BULLETIN 354A

INSTALLATION & OPERATION

Flexar®

Guided Wave Radar
Continuous Level Measurement System

Guided Wave Radar

Thank you for purchasing a quality product from Monitor Technologies LLC. We realize that you do have a choice of vendors when procuring level measurement equipment and we sincerely appreciate your business!

⚠ This manual contains the information necessary to ensure a safe and successful installation. Please read and comply with the section on page 34 of this manual pertaining to SAFETY. Doing so will ensure proper operation of the equipment and the safety of all personnel.

Before discarding the shipping container, please inspect it thoroughly and verify that all parts ordered are accounted for. Sometimes smaller parts become stuck under carton flaps and other packaging materials.

In the event that information contained herein does not completely satisfy your requirements or answer your questions, you may contact our Technical Support personnel on our website www.monitortech.com, by telephone at 800-766-6486 (630-365-9403) or by fax at 630-365-5646. If your level measurement system ever requires service either in or out of warranty, please contact us and obtain an RMA (return material authorization) number prior to shipping the unit to us.

MONITOR®

www.monitortech.com

ATTENTION:

USE OF VOLUME/WEIGHT DISPLAY

The Flexar® guided wave radar continuous level measurement system makes a direct measurement of the distance between the sensor and the material surface when in the Direct measuring mode. This device does not measure the volume or weight of the material within the vessel. Flexar can perform calculations to display volume or weight based upon user data input in the provided "strapping calibration table". The volume and weight values displayed are based on the level/volume data entered by the user during setup.

NOTE 1: The volume and weight values calculated and displayed by Flexar units should be considered "estimates". Since these displayed values of volume or weight depend upon the precision of the strapping table data provided by the user, Monitor Technologies LLC accepts no responsibility for the accuracy of the calculated and displayed volume or weight values. The accuracy of the volume or weight display is not stated or warranted.

NOTE 2: When using Flexar units in conjunction with **SiloTrack**™ inventory management software or the **HMI²** control console the accuracy of calculated volume and weight by **SiloTrack** or **HMI²** is based upon vessel dimension and bulk density data provided by the user. The fluctuation and accuracy of various factors affect the accuracy of volume and weight calculations by **SiloTrack** or **HMI²** (not stated or warranted). These factors include, but may not be limited to, actual vessel dimensions, sensor mounting location, angle of repose (negative and positive), actual material bulk density, material flow properties (ratholes, bridging, etc.), material inlet/discharge locations and material packing.

Prior to equipment installation, please consult the factory to discuss the application details if the volume/weight calculation are of critical importance.

PRINCIPLE OF OPERATION

The Flexar® guided wave radar sensor has been developed from proven technology called "Time Domain Reflectometry" (TDR). Other applications of TDR include checking for and locating damage along telecommunication cable lines.

The Flexar unit sends low-power electromagnetic pulses of one nanosecond width along a rod or cable conductor. This pulse travels at a known speed, the speed of light. Upon reaching the surface of the material to be measured, the pulses are reflected back with an intensity that is dependent on the dielectric constant, ε_r, of the material.

A material's dielectric constant, ε_r, is an electrical property. The strength of the pulse reflection from the surface of the material being monitored is measured and processed by the Flexar electronics as a signal with an amplitude in volts. The higher the dielectric constant, ε_r, the stronger the reflection. As an example, up to 80% of the pulse strength is reflected from the surface of water which is a high ε_r material.

Flexar sensors measure the time between the emission and the reception of the pulse signals. Half of this time corresponds to the distance from the instrument reference point (the process connection / flange face on the sensor) to the material surface. This value of time is converted into a digital signal corresponding to a calibrated distance or an analog current output between 3.8 and 20.5mA. The resulting signal is also displayed digitally on the sensor's LCD display.

A measurement made using this sensor technology (TDR) has the advantage of being uninfluenced by dust, vapor, foam and agitated and boiling surfaces. Pressure, temperature and density variations also have no affect. Figure 1 illustrates a basic measurement application. Figure 2 shows the calibrated output values within the effective measuring range assuming a current output is selected.

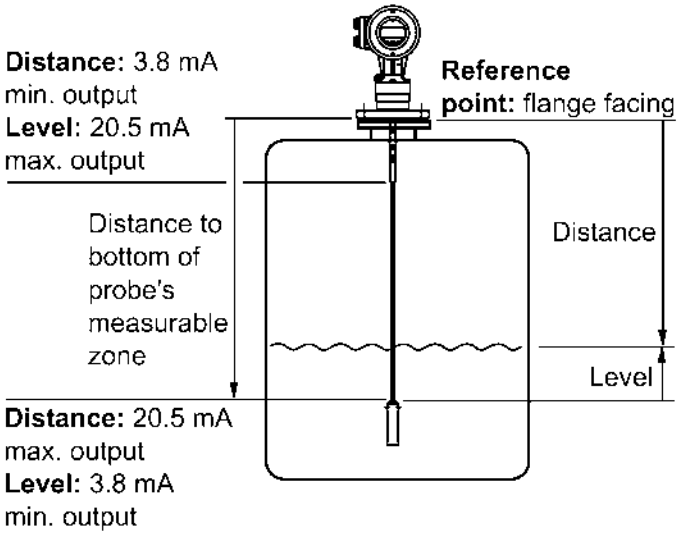


Figure 1

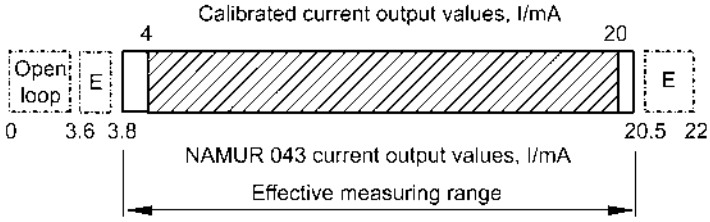


Figure 2

"I" = current output in mA
"E" = error

When: I < 3.6mA: the current loop is open
I = 3.6mA: error status
(when programming Fct. 1.3.2 is set to
send 3.6mA upon error)
3.8mA ≤ I ≤ 20.5mA: minimum-to-maximum
measuring range
I = 22mA: error status
(when programming Fct. 1.3.2 is set to
send 22mA upon error)

The Flexar guided wave radar level sensor can determine the level of a target material in one of two ways, depending on the dielectric constant, ε_r, of the material:

Direct Mode: Used for level measurement of materials where the dielectric constant is above 1.8 (twin cable; 2.1 for single cable units). The electromagnetic pulse is emitted by the Flexar sensor and guided along the probe ("wave guide"). Refer to Figure 3. The pulse reflects off the first material surface it meets and returns to the sensor electronics. The distance from the sensor process connection (flange or threaded connection) to the target material is proportional to the time-of-flight of the pulse. The level of the material is determined by subtracting the distance to the material from the distance to the bottom of the tank.
(1) = Flange reflection, (2) = Level measurement.

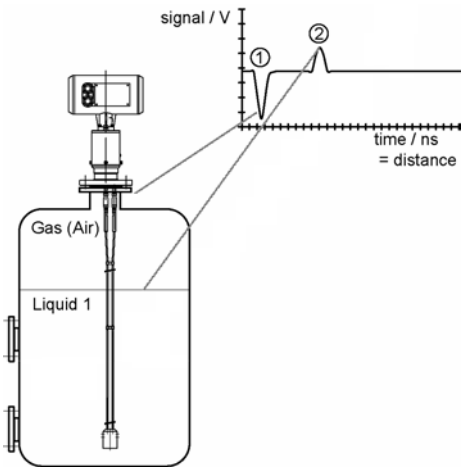


Figure 3

Tank Bottom Following (TBF) Mode: A material with a dielectric constant of less than 2.1 (depending on the probe type) does not always permit an electromagnetic pulse to reflect enough energy off its surface. Much of the electromagnetic pulse passes through the very low dielectric material. Because of very weak reflection off the material surface, when using the Direct mode in these cases the level sensor may confuse erroneous signals or other objects in the tank as being the material level. If this occurs, the TBF mode should be used to achieve the measurement. The TBF mode is typically considered to be used for applications where the dielectric constant is below 2.1 (depending on probe type and application) and as low as 1.40.

In the TBF measuring mode the level sensor will compare the time it takes for the pulse to reflect off the bottom of the probe through material to the time it takes with no material present (air). The time taken for the pulse to travel to the bottom of the probe (end of the measuring section of the probe) when the tank is empty is measured and calibrated at the factory. The reflection off the bottom of the probe takes an increasing amount of time to return to the sensor electronics as the tank is filled with material.

Refer to Figure 4. The emitted pulse travels through air at a known speed, c_0 (the speed of light), and upon reaching the surface of the target material it continues through the material at a slower speed, c_1, this being dependent upon the dielectric constant of the product. Knowing c_0, the difference in time spent travelling at speed c_0 and speed c1 is proportional to the material level.
(1) = Flange reflection, (2) = Reflection from end of probe when vessel is empty, and (3) = Reflection from end of probe when material is present in the vessel.

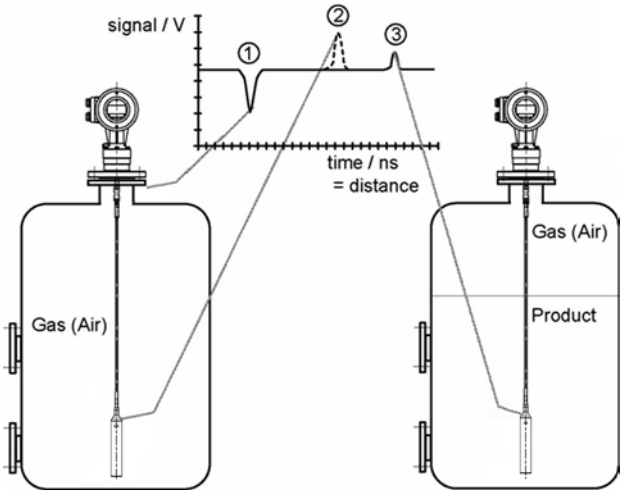


Figure 4

PRE-INSTALLATION CONSIDERATIONS

Handling The Sensor: ⚠ The Flexar® sensor will normally weigh between approximately 25lbs (11kg) and 77lbs (35kg). Carry the sensor using two people, lifting it by the process connection and supporting the probe. Lifting equipment (Figure 5) may also be used, but no attempt should be made to lift the device by the probe itself.

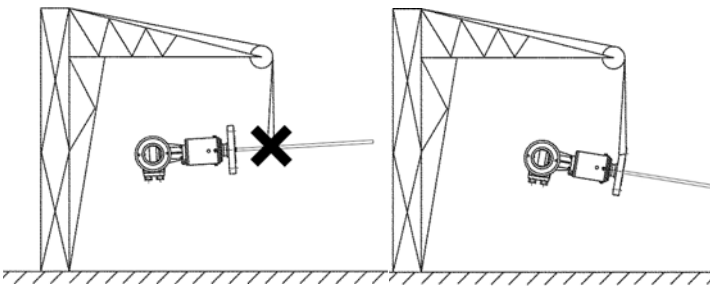


Figure 5

⚠ Caution: The Flexar probe is a critical sensor component. Do not damage – Handle with care!

Avoid hard blows, impacts and jolts when handling the Flexar guided wave radar sensor. Refer to Figure 6.

⚠ Caution: Fragile electronics.

