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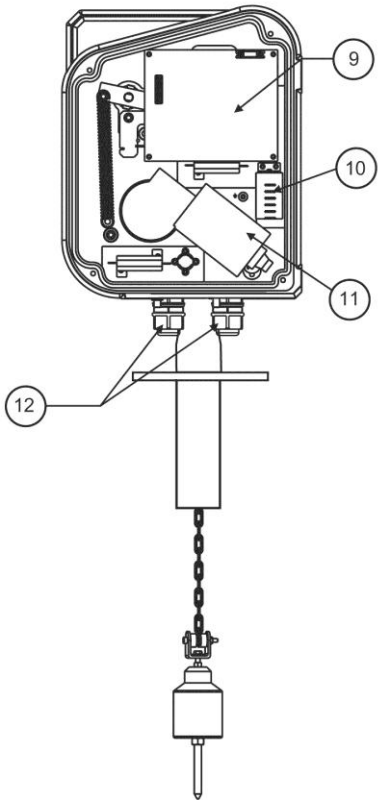
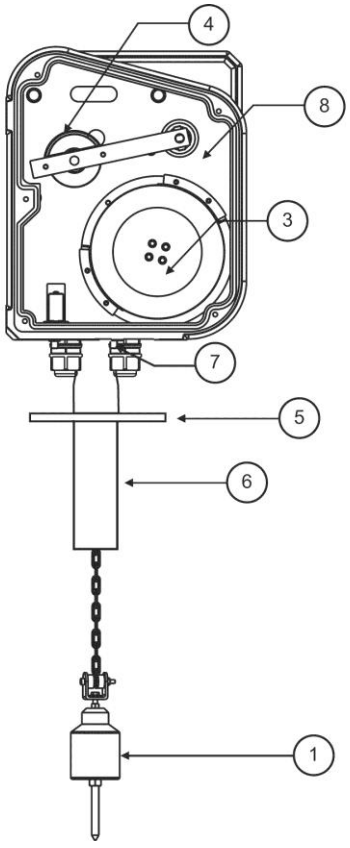
Principle of Operation

Introduction

The BlueLevel Technologies Model WC is a 3G smart sensor used for monitoring the inventory levels of powder, granular and liquid materials in bins, silos and other types of vessels. Using third generation weight & cable technology the Model WC directly measures a vessel empty space distance and indirectly the material level within the vessel. The Model WC consists of the following primary components; 1 - Sensing Weight, 2 - Cable (not shown, travels within #6 and attached to top of chain shown), 3 - Cable Storage Pulley, 4 - Measuring Pulley, 5 - Mounting Flange/Pipe Assembly, 6 - Cable Wiping Assembly (located inside of pipe shown), 7 - Air Purge Connections, 8 - Housing (mechanical and electronic compartments), 9 - Control PCB, 10 - Switching Power Supply, 11 - Motor, and 12 - Cable Glands.



Electronics Side



Mechanics Side

The Model WC smart inventory monitoring sensor operates in Auto, Manual or SmartStart™ modes of measurement as setup by the operator or installer through simple configuration using the built-in keypad a backlit LCD display. Updates of primary measurement data is transmitted via the standard MODBUS serial communication interface, 0/4-20mA analog output and the Model WC's DC transistor and AC relay pulse outputs. In addition, the Model WC is equipped with relay outputs for High and Low material alarms as well as self-validating sensor faults. The Model WC is a state-of-the-art smart inventory monitoring sensor.

Use

The Model WC is used to monitor bin contents for inventory measurement purposes. The material within the bin being monitored can be a powder, granular or liquid. Inventory monitoring is generally performed on a periodic basis, NOT DURING VESSEL FILLING.

The sensor can be setup to perform measurement in the Auto mode, Manual or via its unique **SmartStart™** mode of operation. SmartStart™ is an intelligent adaptive function that reduces the measurement frequency as the material level increases to assist in vessel level control.

The Model WC smart inventory monitoring sensor communicates the primary measurement information via its MODBUS, analog and pulse outputs. In addition, two (2) material level alarm relay outputs are provided (High level and Low level). These alarms are not intended to replace the distinctive High or Low level control sensor typically installed within vessels to control filling.

A remote control unit, the Model RCU, is available to communicate with, control and display data from up to 128 sensors.

The Model WC smart inventory sensor self-validates the measuring cycle to ensure proper operation. The sensor is capable of detecting and signaling a broken cable, a buried sensing weight and a sensor lockout condition. A sensor alarm relay cycles on/off in the unlikely event that a sensor fault condition exists.

