TIPS

A buoyancy transmitter with displacer and cage is shown in the figure below. Note that particular attention must be paid to the vertical alignment of the displacer and inside surface of cage.



WAFER BODY FACE CONFIGURATIONS

Wafer body faces, gaskets, and flanges must be compatible. The user must provide the proper gaskets and flanges as depicted and described below.



Code	Face Type and Description
E	Type E, Raised Face, DIN 2526
R	Type RF, Raised Face, ANSI B16.5
S	Type SF, Smooth Finish, (RA=125 μin)
N	Type N, Groove Face, DIN 2512
F	Type F, Tongue Face, DIN 2512
L	Type L, Lense Face, DIN 2696
J	Type RJF, Ring Joint Face, ANSI B16.5

AFTER INSTALLATION CONSIDERATIONS

INITIAL ZEROING

Zero the transmitter to eliminate the effects of:

- Mounting Position
- Supply Voltage
- Vibration
- Chain Weight

FINAL REZEROING

Rezero the transmitter after it has stabilized in its installed 0% level (empty tank or drained cage), ambient temperature, and process temperature environment. This final check is CRITICAL to obtaining premium performance.

NOTES

TO CONTACT US

- In the U.S.A., contact Global Customer Support at:

1-866-746-6477

- Outside the U.S.A., contact your local representative, or call Global Customer Support at:

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