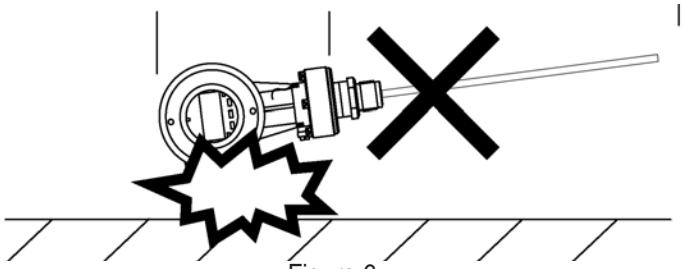
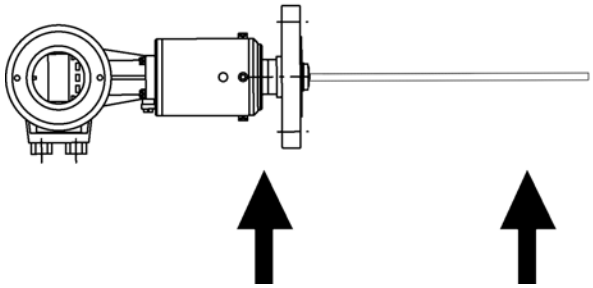


Figure 6

Rod probes: Support the probe to avoid bending.
Refer to Figure 7.



Support Probe Here

Figure 7

Cable probes: Avoid cable kinks or fraying. Do not coil cable less than 16" (400mm) in diameter. Cable kinks or fraying will cause measurement errors.

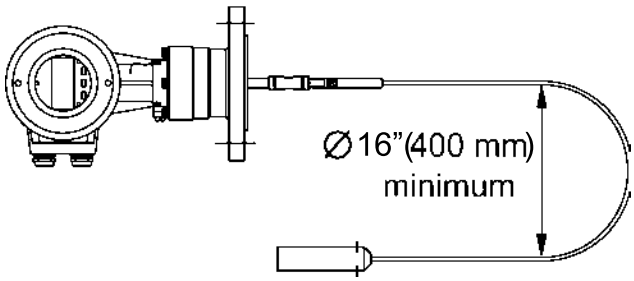


Figure 8

Flexar guided wave radar continuous level sensors are designed to be top mounted on vessel using a suitable process connection. Install the sensor using two people to avoid damaging the probe. Support the housing and the probe. Refer to Figure 9 for guidance in handling single and twin cable probes.

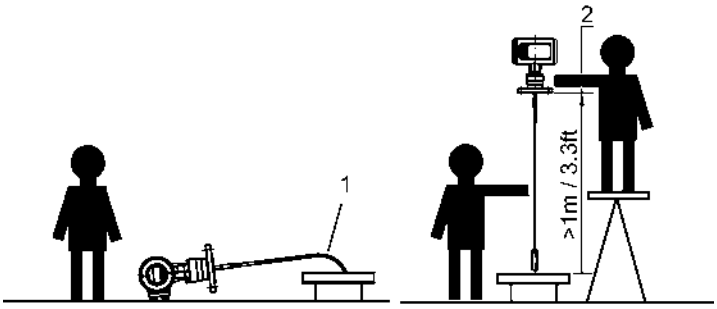


Figure 9

⚠

1) **Caution**: Do not over-bend the probe!

2) **Inserting the probe**: Hold more than 3.3ft. (1m) above the opening to avoid cable bending.

Mounting Connection - Nozzles: Many installations will utilize a flanged process connection that will allow the Flexar sensor to mount to a mating flange on the top of the vessel. To ensure that the emitted pulse is unobstructed, prior to installation the installer should consider the tank connection fitting and the tank shape as noted below:

- The mounting location in relation to the vessel walls and other objects inside the vessel should be considered. (Warning: space between sensor probe and vessel walls and internal objects depends upon probe type; refer to section regarding “Electromagnetic Field Shape” in this manual for further information).
- The type of vessel roof that the sensor will be mounted to, i.e. flat, sloped (angle), concrete, floating, etc.; and the ves sel bottom, i.e. flat, conical, etc. should be considered.

⚠ The nozzle height should never be longer than its diameter (up to a max. height of 6”). In Figure 10, h ≤ d, where h = nozzle height and d = nozzle diameter. Contact Monitor Technologies technical support personnel if this relationship cannot be achieved.

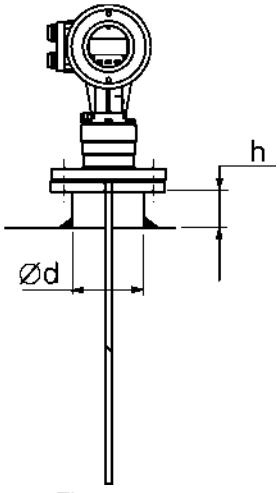


Figure 10

⚠ Do not use nozzles that extend into the vessel. This will block the emitted pulse. Refer to Figure 11.

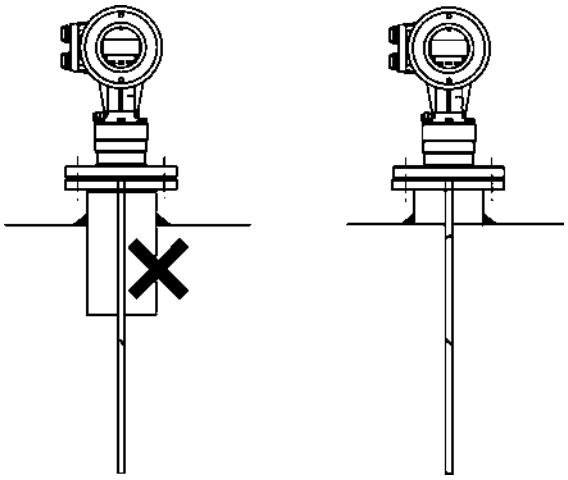


Figure 11

Mounting Connection – General:
For the Flexar sensor to make accurate measurements:

- The vessel connection must be level and the sensor probe must hang plumb when mounted.
- Ensure a good fit with the sensor process connection.

Refer to Figure 12 and Table 1. Install the process connection away from protruding objects such as:

- Tank wall reinforcements, beams and ladders
- Weld lines
- Sudden changes in vessel cross-section
- Heating tubes.

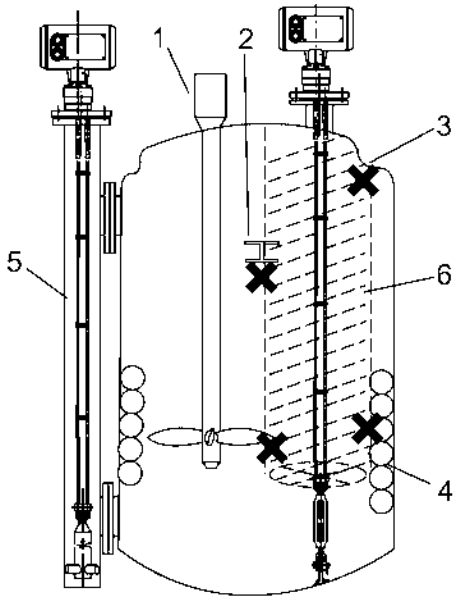


Figure 12

(**X** = Do not locate the process connection near to these objects.)

See next page for descriptions of numbered items. >>>

1) Agitator/mixer
2) Support beam perpendicular to the pulse direction
3) Abrupt changes in vessel cross-section
4) Heating tubes
5) Alternate solution: reference chamber where electromagnetic field is contained within chamber
6) Probe electromagnetic field: any intruding metallic object in this area will create interference if perpendicular to the emitted pulse direction.

Table 1

Probe Type	Recommended minimum distance of probe from objects inside the tank
Single Twin	12" (305mm) 4" (102mm)

Electromagnetic Field Shape:
Refer to Figure 13. The shape of the electromagnetic field differs by probe type. Make sure that the mounting location will be such that no obstruction or vessel wall will be within this field as this will result in measuring and reliability problems. Because the electromagnetic pulse is guided by the probe (wave guide) there is no beam angle for any probe type.

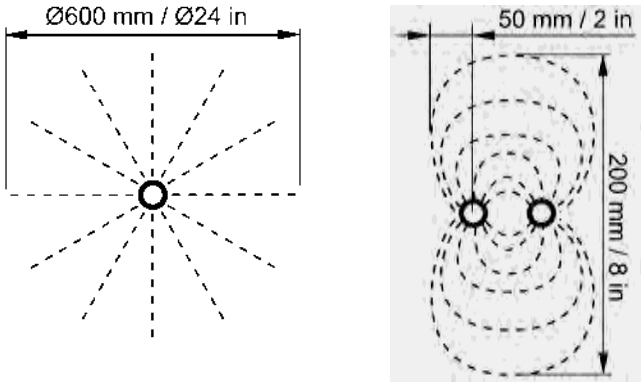


Figure 13

Single Cable / Rod Twin Cable

Sensor Dead Zone:
The Flexar guided wave radar continuous level sensor has measurement limits, including a top dead zone and a bottom dead zone where measurement is not possible. Consideration should be given to these limits when selecting and installing a probe. Refer to Figure 14.

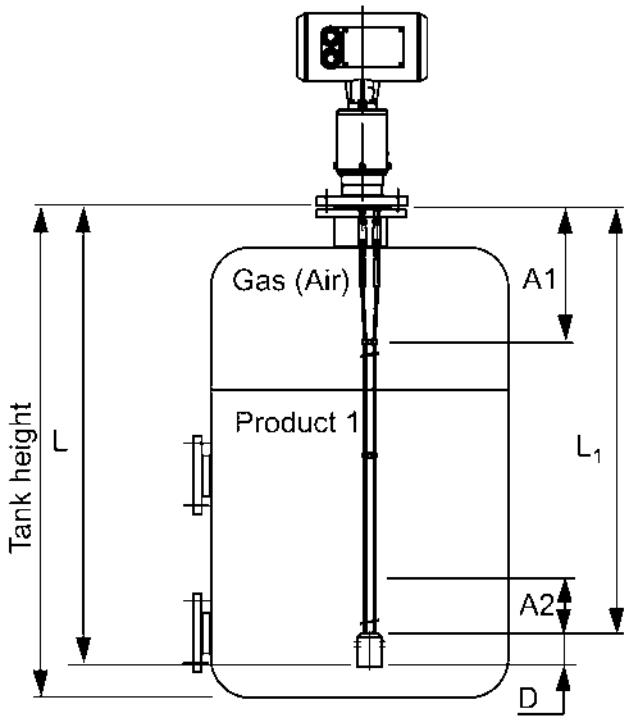


Figure 14

A1, the top dead zone, is the minimum distance from the process connection to the top limit of the measuring range. The measurement displayed on the sensor display will freeze below this distance (when level of material is above this point) and status markers will indicate that the reflection has been lost.

A2, the bottom dead zone, is a length at the end of the probe where measurement is not possible. For material with very low dielectric constants ($\varepsilon r < 5$), accuracy may be affected in a non-linear zone up to 6" (152mm) above the bottom dead zone, A2.

D, the non-measurement zone, is a zone where measurements cannot be taken (i.e. the counterweight, turnbuckle, etc. – except the 0.47" x 3.90"(12mm x 100mm) counterweight for the 0.31"(8mm) single cable probe). The measurement indicated on the Flexar display will freeze to L1.