Function

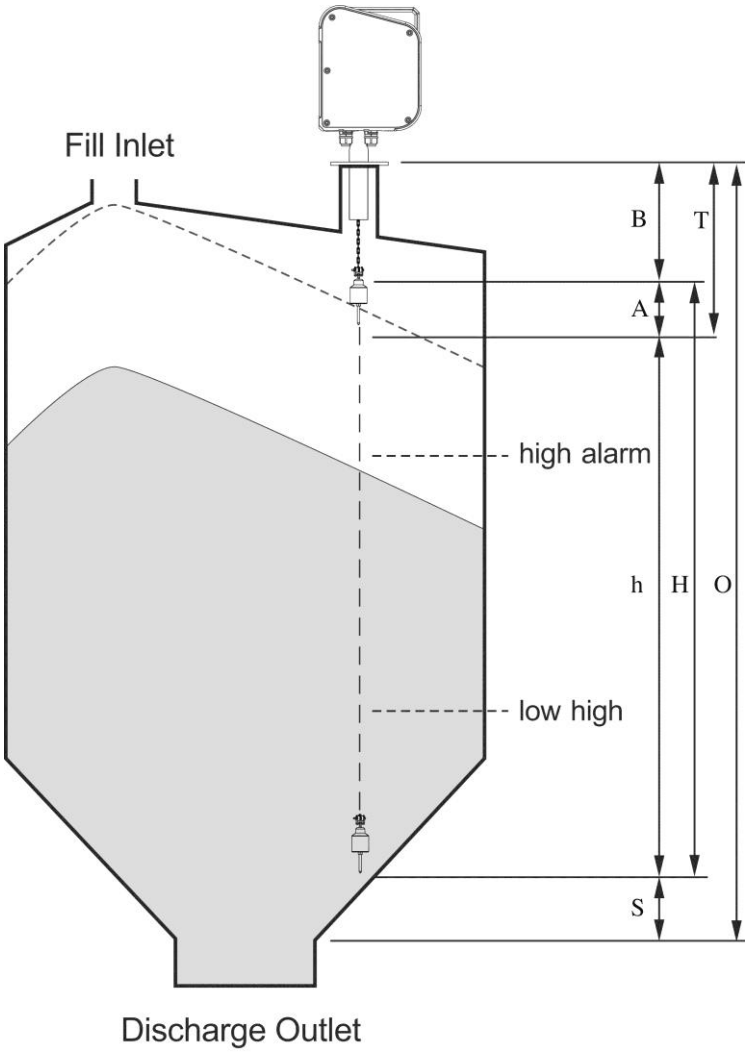
The Model WC state-of-the-art electronics employs intelligent motor control. Each measurement cycle begins by lowering the sensing weight/cable assembly into the vessel. The amount of cable lowered/raised is equivalent to the empty space distance between the starting point and the material surface directly beneath the Model WC mounting point. The distance is measured using Hall-effect sensing technology and the microcontroller timer circuit to within 0.045” resolution. Magnetic technology is also employed to detect contact with the material surface. Measured data is updated and the motor direction is reversed and the sensing weight/cable is returned to its starting position. Distance is measured during the ascent and validated.

The material level is determined based upon the measured distance and the effective measuring range which is configured by the operator or installer during setup. Material level alarms (High and Low) are compared to the measured material level and the High and Low alarm relay outputs will change state if necessary.

Applications

General

Measurements made by the Model WC smart inventory monitoring sensor are unaffected by sound, dust, light, color, dielectric constant, humidity and temperature changes that can affect other inventory monitoring sensor technologies.



Refer to the illustration to the right. The Model WC inventory monitoring sensor is shown mounted using a nozzle or standpipe and at a location away from or opposite the off-center fill inlet in this example. Locating the sensor needs to be considered in advance of installation. The most appropriate mounting location will be away from the material inlet, close to or at a neutral point on the material surface (angle of repose) and will facilitate mounting the sensor plumb or level. The sensor can be mounted using a nozzle or flush to the surface of the vessel roof. The Model WC inventory monitoring sensor is available with a mounting flange that can be either flat, or have a 5 degree or 10 degree angle. For more information please refer to the Model WC Installation, Operation and Maintenance Instruction document.

ICON	FEATURE	DEFINITION
O =	Overall Tank Height	distance from sensor mounting flange to vessel discharge/outlet
B =	Blind Distance	distance from sensor flange where measurement will not take place
A =	Air Zone	adjustable deadband (factory set to 0); sets where measurement begins
T =	Total Deadband	includes blind distance (B) and air zone (A)
H =	Height	**AutoReturn™** distance - the maximum measuring distance and the maximum travel distance of sensing weight/cable for specific application
h =	Effective Distance	effective measuring distance; varies based on values of H and A; corresponds to the analog 0/4-20mA output signal range
S =	Safety Zone	distance between AutoReturn™, H above, and discharge opening

AutoReturn™ Function

Each Model WC smart inventory monitoring sensor is capable of a maximum measuring range of 98ft (30m). The maximum travel distance specific to your application is controlled by the AutoReturn™ feature. **To prevent the sensing weight/cable from traveling into the vessel discharge** when an empty vessel condition exists, the maximum sensing/weight cable travel distance must be set by simply adjusting the Model WC sensor configuration parameter "H". The value set as "H" using the built-in LCD display and keys on the sensor circuit board establishes the AutoReturn™ distance. When the sensing weight/cable travel is equal to the value set as configuration parameter "H", the sensor will automatically stop lowering the sensing weight/cable and return it to the original starting point. If desired, the Model WC smart inventory monitoring sensor cable length can be manually adjusted and reduced from its factory provided 98ft (30m).

Measurement Cycle Initiation - Auto, Manual and SmartStart™

There are three methods to initiate a primary measurement update; Auto, Manual and SmartStart™.

Auto - once setup the Model WC will acquire a new measurement with update frequency based upon the Timer configuration parameter, **adjustable from 0.1 to 99.99 in terms of hours**

Manual - acquiring a measurement update can be initiated at anytime **manually from the internal display/keys, external contact closure and MODBUS serial communication**

SmartStart™ measurement **update frequency increases as empty space distance decreases** (used to assist in preventing overfilling and assist in vessel level control)

The SmartStart™ algorithm for measurement update frequency is as follows:

t = SmartStart™ Timer + ((Actual Measured Distance/Height) x (Auto Timer-SmartStart™ Timer))

The *Auto* Timer must always be set to a value greater than the SmartStart™ Timer when SmartStart™ is being utilized. A SmartStart Timer of 0.0 means the SmartStart™ algorithm is not in effect.