L1, factory configured probe length, is the length to the end of the probe (excluding short circuit or counterweight). This parameter is given in the programming Fct 1.1.7 in the configuration mode.

L, Probe Length, is the length specified by the customer for "probe length" on the customer order.

⚠ **Warning**: Set the user programming Fct 1.1.2 "Hold Distance" in the sensor's configuration mode to at least the size of the top dead zone as specified by probe type in Table 2 so that the sensor never displays the material level within this zone. Refer to the user programming Fct. 1.1.2 for more information.

Table 2 (Refer to Fig 14)

Probe Measurement Limits				
Probe type	Top dead zone, A1 $\varepsilon r = 80^*$	Bottom dead zone, A2 $\varepsilon r = 80^*$	Top dead zone, A1 $\varepsilon r = 2.4$	Bottom dead zone, A2 $\varepsilon r = 2.4^*$
Twin cable	9.8" (250mm)	0.8" (20mm)	13" (330mm)	3.9" (100mm)
Single rod	15.75" (400mm)	0.8" (20mm)	19.7" (500mm)	3.9" (100mm)
Single cable 0.16"(4mm)	15.75" (400mm)	0.8" (20mm)	19.7" (500mm)	3.9" (100mm)
Single cable 0.31"(8mm)	15.75" (400mm)	0.8" (20mm)	19.7" (500mm)	3.9" (100mm)
*The dielectric constant, εr, of water is 80. The dielectric constant, εr, of oil is 2.4.				

Solids Applications:
Applications where the Flexar sensor is used to measure the level of a powder or other bulk solid material have unique requirements to be considered. Figure 15 illustrates false readings that can occur if the probe is allowed to touch the side of any mounting connect such as a nozzle.

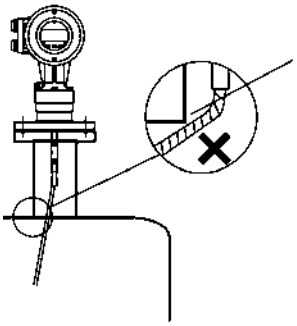


Figure 15

(1) Do not let the probe touch the side of the mounting connection, such as the nozzle.

In addition, most powder or bulk solid applications use a conical shaped silo. These applications require that traction load forces and bending forces be considered. Refer to Table 4. While the optimal mounting location for overall system accuracy with a solids application (where the fill and discharge points are located in the center of the vessel) is 1/6 the diameter from the vessel wall, the best location for Flexar sensors is 1/2 the radius of the cone shaped silo as shown in Figure 16.

(2) High traction forces: It is recommended that the Flexar probe NOT be anchored to avoid excessive traction loads on the probe.

(3) Bending and traction: Position the connection for the sensor on the roof at 1/2 the radius of the vessel. This avoids damage from bending and traction during emptying. Nozzle height should be minimal.

Traction Forces: Traction load is dependent upon the height and shape of the vessel, product particle size and density, and the rate at which the tank is emptied. Table 3 gives the load at which the cable probes will break.

Table 4 provides information regarding traction forces on the 8mm single cable probe according to example materials.

Table 3

Cable Strengths	
Probe	**Maximum Load**
Single cable 0.31"(8mm)	3.9tons / 7700lbs. (3.5 metric tons)
Single cable 0.16"(4mm)	1.1tons / 2250lbs. (1.02 metric tons)

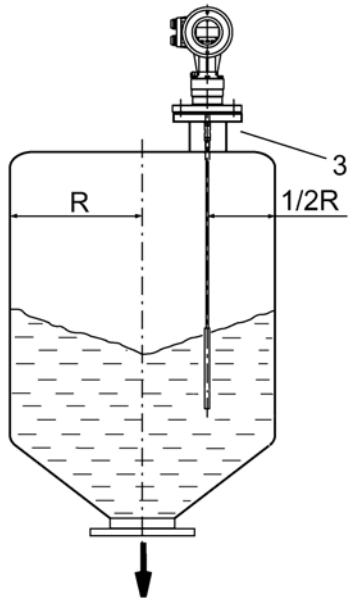


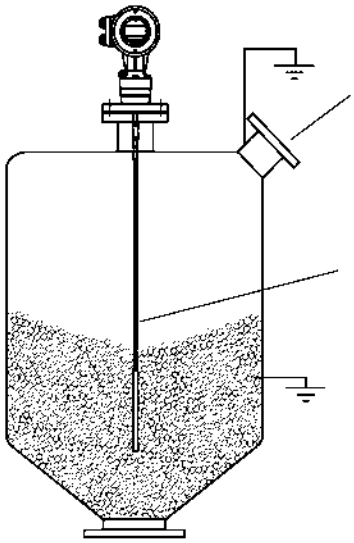
Figure 16

Table 4

Traction Load Examples				
Material	**Probe Used**	**Probe Length 32.8' (10m)**	**Probe Length 65.6' (20m)**	**Probe Length 98.4' (30m)**
Cement	Single cable 0.31"(8mm)	2200lbs (1.0 metric ton)	4410lbs (2.0 metric tons)	6620lbs. (3.0 metric tons)
Flyash	Single cable 0.31"(8mm)	0.5 T / 1100 lb	1.0 T / 2200 lb	1.5 T / 3300 lb
Wheat	Single cable 0.31"(8mm)	0.3 T / 660 lb	0.6 T / 1320 lb	1.2 T / 2650 lb

Electro Static Discharge (ESD):
Flexar guided wave radar electronics are normally shielded up to 16kV against ESD, while for non-hazardous powder applications, Flexar probes are protected up to 32kV.

⚠ **Note:** ESD problems are not solved by Flexar probe ESD protection. It is the customer's responsibility to avoid ESD by grounding the vessel, material and Flexar probe installation as illustrated in Figure 17.



(1) ⚠ **Danger of injury:** The probe may become statically-charged during operation; earth ground the probe by pushing it against the vessel wall with a suitably isolated tool just before touching it to avoid receiving a shock.

(2) Earth ground the fill inlet pipe and the material within the vessel.

Figure 17

Material Deposits:
Material build-up can occur under the mounting connection / nozzle. This build-up may weaken the electromagnetic pulse resulting in problems. Avoid cavities that permit the build-up of material.

Vessel Roof Deformation:
The roof of the vessel upon which the Flexar sensor is to be installed should support loads of at least 3.9 tons / 7700lbs. (3.5 metric tons) for single cable probes.

Process Connection & Inlet Pipe Location:
⚠ **Caution**: Do not put the mounting process connection close to the material inlet location. Refer to Figure 18. Flow of material directly onto the sensor probe will give false readings. Install a deflector plate or relocate the sensor away from the flow of incoming material if possible.

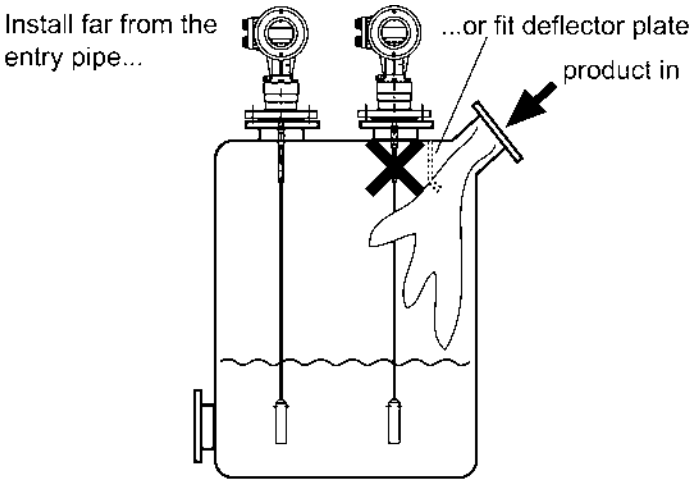
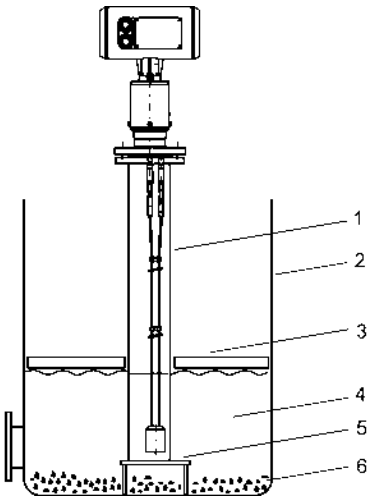


Figure 18

Stilling Wells:
Vessels with floating roofs should use a stilling well. Refer to



1) Stilling well
2) Vessel
3) Floating roof
4) Material (petroleum applications)
5) Stilling well fixed to vessel base (no roof deformation)
6) Sediment

Figure 19

Outdoor Sites:
The ambient operating temperature limits are stated within the Specifications section of this manual. These must be observed. If required, a sunshade may be installed for open-air installations where the operating temperature will exceed the stated limit. Refer to Figure 20.

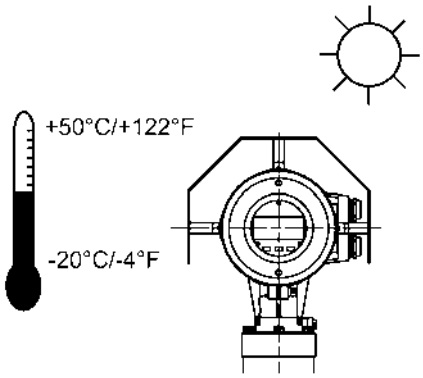


Figure 20

Liquid Applications:
Liquid applications sometimes incorporate agitators or mixers within the vessel. An agitated or mixed fluid can bend the Flexar probe. Refer to Table 5 and Figure 21 for recommended solutions to this installation problem.

Table 5

Probe (Type)	Supports and Fastenings	Stilling Well Installation*
Twin cable	Fit an anchor with an M8 x 1.25 (0.16"/4mm cable) thread (i.e. spring ring or hook) to the counterweight*** CAUTION: 4.4lbf.ft/6Nm maximum torque.	Possible. On-site calibration may be required to maintain accuracy. Repeatability is unaffected. Centering the probe is recommended. Contact Monitor Technologies LLC for more information.
Single rod	Weld a 0.5"/12mm internal diameter tube on the bottom of the vessel, insert the rod****.	Possible. 2"/50 mm minimum diameter chamber. Contact Monitor Technologies LLC for assistance.
Single cable	Fit an anchor with M8 x 1.25 (4mm cable) thread underneath the counterweight : spring ring or hook. CAUTION: 2.9lbf.ft/4Nm maximum torque.	Possible. 2"/50 mm diameter minimum. Contact Monitor Technologies for assistance.

* Reference (bypass) chamber or stilling well.
*** Threaded hole provided in base of counterweight.
**** Contact Monitor Technologies. A factory-only programming menu function may need to be changed.

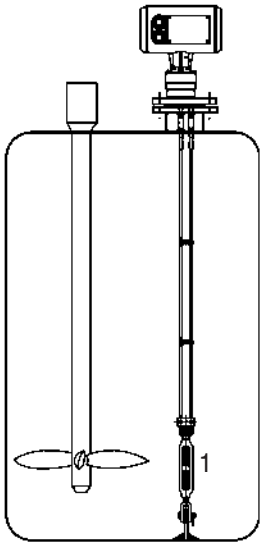
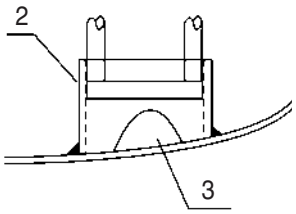


Figure 21



1) Consult factory for assistance in fitting an anchor if required.
2) Avoid play between tube and probe
3) Hole in welded tube for drainage

MECHANICAL INSTALLATION

1) Familiarize yourself thoroughly with the details contained within the Pre-Installation Considerations section before proceeding ahead.
2) Select the mounting location in accordance with the section on Pre-Installation Considerations.
3) The sensor probe must hang plumb when mounted on the vessel top. Use of a nozzle or some other mounting flange arrangement to allow for "plumb" mounting may be required.

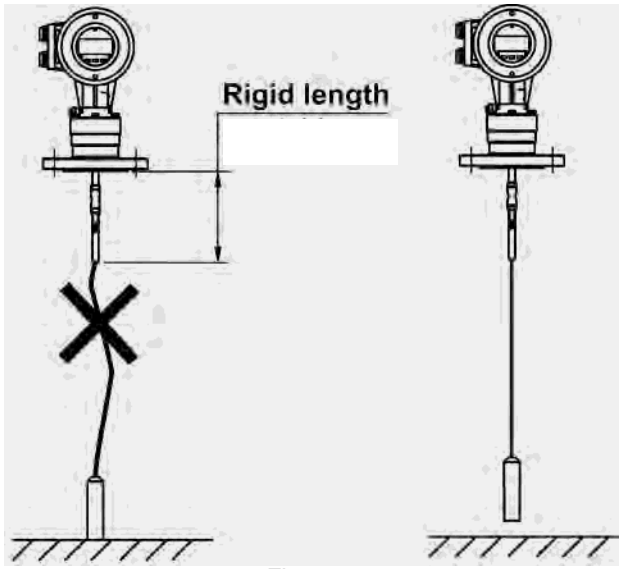


Figure 22

4) Use of a nozzle is not recommended for single probes and powder applications. Follow the guidelines for nozzle design as shown in the Pre-Installation Considerations section and ensure that the height of the nozzle is less than or equal to the diameter. The flange on the nozzle must match the flange provided on the process connection of the Flexar® sensor.
5) If the Flexar sensor is provided with a threaded process connection cut a hole in the top of the vessel. Weld the appropriate size and type fitting in place.
6) Handle the Flexar probe carefully in accordance with all instructions within the Pre-Installation Considerations section. For cable probes also refer to Figure 22 and Table 6. The cable must be straight once inserted into the vessel. The cable counterweight should not touch the bottom of the vessel. The cable must be located away from other objects (e.g. ladders, mixers, etc.) to avoid entanglement and contact.
7) Insert the probe through the process connection fitting and attach probe to vessel.

Special Notes Regarding Hazardous Location Units:
In accordance with current installation standards for hazardous locations, assembly and installation may only be carried out by specialist personnel who have received training in explosion protection.

The notes given in this installation and operation manual shall be observed without fail.

ELECTRICAL INSTALLATION

⚠ **Hazardous Location Precautions**:
Observe the regulations listed in the National Electric Code regarding equipment in hazardous locations. Ensure power is disconnected whenever the cover is removed. Upon completion of work ensure covers are completely reattached.

Where elevated process temperatures (above 212˚F / 100˚C) are concerned, use heat resistant cables with a continuous service temperature of ≥ 75˚C in conformity with the type test certificate.

⚠ Shutting off the power supply in hazardous areas: Wait before opening the housing cover. Should it prove necessary to open the explosion-proof housing or the electronics compartment in the presence of an explosive atmosphere, allow the waiting time specified to elapse:
• 27 minutes for Temperature Class T6
• 12 minutes for Temperature Class T5
In addition, make sure all cables/wires leading into the wiring compartment are isolated from the ground (reference potential) of the hazardous location. This also applies to protective conductors and equipotential bonding conductors.

Calibrating Flexar Sensor in Hazardous Areas: The Flexar sensor can be calibrated with out opening the enclosure by utilizing the Programming Magnet provided only with the purchase of a Hazardous Location rated sensor. Simply point the magnet to the magnetic sensor corresponding to the key that you wish to press through the glass cover of the enclosure, uncovered end first. All functions that are available through the Flexar key pad can be achieved without removing the cover. Refer to Figure 23 & 31.

Uncovered end of magnet

Figure 23

Special Notes Regarding Electrical Connections:
Before connecting or disconnecting the electrical interconnecting cables or wires of the Flexar sensor, make sure that all cables/wires leading to the sensor are isolated from the reference potential (ground) of the hazardous location. This also applies to protective conductors (PE) and equipotential bonding conductors (PA).

Carefully insulate all cores and shields of the connecting cables / wires not safety-connected to the equipotential bonding system for the hazardous location from each other and from ground (insulation test voltage 1500Vrms for conductors in non-intrinsically safe cables/wires).

Connect all shields by the shortest possible route to the press-fitted U-clamp terminal (PE) in the termination compartment. If shields are to be grounded at both ends (e.g. for EMC reasons), adequate equipotential bonding is required between the two shield ends to avoid unacceptable equalizing currents.

Independent of the type of power supply, the sensor must be incorporated in the equipotential bonding system in the hazardous location. This can be done by way of an appropriately conductive connection between the sensor process connection/flange mounting system and the vessel. If connection to the equipotential bonding system is to be made via a separate conductor, this must be connected to the outer press-fitted U-clamp terminal on the sensor flange.

Allowable Pressure:
The maximum allowable operating pressure for Flexar guided wave radar level sensors installed in locations requiring Category 2 G or 2 D equipment is dependent on the device flange, the flange material and the maximum operating temperature. The maximum allowable process pressure is 580psi (4,000kPa) (for PN40 flange). The upper limit applies to a stainless steel flange at ambient and process temperatures of 392° F (200° C). Higher pressure ratings are not allowed.

⚠ **Permanently Connected Equipment**:
Disconnecting devices shall be included in the system installation. In installations where multiple circuits are used (i.e. independent circuits for power input and relay output), individual disconnects are required. The disconnects shall be within close proximity of the equipment, accessible to operators, and marked appropriately as the disconnect for the associated circuit. Assure the disconnect ratings are appropriately sized for the circuit protected (Refer to Specifications).

⚠ **Protective Earthing**:
Each Flexar unit is provided with a “protective conductor terminal” which shall be terminated to the local earth ground potential to eliminate shock hazard in the unlikely event of internal insulation breakdown. Select wire size that can carry in excess of the sum of all circuit'' maximum amperage.

Insulation Rating:
The electrical insulation of the Flexar guided wave radar level sensor conforms to IEC 1010-1. Please note the following information in Table 6 concerning each rating category.

Table 6

Category	Rating	Comments
Power supply	Overvoltage category III	The sensor does not have an integrated switch or circuit-breakers. These elements must be installed in conformance to local regulations and to properly isolate the equipment when necessary. Note that this is not required for instruments with 24 V power supply boards. 4 to 6.3A time delay fuses are recommended for external installation. Fuses must be installed on every electrical conductor for the system to conform to current regulations. Note: the active phase conductor, L, is protected by an internal fuse: the neutral conductor, N, is not.
Output circuit	overvoltage category II	Fuses are unnecessary.
Insulation	contamination level 2	The contamination level refers to the protection of internal elements of the signal converter. Rated IP 66 (equivalent to NEMA 4) against ingress of water and other foreign bodies. Note that the sensor can operate in contamination level 4 conditions if installed correctly.
Protection	class 1	

Galvanic Isolation Of Terminals:
The Flexar guided wave radar sensor conforms to the standard and EU directive in Table 7:

Table 7

Standard/Directive	Description
EN (IEC) 61010-1	Safety requirements for electrical equipment for measurement, control and laboratory use (low tension)
73/23/EEC	Council Directive of 19 February 1973 on the harmonisation of the laws of Member States relating to electrical equipment designed for use within certain voltage limits (low voltage) modified by Directive 93/68/EEC (art.13).

The Flexar sensor outputs are galvanically isolated from the power supply and ground in accordance with the regulations given above. An external barrier is unnecessary.

General Wiring Notes:

⚠ **Read these instructions carefully**. Wiring must comply with any existing local regulations. Use the appropriate wiring methods, conduits and fittings to maintain NEMA 4 (IP 66) rating.

1) Always disconnect the mains power supply before opening the housing in hazardous environments.
2) Open the terminal compartment cover using the special wrench provided.
3) Use the top cable/conduit entry for the power mains.
4) Use a metal cable gland for input power leads to minimize the effects of RFI (radio frequency interference) / EMI (electro-magnetic interference).
5) Use a reinforced cable/wire for the signal outputs.
6) Do not cross or loop wires in the sensor's terminal compartment.
7) Do not kink cables/wires close to the glands. Cover with a metallic sheath at this point if necessary.
8) Make U-bends in the cable/wire to provide water with run-off points (drip loops).
9) Earth grounding the device shall be done according to the local applicable installation standards (EN 60079.14 in Europe).
10) Make sure that the cover threads in the housing are well greased and the O-ring is in good condition before replacing the cover.

⚠ **Shutting off the power supply: non-hazardous areas**. Remember to disconnect the power supply before opening the housing to perform service work.

Wiring Layout:

Open the terminal compartment cover using the plastic wrench supplied. The terminal connections are labeled. The standard connections are illustrated in the following sections.

Non-Hazardous Version:

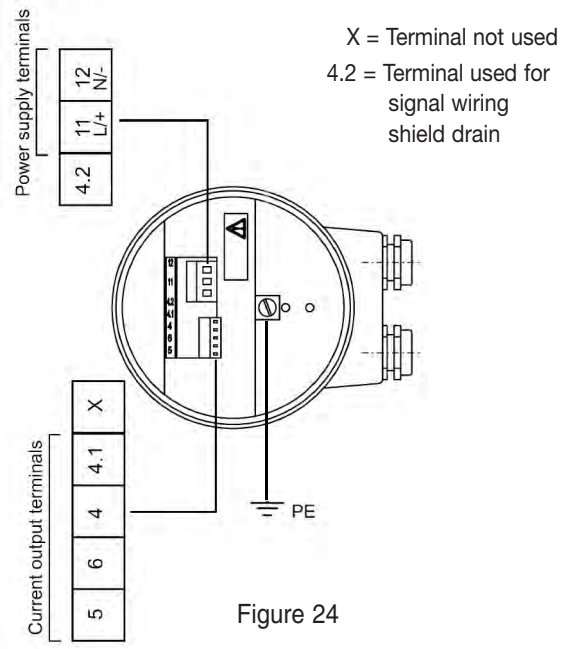


Figure 24

Ensure good contact and protection of wire strands. Local regulations concerning electrical wiring must be followed and obeyed. If no details are given, we recommend:

- crimped metal sheaths over the wire strands
- power supply cables/wires should be rated for at least 500V, with a wire size of 24-14 AWG (0.02" to 0.06" [0.5mm to 1.5mm]) (non-hazardous applications)
- the output current wire size should be 24-20 AWG (0.02" to 0.03" [0.5mm to 0.75mm])

The internal earth ground connection shall be used according to local applicable installation standards. In Europe the Low Voltage Standard prescribes the connection of the yellow/green cable in case of 230VAC.