EXAMPLES:	Auto Timer =	1.1 hours
	SmartStart™ Timer =	**0.5 hours**
	Height =	33ft (10m)
	Last Distance Measured =	16.4ft (5m); Measurement Frequency = 0.8 hours
	Last Distance Measured =	5ft (1.5m); Measurement Frequency = 0.6 hours
	Auto Timer =	1.1 hours
	SmartStart™ Timer =	**0.9 hours**
	Height =	33ft (10m)
	Last Distance Measured =	16.4ft (5m); Measurement Frequency = 1.0 hours
	Last Distance Measured =	5ft (1.5m); Measurement Frequency = 0.93 hours

Auto Timer =	0.4 hours
SmartStart™ Timer =	**0.2 hours**
Height =	33ft (10m)
Last Distance Measured =	16.4ft (5m); Measurement Frequency = 0.3 hours
Last Distance Measured =	5ft (1.5m); Measurement Frequency = 0.23 hours
Auto Timer =	0.4 hours
SmartStart™ Timer =	**0.1 hours**
Height =	33ft (10m)
Last Distance Measured =	16.4ft (5m); Measurement Frequency = 0.25 hours
Last Distance Measured =	5ft (1.5m); Measurement Frequency = 0.145 hours

When using SmartStart™ the measurement update frequency will never be greater than the Auto Timer value, nor will it be less than the SmartStart™ Timer value. It will vary between the Auto and SmartStart™ timer values dependent on the actual measured distance.

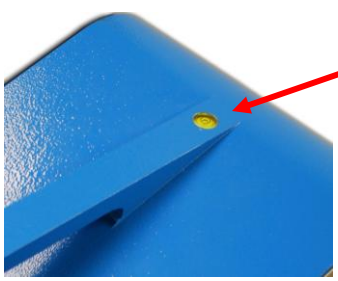
Materials

Typical powder and bulk solid materials that can be monitored using the Model WC smart inventory monitoring sensor include materials with density from 5lbs/ft^3 (80kg/m^3) up to over 100lbs/ft^3 (1600kg/m^3). A variety of sensing weights are available (refer to Options/Accessories section) to fit the application based the material type and bulk density. Example materials that can be monitored with the Model WC include:

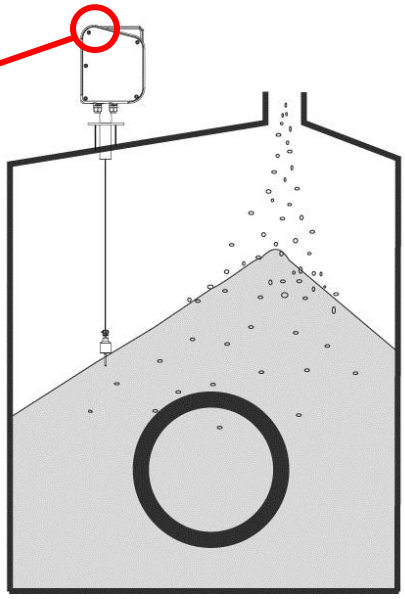
Plastic Pellet	Food Ingredients	Feed
Grains	Cement	Nuts
Resins	Aggregates	Sand
Limestone	Wood	Sawdust
Liquids	Oils	Plastic Regrind

Installation

BlueLevel Technologies Model WC smart inventory monitoring sensors can be mounted on the top of most vessels. The sensor must be installed so that the mounting flange is level and plumb allowing the sensing weight/cable to drop directly down. The Model WC is provided with a built-in "bulls eye" style of leveling device to assist in proper installation.



Bulls-Eye Level Assistant



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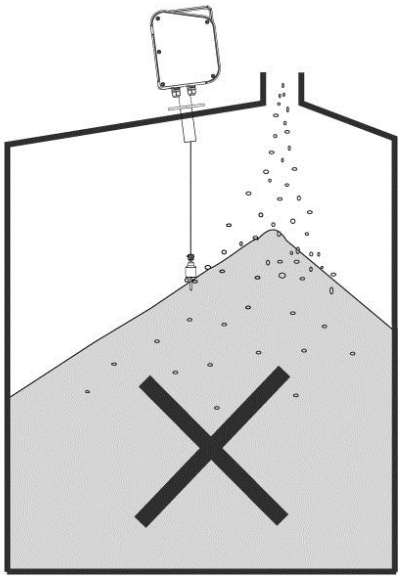
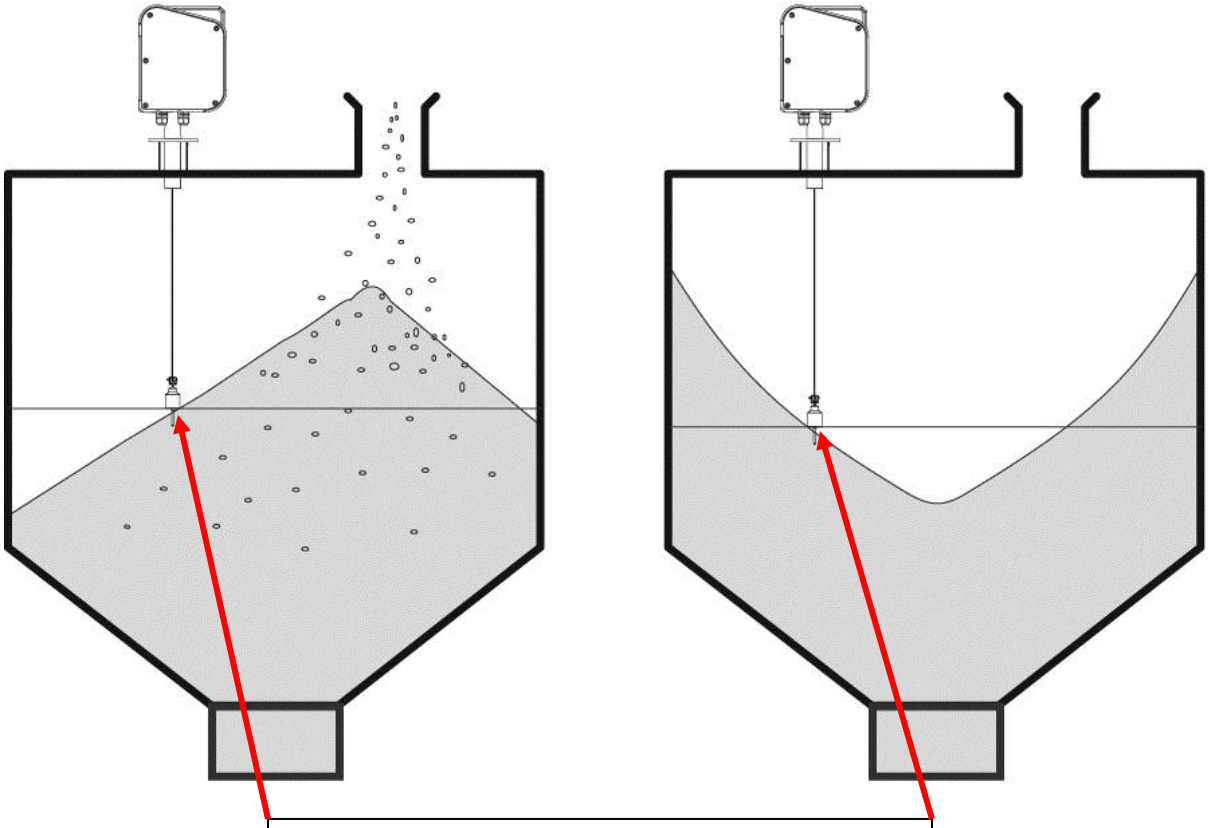