Hazardous Location Version:

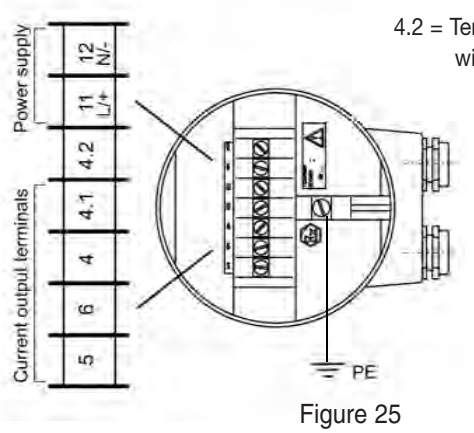


Figure 25

Wiring the sensor for use in hazardous areas requires the use of the correct wires and spade tags for terminal connections. The connecting cables or wire must be in keeping with valid applicable local installation standards (for Europe: EN 60079-14 / VDE 0165).

Where elevated process temperatures (above 212˚F / 100˚C) are concerned, use heat-resistant cables /wire with a continuous service temperature of ≥ 167˚F (75˚C) in conformity with the type test certificate.

Power Input:

The Flexar guided wave radar continuous level sensor is designed to be used with either high voltage or low voltage. The specific type of power supply to be used will be indicated on the sensor nameplate and are as shown below. Please select the wire size that can deliver suitable voltage and current for the application.

1) Universal High Voltage (100-240VAC; -15%/+10%; 9VA)
2) Low Voltage (24VAC/VDC; -15%/+10%; 9VA)

Connect the power supply as shown in Figure 26.

When connecting a DC source observing polarity is not critical but it is suggested to follow the diagram as a matter of good installation practice.

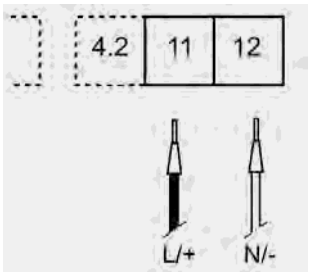


Figure 26

Output:
Flexar® guided wave radar level sensors are available with an RS-485, an active analog 4-20mA output or both an RS-485 and a passive analog 4-20mA output. Output wires should be wired to the sensor terminals according to the type of output provided. The type of output provided will be indicated on the sensor nameplate.

"Smart" RS-485 Output (with / without optional passive analog current output):
A) An RS-485 network can be constructed of multiple sensors (Flexar® & SMU), one master device (SiloTrack* or HMI²), and 2-conductor shielded cable (such as Belden 9322 or similar). All instruments are interconnected in a daisy-chain, multidrop configuration. The order of connection is not important (i.e. Flexar's Address numbers do not have to be sequential along the RS-485 cable, and/or SMU's can be included). A communication network such as this operates most effectively when the interconnection has only two ends. "T"s in the network cable should be avoided whenever possible. Observe polarity when making the communication interconnection to terminals 4.1 (A/+) and 4 (B/-). Attach the cable shield in the terminal identified as "4.2". Do not run communication cable in the same conduit as power. (Refer to Fig. 27)

* When using SiloTrack™ software as the operator interface, Flexar® and SMU sensors must be on different RS-485 networks. Flexar and SMU sensors may coexist when used with an HMI².

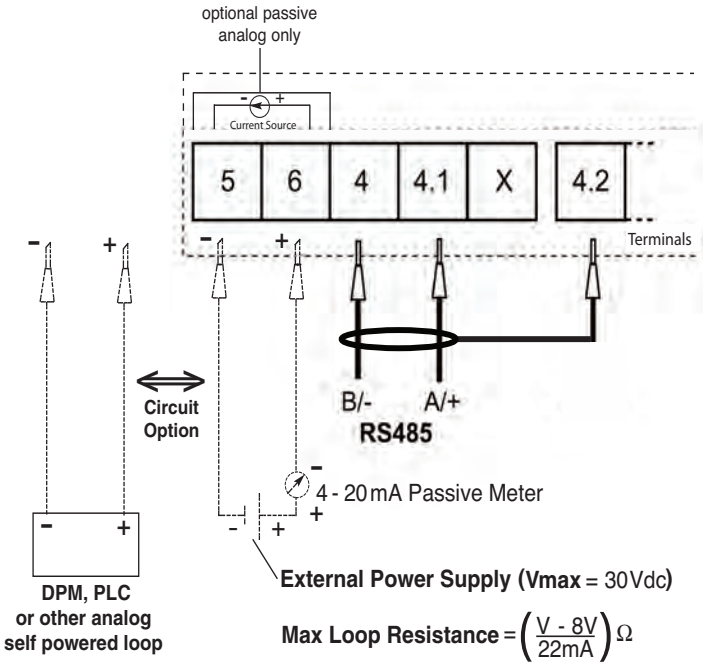


Figure 27

B) As a matter of good practice, only the two instruments positioned at the network ends should have their termination switches "on", and the rest of the devices on the network should have their termination switches "off". Improper setup of the termination switches rarely results in network failure, but the system will not be as robust as it could be. Occasional communication problems could arise.

The newer Flexar® sensors (manufactured after late 2007) have a network termination switch. The termination switch on the Flexar sensors is located immediately behind the LCD display PCB (Refer to Fig. 28). This can be accessed without removing the LCD module by using a non-conductive, small diameter rod (dowel rod for example). This slide switch is positioned such that Right=ON, and Left=OFF.

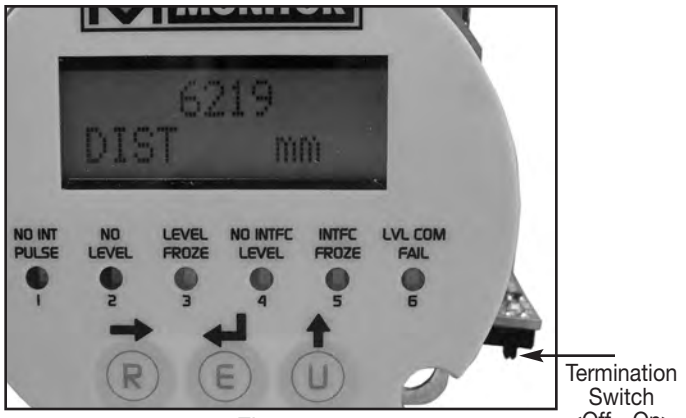


Figure 28

Analog Output:
Wiring for the analog output signal should be connected to terminals 4.1 and 5 as shown in Figure 29. The analog output can be an active output, meaning that a power source internal to the Flexar level sensor is used to power the output, if the appropriate option was purchased. A customer supplied jumper wire should be connected between terminals 4 and 6. Maximum loading for this output is 350 ohms. Refer to Figure 27, terminals 5 and 6 for passive analog wiring schematic.

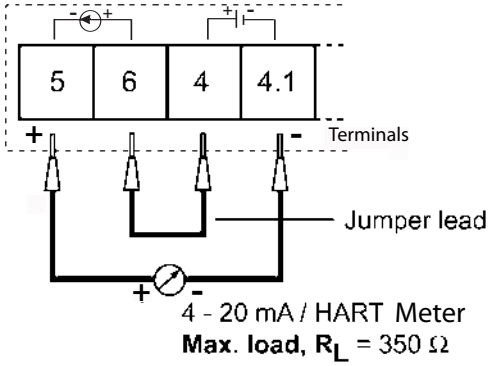


Figure 29

Remote Electronics Interconnection:
The remote electronics version comes pre-wired and connected with the probe when ordered with this option. The interconnecting cable is pre-set at the factory with a standard length of 16.4ft.

USER INTERFACE

The Flexar® guided wave radar level sensor can be configured and operated using the user interface located within the enclosure.

Power-On & Self-Test Mode:

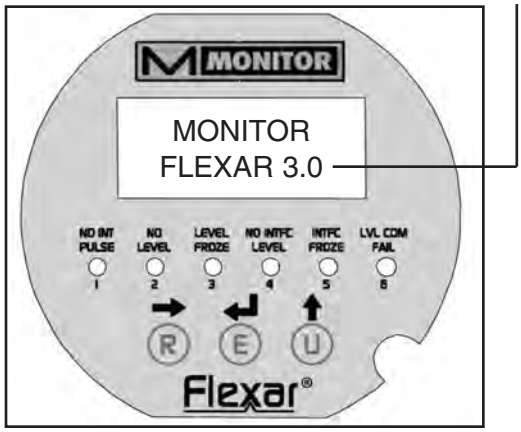


Figure 30

The Flexar® level sensor automatically self-tests once connected to a power source. The read-out as shown in Figure 30 will be displayed while the self-test is in process. The self-test takes from 20 seconds to about 1 minute to complete. After the self-test is complete the local display will change to the operation mode display (Refer to Figure 31).

Local User Interface:

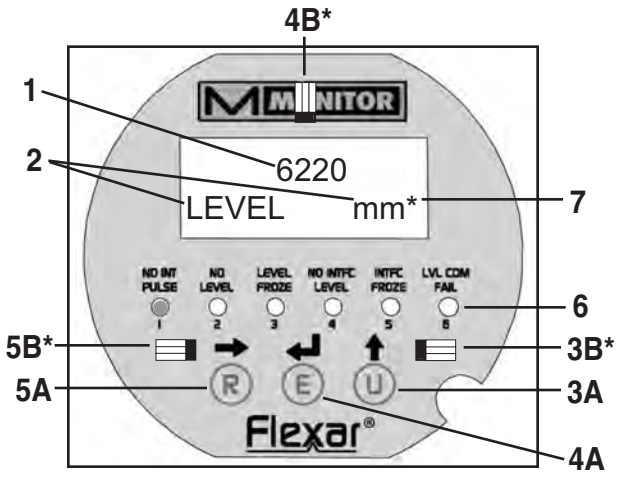


Figure 31

* Available Only on Hazardous Location Units

The Flexar® level sensor's local user interface is easy to use. It has three pushbuttons [3A, 4A, 5A in Figure 31], three magnetically actuated sensors [3B, 4B, 5B in Figure 31] (for configuring the sensor without removing the front cover in hazardous areas - available only on Hazardous Location units) and a two-line LCD screen at the front of the housing.

1 First Display Line:
- In the Operating Mode; measurement value
- In the Configuration Mode; function number

2 Second Display Line:
- In the Operating Mode; item measured and units
- In the Configuration Mode; function definition

3A Press the "UP" Pushbutton / 3B* Mangetic Sensor:
- To increase the value of a selected digit
- For password definition: code U or ↑

4A Press the "ENTER" Pushbutton / 4B* Magnetic Sensor:
- To go back a step in the menu
- To validate data entered
- For password definition: code E or ↵

5A Press the "RIGHT" Pushbutton / 5B* Magnetic Sensor:
- To enter the Configuration Mode
- To move the cursor right while in the Configuration Mode
- For password definition: code R or →

6 Status Marker Flags:
Refer to section on Status Marker Flags.

7 Key Register Symbol:
< "Enter" Pressed
^ "Up" Pressed
> "Right" Pressed

* Available Only on Hazardous Location Units

Status Marker Flags:
The line of numbers on the display label identifies the six types of errors that can exist. An error is indicated by use of a triangular "pointer" being displayed over the applicable number, if any. Example: The display shown in Figure 31 indicates error 1 as active. Refer to Table 8 for information regarding these six possible errors.