DO NOT

The Model WC can be mounted using any of the three available flanges, flat, 5 degree or 10 degree so that it can accommodate easy installation on most vessel roofs, including standard angled/sloped roofs with 5 degree or 10 degree pitch.

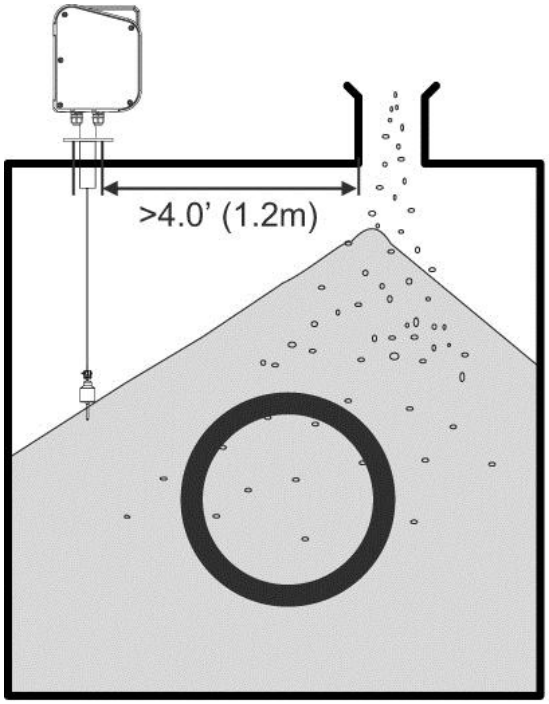
The Model WC smart inventory sensor flanges are designed with an industry standard mounting pattern incorporating six (6) 0.34" holes equally spaced on a 7.0" diameter bolt circle. This applies to the flat, 5 degree and 10 degree flanges. The cutout opening in the vessel roof should be 4.5-5.5" diameter.

Mounting location on the vessel roof is important to ensure proper operation as well as to provide the opportunity for the best accuracy when converting the empty space distance of material level to volume or weight. Mounting where a "neutral point" exists is best. The neutral point is a point on the surface of the material profile or angle of repose where the material above an imaginary horizontal line (based on a empty space distance measurement) is equal to the empty space below the same line. With cylindrical vessels having a single center fill inlet and a single center discharge, the neutral point can be found 1/6th of the diameter in from the vessel wall. Consult with the BlueLevel Technologies factory with any questions regarding the optimal mounting location.



Find the neutral point where material above the imaginary line is close to or equal to the empty space below the line during filling and discharge, whether a positive or negative angle of repose. Vessels with off-center fill or discharge locations can present challenges to locating the optimal neutral point.

The Model WC smart inventory sensor should be mounted away from the material fill inlet. Optimal installations will have the sensor mounted at least 4.0’ (1.2m) away from the fill inlet. Distance from the vessel sidewall should also be maximized to at least 2.5’ (0.6m).



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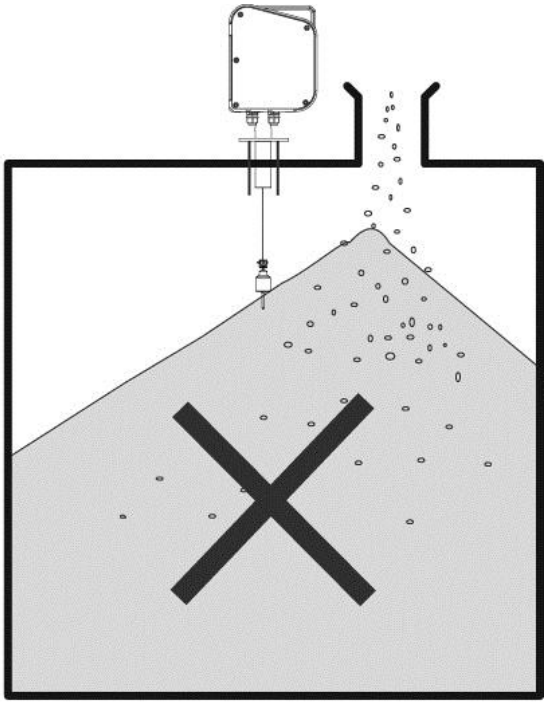