Table 8

Status marker flag	Error / Status message	Result and action
1	No initial pulse detected	See the section on Troubleshooting in this manual.
2	No level reflection detected	See the section on Troubleshooting in this manual.
3	Level measurement frozen	Output and indication frozen; search initiated to redetect level: if no reflection is detected: Status marker 2 is activated.
4	No interface reflection found	See the section on Troubleshooting in this manual.
5	Interface measurement frozen	Output and indication frozen; search initiated to redetect interface. If no reflection is found, Status marker 4 is activated.
6	Output communication failure	Contact Monitor Technologies Tech Support Department.

OPERATION

⚠ Do not apply power to the Flexar® level sensor until the following points are checked before start-up. This is especially important for hazardous location units:

- Does the probe, flange/process connection and gaskets (if applicable) have adequate corrosion resistance to the material in the vessel?
- Does the data on the sensor nameplate agree with your operating data?
- Verify that the level sensor has been properly installed on your vessel.
- Is the equipotential bonding system correctly connected?
- Are the covers of the terminal and electronics compartments firmly in place?
- Have the special cover locks been tightened down?

⚠ Do not open the covers of the terminal compartment and the display/electronics compartment on hazardous location units while operating in a potentially explosive atmosphere.

In a potentially explosive atmosphere, for all hazardous location units, you can perform setup operations with the aid of the bar magnet supplied with the level sensor (actuate magnetic keys with bar magnet without removing cover) or digitally via the RS-485 communication output used with SiloTrack™ inventory management software.

NOTE: Before remote sensor configuration can be performed, a unique sensor address must be programmed. Please see Table 12 on Page 19 for Flexar sensor addressing procedures.

At this point your Flexar® guided wave radar level sensor should be installed on your vessel and the necessary electrical connections have been made. Once power is connected and switched on it may be necessary to configure the level sensor to:

- display the readings using the correct units and measurement (level / distance),
- change the measurement range, or
- give the sensor a communications "address" to uniquely identify it within a network when using Flexar with Monitor Technologies' SiloTrack™ inventory management software or an HMI² operator interface control console.

We recommend that all configuration settings be noted on the configuration record supplied in Appendix A to enable Monitor Technologies technical support personnel to provide prompt response to any questions you might have regarding setup and operation.

The Flexar level sensor will start-up in the Operating Mode displaying either information according to customer specification (probe length, etc.) or factory defaults.

To change parameters or complete set-up of the unit the Configuration Mode can be accessed and parameters modified. The configuration procedure is described in more detail in the section entitled "Quick Configuration" on the next page.

After setting a valid address in parameter 1.6.2, Flexar units may also be configured using SiloTrack™ inventory management software or HMI² operator interface control console. Please refer to the installation & operation manual for SiloTrack™ or HMI² for further information.

Quick Configuration – Examples:
The minimum functions that should be configured are as follows:

Function (Fct.)	Description
• 1.1.1	Tank Height
• 1.2.1 through 1.2.6	Display Functions
• 1.3.1 through 1.3.4	Analog Output (if equipped)
• 1.3.1, 1.4.4 and 1.6.2	RS-485 Network Configuration (if equipped)

Example procedures for setup of each of the above functions follow. Each procedure is given in a series of steps in table form and begin from the Operating Mode. (Refer back to Figure 31 for keypad layout.)

Useful Definitions:
Refer to Figure 32.

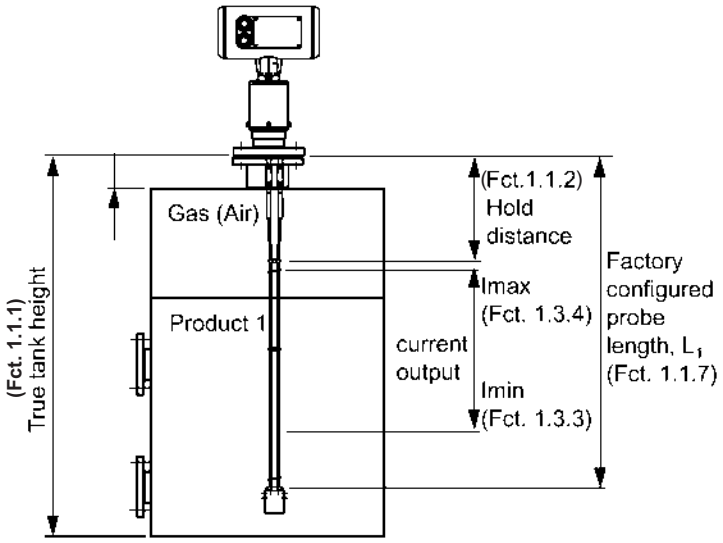


Figure 32

Configuring "Tank Height":
Configuring the tank height is recommended for the following reasons:

- Setting the tank height (configuration parameter Fct. 1.1.1) equal to L1 (factory configured probe length Fct. 1.1.7) avoids having a non-measurable zone underneath the probe where the measurement shown on the display freezes. Refer to Figure 32 and compare "True Tank Height" to "Factory Configured Probe Length".
- When setting up a measurement scale, explained later, setting the tank height to be equal to L1 establishes the level reading at the end of the probe to be taken as "zero" instead of the tank bottom.

How the "tank height" parameter Fct. 1.1.1 affects the measurement when either "Level" or "Distance" is configured for the measurement display is illustrated in Figure 33.

1 True tank height
2 Measurable height (factory configured probe length, L1)
3 Non-measurable zone
4 With True Tank Height (1) set in Fct.1.1.1
5 With factory configured probe length, L1, set in Fct. 1.1.1

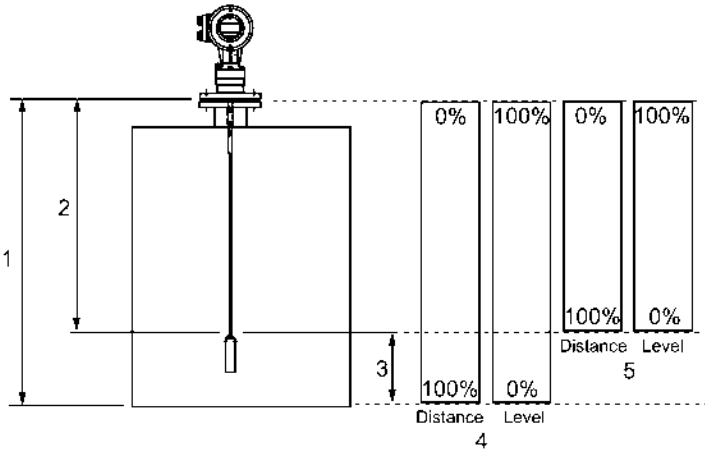


Figure 33

Example Procedure 1 (changing "tank height"):
Adjust Fct. 1.1.1 (Table 9) to be equal to the factory configured probe length, L1 (Fct. 1.1.7). In this example we wish to change 1.1.1 to be equal to 29.5ft (9,000mm), and then save the change. This results in the 0-100% range for distance and level being changed to that represented as item 5 in Figure 33.

Table 9

Step	Action	Press buttons to finish step	Information displayed at the end of each step
1	Start from Operating Mode screen	N/A	"LEVEL "xxxx ft"
2	Go to function Fct. 1.1.1 from Operating Mode	→ → →	"Fct. 1.1.1 "TANK HEIGHT"
3	Enter function (current value: 33ft)	→	"00033.00"
4	Modify value to 00029.50 (ft)	Use → to move cursor,	"00029.50" Use ≠ to increase value For each place as req'd.
5	Exit to Save function	↵ ↵ ↵ ↵	"STORE Yes"
6	Save & exit to Operating Mode	↵	"xxxx""LEVEL" ft"

Configuring Display Functions:
Adjusting Fct. 1.2.1, 1.2.2 and 1.2.3 will set the display mode, displayed measurement function(s) and cycle time (for displaying more than one value). Adjusting Fct. 1.2.4 and 1.2.5 will set the engineering units for "Length" values (distance and level) and "Volume" values. Fct. 1.2.6 can be adjusted to set an error message (flashing display) when a reading error occurs.

Fct. 1.2.1 through 1.2.6 are used to choose the information to be displayed in the "Operating Mode"
- The measurement function (distance, level, volume, etc.) and the units (mm, ft, tons, etc.)
- Display mode (a single value, OR 2 or more values in a repeating loop (cyclic mode))

Table 10

Step	Action	Press buttons to finish step	Information displayed at the end of each step
1	Start from Operating Mode screen	N/A	"xxxx""LEVEL ft"
2	Go to Fct. 1.2.1 from the Operating Mode	→ → ↑ →	"Fct. 1.2.1" "DISP. MODE"
3	Enter Fct. 1.2.1 Display Mode (default value: SINGL. MODE)	→	"SINGL. MODE"
4	Modify value to CYCL. MODE	↑	"CYCL. MODE"
5	Exit Fct. 1.2.1 data set field and go to Fct. 1.2.2	↵ ↑	"Fct. 1.2.2" "DISPL. ITEM"
6	Enter Fct. 1.2.2 (Display Item) data set field (default value: LEVEL)	→	"LEVEL"
7	Select "DISTANCE"	↑ ↑	"DISTANCE"
8	Press "RIGHT" to confirm, or cancel data item to be added to display loop	→	"No"
9	Press "UP" to confirm parameter	↑	"Yes"
10	Exit data set field to confirm. Go to Fct. 1.2.3	↵ ↵ ↑	"Fct. 1.2.3""CYCLIC TIME"
11	Enter Fct. 1.2.3 data set field (default value: 01). Change to 05 seconds.	→ → ↑ ↑ ↑ ↑	"05""Sec"
12	Exit data set field, function, submenu and menu. Save new configuration and return to Operating Mode	↵ ↵ ↵ ↵ ↵	"xxxx""LEVEL ft"

Example Procedure 2 (changing display mode and choosing values to display): Refer to Table 10.

- To modify display mode from “single” to “cyclic” to configure a repeating loop displaying more than one piece of data,
- To select Level and Distance and display each item for five seconds.

Refer to the detail in submenu 1.2 for information regarding changing units for length and volume. The operator may display “volume” once the level sensor has been setup to calculate volume in submenu 1.7.

Establishing Analog (4-20mA) Output Scale (min/max):
Adjustment of functions 1.3.1 through 1.3.4 allows the user/operator to establish the scale for the analog current output (if equipped). Not all Flexar® level sensors include an analog output. Check the data label on the instrument and your ordering information. The minimum (4mA) and maximum (20mA) values of the analog current output should ideally lie between the sensor’s active measuring zone as the display will freeze if the signal is lost. Refer to the measuring limits table in the section entitled “Sensor Dead Zone”.

Example Procedure 3 (setting the analog output scale): Refer to Table 11.

- Personalize a measurement,
- Select “Level” as the current output parameter for the scale to be set up from the tank bottom,
- Choose suitable minimum and maximum values for the scale.

Table 11

Step	Action	Press buttons to finish step	Information displayed at the end of each step
1	Start from Operating Mode screen	N/A	“xxxx” “LEVEL ft”
2	Go to Fct. 1.3.1	→ → ↑ →	“Fct. 1.3.1”“FUNCTION. I.1”
3	Enter data set field (current value: Distance)	→	“DISTANCE”
4	Set to “Level”*.	↑ ↑ ↑	LEVEL
5	Exit data set level and go to Fct. 1.3.2	↵ ↑	“Fct. 1.3.2”“RANGE I 1”
6	Enter Fct. 1.3.2 (current value: 4 – 20mA) to set the error output to 3.7mA or 22mA or having no error output.	→	“4 – 20”
7	Modify value to 4 – 20mA with error output at 22mA.	↑ ↑	“4 – 20 / 22 = E”
5	Exit data set field and go to Fct. 1.3.3. Enter (current value: 00000.0ft) to set the “Level” that corresponds to the minimum current output 4mA.	↵ ↑ →	“00000.0”“ft”
6	Modify value to 00003.0ft (this sets the minimum point 3ft above the tank bottom). The tank is considered to be empty below this point.	→ → → ↑ ↑ ↑	“00003.0”“ft”
7	Exit data set “Level” and go to Fct. 1.3.4. Enter Fct. 1.3.4 (current value: xxxxx.xft) – to set “Level” that corresponds to the max. current output 20mA	↵ ↑ →	“xxxxx.x”“ft”
9	Change to 00030.0 (this sets the maximum below the top dead zone). The tank is considered to be full above this point.	Use → to move cursor right, ↑ to increase value where cursor is at.	“30.0”“ft”
10	Exit data set level, function submenu and menu. Save configuration and return to Operating Mode.	↵ ↵ ↵ ↵	“xxxx”“LEVELft”

To establish the analog current output based upon “Volume” instead of “Level” or “Distance”, setup the volume measurement in submenu 1.7, then select “Volume” as the analog current output scale parameter as shown above for “Level”.

Network Configuration – "Smart" RS485 Output:In order for the Flexar® level sensors to be connected to a SiloTrack™ inventory management system the RS485 network configuration must be completed.

Example Procedure 4 (Setup RS485 "Smart" Output): Refer to Table 12.

• Give each level sensor on the network a unique address and device number

Table 12

Step	Action	Press buttons to finish step	Information displayed at the end of each step
1	Start from Operating Mode screen	N/A	"xxxx""LEVEL ft"
2	Exit data set level and go to Fct. 1.6.2 to set the sensor's network address.	↵ ↵ ↑ ↑ ↑ → ↑	"Fct. 1.6.2""ADDRESS"
3	Enter Fct. 1.6.2. A number will be displayed (default value: 000 - no network).	→	"000"
4	Change address to 001.	→, →, ↑	"001"
5	Exit data set field, function, submenu and menu. Save configuration and return to Operating Mode.	↵ ↵ ↵ ↵	"xxxx""LEVEL ft"

Summary Of User Configuration Parameters:
Below is an overview of all parameters that can be set in the configuration menu. Reset default values are in bold type in the "Input Range" column.

Submenu 1: Refer to Table 13.
This submenu (1.1.0 through 1.1.7) allows the user to configure basic parameters critical to the viewing of the distance/level measurement on the Flexar® level sensor display.

Table 13

Function (Fct.)	Input Range	Default	Description
1.0.0 OPERATION			
1.1.0 BASIS.PARAM			
1.1.1 TANKHEIGHT	Enter 3.3 to 197ft (0.1 to 60m)	*As per order*	This is the distance from the process connection/flange to the bottom of the vessel. It can be set to the probe length to ignore the bottom non-linear & non-measurable zones. Refer to the previous section on "Configuring Tank Height".
1.1.2 HOLD DIST. (Hold Distance) **WARNING : Critical Parameter**	Enter a value from 0in(0mm) to probe length. The Minimum value = 0 • Twin probes Probe length<6.5ft/2m Probe length>6.5ft/2m • Single probes Probe length<6.5ft / 2m Probe length>6.5ft / 2m	 *9.8in / 0.25m* *17.7in / 0.45m* *9.8in / 0.25m* *23.6in / 0.60m*	This prevents the level sensor from displaying an area or zone near the process connection/flange where measurements may not be possible. Configuration parameter Fct. 1.5.3, "Detection Delay", should be used to suppress any non-material reflections as reflections within this zone are still detected.
1.1.3 TIME CONST. (Time Constant)	1 to 100 seconds	*5 seconds*	This function filters possible signal fluctuations when the tank is turbulent.
1.1.4 WIN.FROZEN (Window Frozen) **WARNING : Critical Parameter**	Select YES or NO	*NO* *(window open)*	This causes the instrument to freeze or open its search window if product reflection is lost. See function 1.1.5 / 1.1.6 for more details. "YES" means the level sensor will only search in the zone specified in Fct. 1.1.5.
1.1.5 LEVEL WIN. (Level Window)	Enter 7.9in / 0.2m to probe length, L • Powders • Others	 *13.12ft / 4.0m* *19.7in / 0.5m*	Sets the operating window for level measurement. The window is centered about the material level and moves as the level changes. If reflection from the material is lost, the level sensor reacts according to the configuration set in Function 1.1.4. The value refers to the total window: a value of 20in / 500mm denotes a window +/-9.84in / 250mm.
1.1.6 INTERF. WIN. (Interface Window)	Not Used in Flexar® sensors		
1.1.7 PROBE LGTH. (Probe Length) **WARNING : Critical Parameter**	Enter 7.9in / 0.1m to probe length 197ft / 60m	*As per order*	Length of probe, L1, measured from the process connection / flange. Do not include the counterweight length. Modify this only if the probe length has been changed.

Submenu 2: Refer to Table 14.
This submenu (1.2.0 through 1.2.6) allows the user to configure parameters associated with the display of the Flexar level sensor.

Table 14

Function (Fct.)	Input Range	Default	Description
1.2.0 DISPLAY			To display readings in the form and units required.
1.2.1 DISP. MODE (Display Mode)	Select SINGLE or CYCLIC display mode.	*SINGLE*	Cyclic mode permits more than one item to be dis played in a cycle when used with Fct. 1.2.2 and 1.2.3.
1.2.2 DISPL. ITEM (Display Item)	**FACTORY USE ONLY**		
1.2.3 CYCLIC TIME	**FACTORY USE ONLY**		
1.2.4 LGTH UNIT (Length Unit)	Select “m”, “cm”, “mm”, “0.1 mm”, “inch” and “feet”	*Feet*	Sets the length units for displayed readings.
1.2.5 VOL.UNIT (Volume Unit)	Select “m3” (cubic meters), “Liter”, “USGal” (gallon), “GB Gal” (Imperial gallon), “Ft3” (cubic feet),“bbl” (barrel), “KG” (kilogram), “ton” (metric ton), “GBton” (Imperial ton), or “USton” (USA ton).	*Ft3*	Sets the volume units for displayed readings.
1.2.6 ERROR MSG (Error Message)	Select YES or NO	*NO*	Turns an error indicator on or off. If configured “YES”, the display flashes when a reading error occurs.

Submenu 3: Refer to Table 15.
If equipped with the analog current output, this submenu (Fct. 1.3.0 through 1.3.8) allows the user to setup the analog output function and scale.

Table 15

Function (Fct.)	Input Range	Default	Description
1.3.0 CUR. OUTP. I			This configures the current output. These functions are independent from what is displayed.
1.3.1 FUNCTION.I.1	Select “Off”, “Level”, “Mass”, “Distance” or “Ullage Mass” (barrel).	*Level*	Assigns a measurement parameter to analogue output number 1. Calibrate the level sensor using Fct. 1.7.2 Strapping “Calibration” Table before selecting “Mass” or “Ullage Mass” here.
1.3.2 RANGE.I 1	Select “4-20”, “4-20 with a 3.7mA failsafe output” or “4-20 with a 22mA failsafe output”.	*4-20 mA, E=22mA*	Sets the analog output range. Settings with failsafe selection will send an error message if an error occurs, i.e. the level is lost.
1.3.3 SCAL.I.1 MIN (Scale I1 Minimum)	Enter value with regards to measure method selected in Fct.1.3.1 and the units set in Fct. 1.2.5.	*0.0*	Assigns a length or volume value to 4mA. Refer to Example Procedure 4.
1.3.4 SCAL.I.1 MAX (Scale I1 Maximum)	Enter value as in 1.3.3	*probe length per order*	Assigns a length or volume value to 20mA. Refer to Example Procedure 4.

Submenu 4: Refer to Table 16.
This submenu, Fct. 1.4.0 through 1.4.9 allows the user to select the Language and an access code. Other information such as the network device number, factory set data and the factory set probe type are set in this menu.

Table 16

Function (Fct.)	Input Range	Default	Description
1.4.0 USER DATA			
1.4.1 LANGUAGE	Select “GB/US” (English), “F” (French) or “D” (German)	*GB/US*	Sets the language for readings & configuration.
1.4.2 ENTRY.CODE 1	Select YES or NO	*NO*	Activates an access code for protection of user con figuration information. The access code is then set in Fct. 1.4.3.
1.4.3 CODE 1 (accessible only if Fct.1.4.2 set at “YES”)	Enter code	*If no code entered: UUUEEERRR*	Enables user to enter a 9-letter code. This code is any sequence of the Right (R), Enter (E), and Up (U) keys. Once entered the display prompts the user to verify it by entering it again.
1.4.4 DEVICE No (Device Number)	Enter tag name (10 characters or less).	*0000000.001*	Enables user to identify a device when used in the digital RS485 network. Characters available include upper(A-Z) and lower (a-z) case alphabets, plus (+), minus (-), space (_) and numerals (0-9)
1.4.5 SERIAL No (Serial Number)	(factory-set)		To be noted for warranty and service requirements.
1.4.6 F. NBR.	(factory-set)		To be noted for warranty and service requirements.
1.4.7 G. NBR.	(factory-set)		To be noted for warranty and service requirements.
1.4.8 OPTION	Enter information (10 characters or less). Optional		For noting information concerning the device or its application. Characters available as in 1.4.4.
1.4.9 PROBE TYPE	TYPE A (Twin Rod), TYPE B (Twin-cable) TYPE H (Single-cable), TYPE F (Single Rod),	*As per order*	For information only: this shows probe type being used and does not affect the performance of the instrument if changed.

Submenu 5: Refer to Table 17.

⚠ This submenu structure allows the entry and configuration of application data. This data should not be modified without first consulting Monitor Technologies LLC technical support personnel.