DO NOT

Features

Important features create uniqueness in the Model WC smart inventory monitoring sensor. These features include:

- Multiple measurement outputs standard in each unit, including MODBUS serial communication, 0/4-20mA analog, DC transistor pulse and AC Relay pulse outs.
- Material alarm relay outputs include High and Low level to assist in vessel level control.
- Self-Validating smart technology alerts you via a sensor fault relay output in the event of a problem during a measurement cycle, including cable break, buried sensing weight and sensor lockout.
- 3G (third generation) smart weight & cable technology including AutoReturn™ and SmartStart™ measurement cycle initiation.
- Choice of measurement cycle initiate including Auto, Manual and SmartStart™.
- Intelligent measurement control system continues pull of weight/cable to original position in methodical programmed manner even if return is slowed or delayed to improve reliability.
- Maximum measuring range of 98ft (30m).
- Universal 100-240VAC power supply minimizes versions.
- AutoReturn™ function ensures sensing weight/cable retraction at operator configured distance for application.
- Magnetic Hall-Effect technology and microcontroller provide high resolution measurement and reliability.
- Built-in LCD and keys simplifies sensor setup.
- Replaceable wiping block and brushes keep cable clean.
- Optional Model RCU remote control unit is available to provide remote access and display of sensor for up to 128 sensors per each of two (2) MODBUS sensor networks.

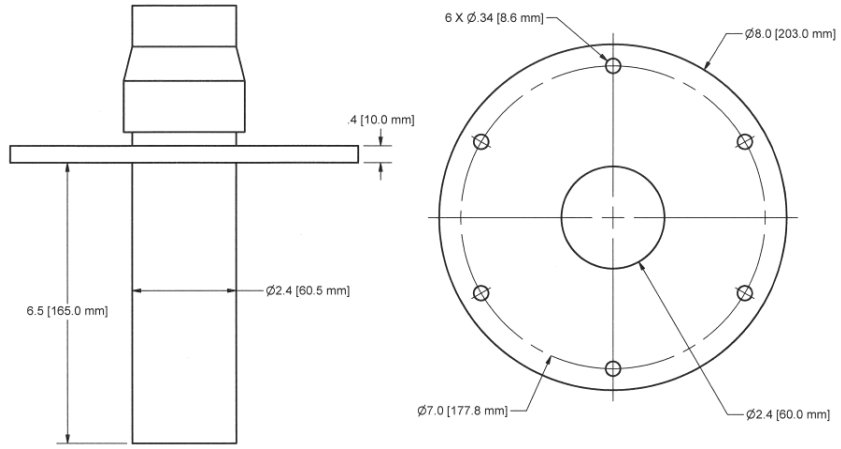
Options/Accessories

Each Model WC smart inventory monitoring sensor is available with a choice of mounting flange and sensing weight.

Mounting Flanges

A choice of four (4) mounting flanges are available; Flat Flange, 5°, 10° and 30° Angled Flange to suit a range of vessel roofs and provide for a plumb level mounting of the sensor. All mounting flanges are of 304 stainless steel material welded to the mounting pipe which houses the wiper block/brush assembly.

Flat Mounting Flange (refer to Dimensions section for all flange types)

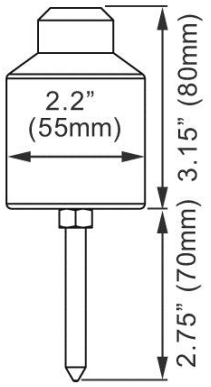


Sensing Weights

Standard Aluminum

The standard sensing weight is constructed of aluminum alloy and is used for a wide variety of bulk solids with a minimum bulk density of 20lbs/ft^3 (320kg/m^3).

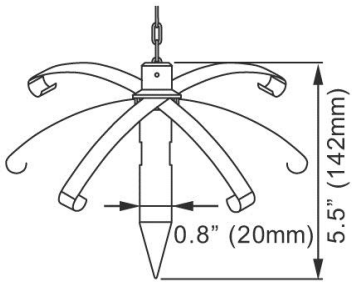
Standard Aluminum



Umbrella

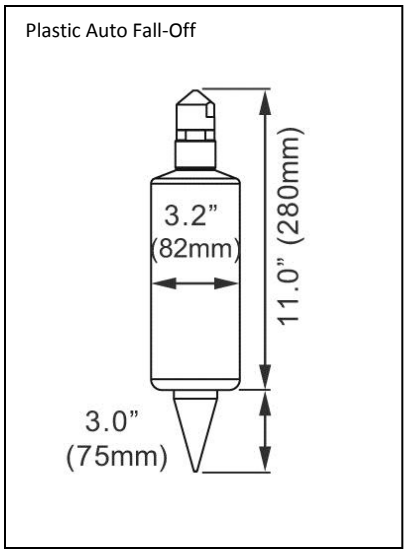
For lighter weight materials a larger sensing weight is required for buoyancy on an adequate amount of material. The umbrella sensing weight is constructed of 304 stainless steel and is typically used with materials that have bulk density from 5.0lbs/ft^3 (80kg/m^3) and up.

Umbrella - 304 SS



Plastic Auto Fall-Off

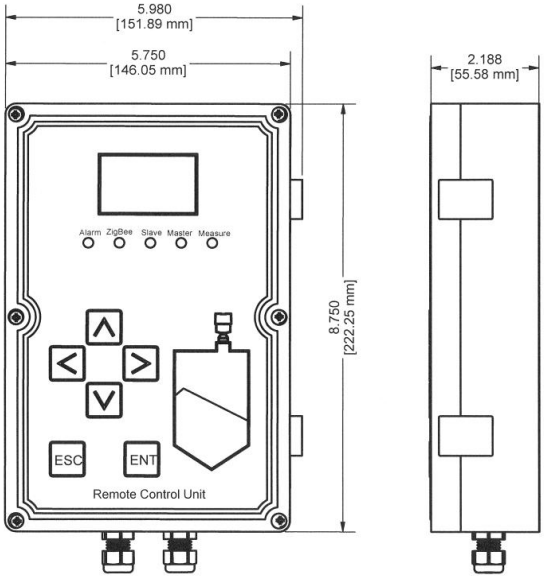
This sensing weight is used when the weight needs to be constructed of a relatively inert material and the application requires further protection against breaking the heavy duty nylon jacketed stainless steel cable. The Plastic Auto Fall-Off sensing weight constructed of polyethylene and filled with polyethylene pellet. The attachment system of this sensing is designed such that it will separate cleanly from the cable if the tension weight exceeds 220lbs (100kg). If desired, the operator can remove the polyethylene pellet and replace it will the material that is within the vessel. The maximum weight for the Plastic Auto Fall-Off sensing should between 1.3 to 2.2lbs (0.6 to 1.0kg).



Remote Control/Display

Model RCU Remote Control Unit

The Model RCU remote control unit connects with up to 128 sensors per MODBUS RS-485 network. Two network serial connections are provided. The RCU will display measured data of one or four sensors at a time. Sensor programming of select parameters can also be performed through the RCU. In addition, the RCU allows the operator to manually initiate measurements of a single sensor or all sensors at one time. The RCU can provide empty space distance or material level data in Metric (meters) or English (feet) units to two decimal places. The data is displayed on a backlit LCD display module with white characters on a blue background.



The RCU can interface with a PC slave using a slave RS-485 serial MODBUS connection.

A SPDT relay output is also provided to indicate that a sensor alarm exists within the network(s) connected to the RCU.

Ordering Information

Model WC Smart Inventory Monitoring Sensor
Part Number Structure

5 0 – 1 X 1 X – X X X

Cable
- 1 – Nylon Jacketed Stainless Steel

Sensing Weight
- 1 – Standard - Aluminum
- 2 – Umbrella - Stainless Steel
- 3 – Plastic Auto Fall-Off - Polyethylene
- 4 – Ball Float - Stainless Steel
- 5 – Standard - Stainless Steel

Mounting Flange
- 1 – Flat
- 2 – 5 Degree Angled
- 3 – 10 Degree Angled
- 4 – 30 Degree Angled

Approvals
- 1 – CE Mark

Model
- 1 – Standard

Model RCU Remote Control Unit
Part Number Structure

5 6 – 1 1 1 1 – 1 1 1

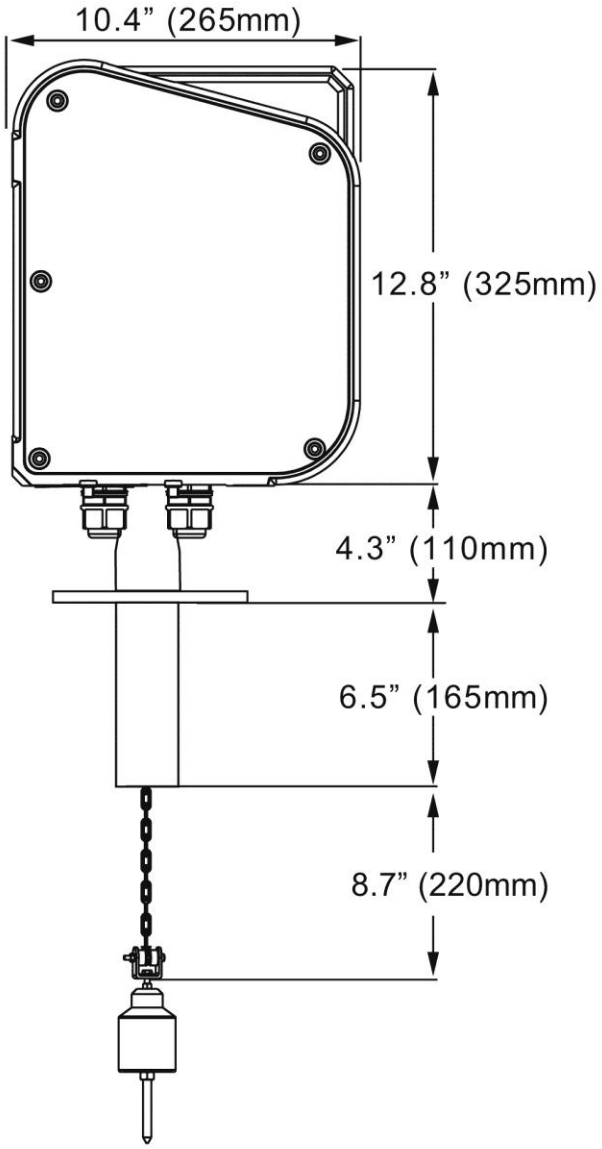
Model WC Technical Data

Power Supply:	100-240VAC; ±10%; 50/60Hz
Power Consumption:	6VA
Ambient Temperature:	-31°F to +140°F (-35°C to +60°C)
Process Temperature:	-31°F to +176°F (-35°C to +80°C)
Enclosure:	NEMA Type 4X, IP66, Powder Coated, Cast Aluminum
Outputs:	
Serial	MODBUS
Analog	0-20mA or 4-20mA
DC Pulse	Transistor NPN/PNP; 0.1ft/pulse or 10mm/pulse; Pulse duration 10ms; ± 3 pulses resolution
AC Pulse	Relay 250VAC; 0.1ft/pulse or 100mm/pulse; Pulse duration 15ms; ± 1 pulse resolution
Material Level	
High Level	SPDT, 3A@250VAC
Low Level	SPDT, 3A@250VAC
Self-Validation	SPDT, 3A@250VAC, Flashes 1s for Buried Sensing Weight, 2s for Broken Cable; Steady for Lockout
Measuring Speed:	0.75ft/s (0.23m/s)
Measurement:	Distance or Material Level
Measuring Range:	98ft (30m) Maximum
Measuring Modes:	
Manual	Remote Contact, Local Keypad, MODBUS
Auto Timer	0.1 to 99.9 hours
SmartStart™ Timer	0.1 to 99.9 hours
Accuracy:	<0.5% of distance reading
Display/Keys:	Dot Matrix, 8x8, LCD; UP, LEFT, ENT, RUN
Process Connection:	Flange - six (6) 0.34” diameter holes on 7.0” bolt circle; Flat, 5 Degree or 10 Degree
Electrical Entry:	Two (2) M25 x P1.5 Cable Glands
Measuring Cable:	$\frac{1}{16}$” Dia. Nylon Jacketed , 7x7 304 SS
Air Purge:	¼” NPT, ¼” PT
Weight:	38.5lbs (17.5kg)
Certifications:	CE Mark

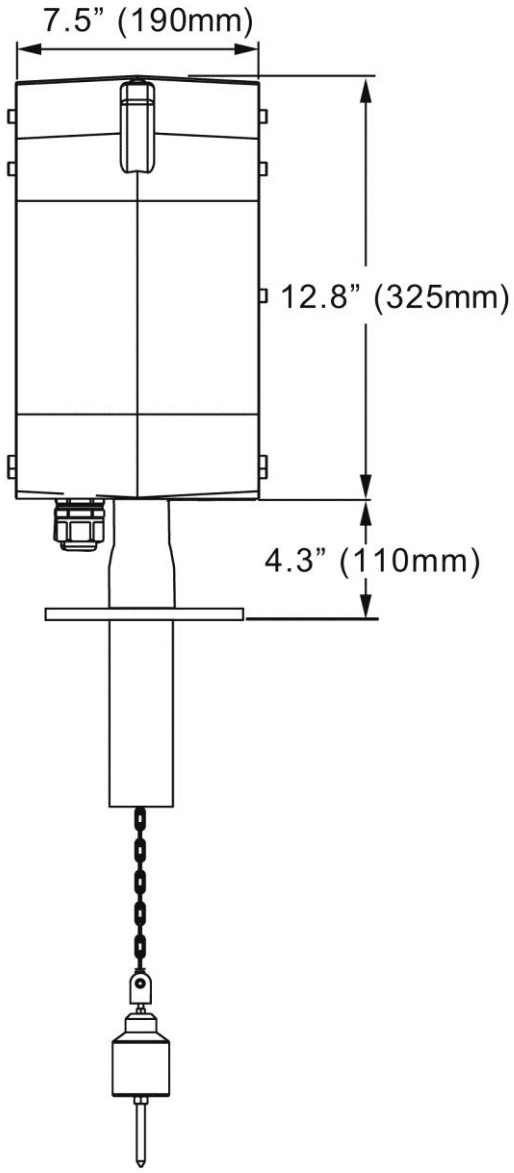
Model RCU Technical Data

Power Supply:	20-250VAC 50/60Hz / 20-250VDC
Maximum Current:	0.2-0.25A (with 128 sensors connected)
Ambient Temperature:	-40°F to +185°F (-40°C to +85°C)
Process Temperature:	-40°F to +185°F (-40°C to +85°C)
Enclosure:	IP65, Polypropylene
Display:	LCM (liquid crystal display module)
Outputs:	
Serial	(2) RS-485 MODBUS Master (up to 128 sensors each) (1) RS-485 MODBUS Slave (for PC)
Relay	(1) SPDT 3A @ 250VAC (sensor alarm indication)
LED Indicators:	MASTER (indicates activity on RS-485 Master serial line) SLAVE (indicates activity on RS-485 Slave serial line) ZIGBEE (indicates activity when installed and operating) MEASURE (indicates and sensor measurement in process) ALARM (indicates a sensor alarm condition exists)
Keys:	UP, DOWN, LEFT, RIGHT, ENT, ESC
Electrical Entry:	Two (2) Cable Glands
Weight:	1.3lbs (0.6kg)
Certifications:	CE Mark

Dimensions

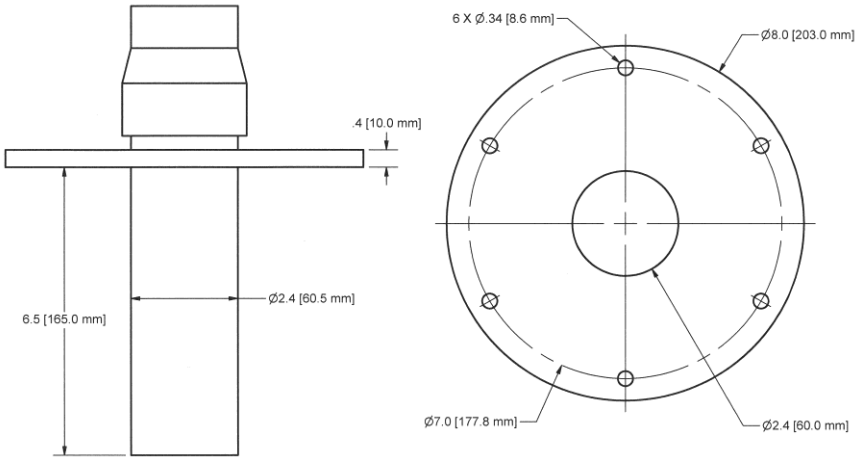


FRONT/REAR VIEW
(mechanics view shown)

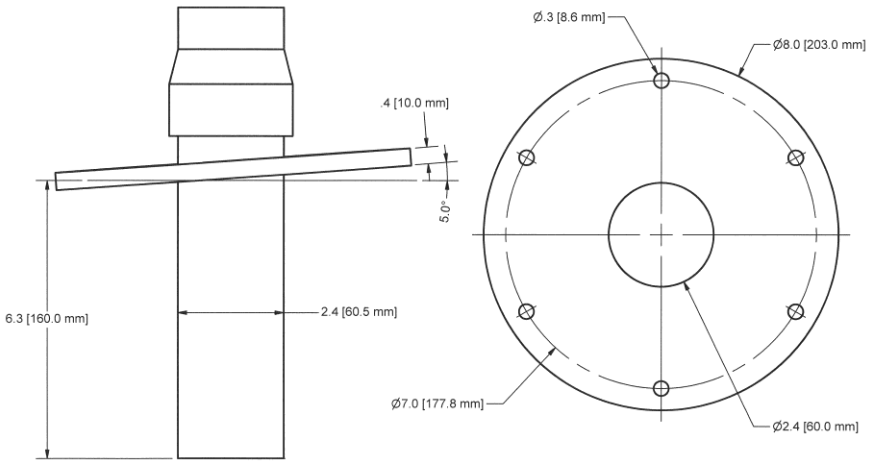


SIDE VIEW

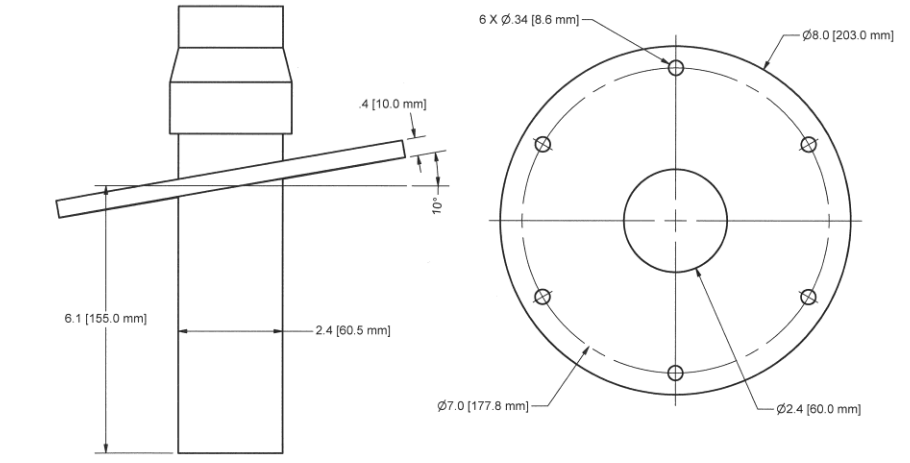
Flat Mounting Flange/Pipe Assembly



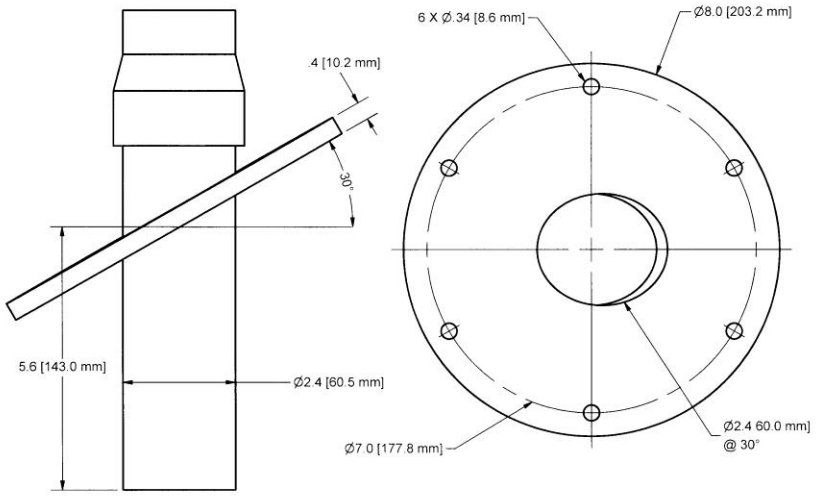
5 Degree Mounting Flange/Pipe Assembly



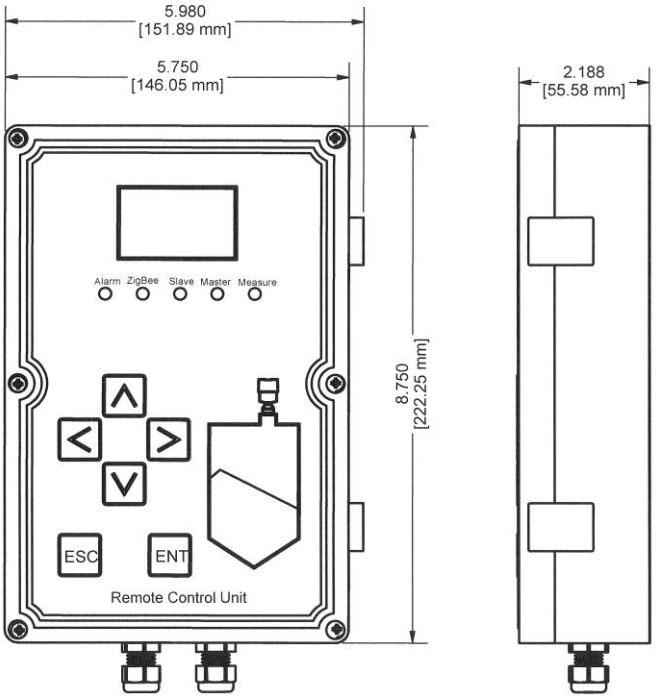
10 Degree Mounting Flange/Pipe Assembly



30 Degree Mounting Flange/Pipe Assembly



Model RCU Remote Control Unit



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