Table 17

Function (Fct.)	Input Range	Default	Description
1.5.0 APPLICAT. (Application)			**For difficult applications. Consult Monitor Technologies LLC technical support personnel.**
1.5.1 LEVEL (Level Threshold) **WARNING : Critical Parameter**	Press ENTER to access and modify the threshold value using the display.	*2.71 GAIN 1*	This function acts as a filter. Real-time gain and reflection amplitude are displayed along with threshold value.
1.5.2 DIST. INPUT (Distance Input)	Enter value. 0 to probe length.	*No value*	This forces the device to look for the target material in a particular area or zone measured from the process connection/flange face: enter an estimated value if there is no level signal. Do not enter the value of the dead zone.
1.5.3 DETE. DELAY (Detection Delay)	Enter value. Maximum value = Fct. 1.1.2 – 150 mm (6 in) unless Fct. 1.1.2 is higher than 150	*0.0*	This forces the instrument not to analyse reflections in a defined area or zone immediately below the flange. Modification of the maximum value: increase Fct. 1.1.2 Hold Distance.
1.5.4 INTERF. LEV ** (Interface Level Threshold) **WARNING : Critical Parameter**	Press ENTER to access and modify the threshold value using the display.	*2.86 GAIN 1*	This function acts as a filter. Real-time gain and reflection amplitude are displayed along with threshold value.
1.5.5 EPSILON R ** (Dielectric Constant)	Enter value from 1.05 to 99	*2.5*	This configures the dielectric constant value for use in TBF mode.
1.5.6 INT. INPUT ** (Interface Distance Input)	Not used.		Not used.
1.5.7 SETTLING **	Select YES or NO	*NO*	For decanting processes & mixed products that separate over time. YES : For decanting processes NO : For when 2 products are immiscible (remain separated)
1.5.8 C.I.P. (Cleaning In Place)	Select YES or NO	*NO*	If YES is selected and the signal is lost, the level sensor will search for a reflection along the whole length of the probe rather than the designated measurement zone. This allows a reset to be made following a cleaning cycle. If the sensor doesn't find a reflection or the reading is frozen at the end of the probe then the tank hasn't been filled or drained.
1.5.9 MODE (Application Mode) **WARNING : Critical Parameter**	Select DIRECT.MODE, MANU. MODE or TBF. Never use MANU. MODE.	*DIRECT MODE*	This is used for setting the measurement mode automatically (Direct or TBF). Contact Monitor Technologies LLC technical support personnel for more information on TBF mode.

Submenu 6: Refer to Table 18.
This submenu includes configuration of Fct. 1.6.1 and 1.6.2 which is required when the level sensor has been supplied with the RS485 "smart" output for use with SiloTrack™ inventory management software.

Table 18

Function (Fct.)	Input Range	Default	Description
1.6.0 SERIAL I/O (Serial Input/Output)			**For integrating into a SiloTrack™ or other digital network**
1.6.1 BAUDRATE*	Select 1200, 2400, 4800, 9600 or 19200 baud	*9600 bd*	Defines transmission rate of information between Flexar™ level sensors and remote terminal.
1.6.2 ADDRESS	Enter a number from 1 to 255	*001*	Address of a device in a digital network. Entering >0 will configure the level sensor for multidrop networks.

*RS485 interface only

Submenu 7: Refer to Table 19.
Fct. 1.7.1 through 1.7.3 are used to setup a volume strapping (calibration) table so that Volume values can be calculated and displayed.

Table 19

Function (Fct.)	Input Range	Default	Description
1.7.0 STRAP. TAB (Strapping Table)			**For calibrating the level sensor for volume measurement.**
1.7.1 VOL. UNIT (Volume / Mass Unit)	Select m_, litre, "USton" , "m3", "Liter", "USGal", "GBGal" (Imperial gallon), "Ft3", "bbl", "KG", "ton" (metric), or "Gbton" (imperial).	*USton*	Selects the volume or mass unit for a volume strapping table.
1.7.2 INPUT.TAB. (Strapping Table Input)	Select point 01 to 50. Enter level and then vol. values respectively.	*00*	Table or calibrating the level sensor point by point in terms of product level and volume values.
1.7.3 DELETE TAB. (Strap Table Delete)	Select SURE YES or SURE NO.	*SURE NO*	Clears the data from the existing strapping table.

Flexar Guided Wave Radar Level Sensor Characteristics:
This section explains the following:

- The four principle configurations (A, B, C, D) for setting up a measurement scale and the user should be aware of ramifications in each case.
- What happens when the tank is full or empty.
- What is the level threshold and how do you modify them.

<u>The Measurement Scale: possible configurations for analog output – w/ "Level" selected in Fct. 1.3.1:</u>

1 True tank height
2 Measurable height (probe length), L1
3 Non-measurable zone
4 Hold distance (Fct. 1.1.2)
5 Minimum dead zone value: (Fct. 1.5.3 – Fct. 1.1.2)
6 Detection delay (Fct. 1.5.3)
7 Active measurement zone

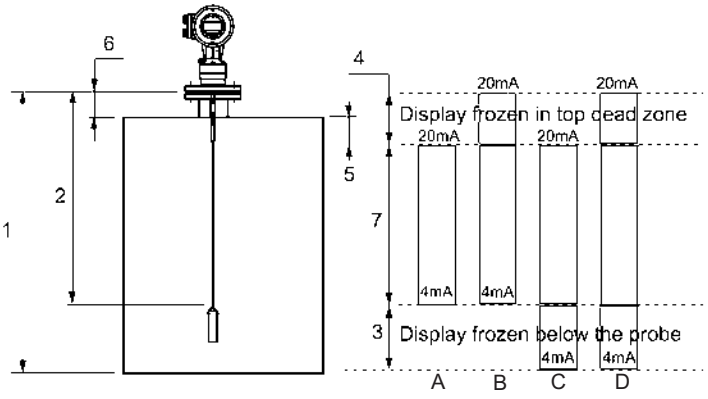


Figure 34

Note that 4mA is set in Fct. 1.3.3 and 20mA is set in Fct. 1.3.4.

As can be seen in Figure 34, there are four principal scale configurations for measuring the Level of the material:

Configuration A (refer to "A" in Figure 34)
This is the configuration used in Example Procedure 4. When the sensor reaches the minimum and maximum outputs the measurement will freeze as the vessel in now considered to be empty or full respectively.
Parameters:
Fct. 1.1.1 = Probe Length, L1 (excluding counterweight*)
Fct. 1.3.3 (4mA) = 0.0 ft/in/mm/m units as defined by Fct. 1.2.44 (for 4mA)
Fct. 1.3.4 (20mA) = Probe Length, L1 – Hold Distance (maximum value)

Configuration B (refer to "B" in Figure 34)
In this configuration the top of the scale is set to the sensor process connection / flange face. The measurement will freeze in the top dead zone.

⚠ **Warning: danger of overflow!** It is impossible to detect reflections in the top dead zone, therefore, there is a risk and danger of overflow if top 20mA scale is set to process connection / flange face.
Parameters:
Fct. 1.1.1 = Probe Length, L1 (excluding counterweight*)
Fct. 1.3.3 (4mA) = 0.0 ft/in/mm/m units as defined by Fct. 1.2.4 (for 4mA)
Fct. 1.3.4 (20mA) = Probe Length, L1 (excluding counterweight*)

Configuration C (refer to "C" in Figure 34)
In this configuration the top of the scale is set below the dead zone, but the bottom of the scale is below the end of the probe (on the vessel/tank bottom). Flexar technology (TDR) is a contact technology. As such, the display will freeze at a level above the 4mA limit when the material level drops below the end of the probe.
Parameters:
Fct. 1.1.1 = True Tank Height
Fct. 1.3.3 (4mA) = 0.0 ft/in/mm/m units as defined by Fct. 1.2.4 (for 4mA)
Fct. 1.3.4 (20mA) = True Tank Height (1.1.1) – Hold Distance (1.1.2)

Configuration D (refer to "D" in Figure 34)
This configuration combines configurations B and C. Care must be taken when the material in the vessel rises into the top dead zone or drops into the bottom non-measurable zone as Flexar technology, TDR, cannot monitor in these zones.
Parameters:
Fct. 1.1.1 = True Tank Height
Fct. 1.3.3 (4mA) = 0.0 ft/in/mm/m units as defined by Fct. 1.2.4 (for 4mA)
Fct. 1.3.4 (20mA) = True Tank Height (Fct. 1.1.1)

All of the configurations above, A, B, C and D, also apply when "Distance" is selected in Fct. 1.3.1 (after adaptation of parameters entered)

*Factory configured Probe Length, L1, does not include the D12 x 100mm (0.5" x 4") counterweight for the 8mm (0.3") single cable probe.

Gauge Operating Logic When Reflection Is Lost:
The material reflection pulse is usually lost when the level is in the top dead zone or near the bottom of the tank. Figure 35 shows the action taken by the level sensor depending on where the last reflection was lost.

Zone 1: Dead Zone
- Status marker 3 is displayed when the product enters the dead zone.
- Level sensor assumes the vessel is full and displays the maximum level value.

Zone 2: Full Zone
- If the sensor loses the signal in this zone it reacts as in Zone 1: the vessel is assumed to be full.
- The sensor searches for a reflection in this zone.
- On reaching the Full Zone the level will continue to rise, up to a signal corresponding to an analog current output of 20.5mA (i.e. +3_%), if signal is not lost.
  Note: the search zone increases to: Fct. 1.1.2 Hold Distance + (Fct. 1.1.5 Level Window / 2), if this value is greater than 12in / 300mm.

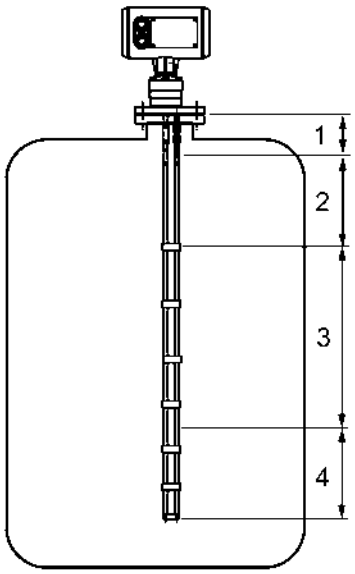


Figure 35

Zone 3: Central Measurement Zone
- The sensor uses Fct. 1.1.5 Level Window to search in this zone for the largest pulse reflection.
- If pulse is lost the reading freezes at the last value. Status marker 3 will be displayed.
- Status marker 2 will then be displayed if no reflection is found in the Level Window search zone, and the reflection search will be enlarged to the Probe Length.
- The reading will remain frozen during this time.

Zone 4: Empty Zone
- If the reflection is lost in this zone, the sensor assumes the vessel / tank to be empty.
- The short circuit reflection will become larger than material reflection at this time.
- If level is not at zero, the sensor will descend further to a level equivalent to a minimum analog current output of 3.8mA.
- The sensor searches for a reflection in this zone. The search zone increases to: Fct. 1.1.7 Probe Length – (Fct. 1.1.5 Level Window / 2), if this value is greater than 12in / 300mm.

Gain And Voltage Amplitude:

As explained in the Principal Of Operation section, the level of a material is converted from a return signal (material reflection) received by the sensor. This signal has taken a certain amount of time to return to the sensor and it has a certain signal strength / size measured in millivolts (dependent on the dielectric constant of the material being measured).

Refer to Figure 36. All pulse signals returning to the sensor electronics block (including process connection / flange, obstruction and material surface reflections) are converted to voltage amplitudes. The sensor's microprocessor looks for part of the largest signal that is over a set voltage amplitude, called the "threshold", and identifies this as the material being measured. For this signal to be useable by the sensor, the microprocessor will amplify the signal by increasing the gain. Once the signal is within a set "working" range, the sensor follows this signal. The sensor registers any changes in time for this part of the signal to return to the converter and translate this into a displayed level or volume.

Gain is a function of voltage amplitude. This defines the default threshold value when the sensor is searching for the material level. A strong return signal will be given a low gain (i.e. Gain 0 or a small amplification). However, if the signal is very weak, then a Gain of 3 (i.e. high signal amplification) is given.

Level Measurement: Level Pulse Amplitude And Threshold:

After connection to a power supply, the Flexar guided wave radar level sensor will:

1. Measure reflection pulses in terms of voltage amplitude by cycling through a set of gains.
2. Identify the highest amplitude as being the material level.

The diagram in Figure 37 shows a level threshold of 2.71 Volts for a Gain of 1.

1 Initial pulse
2 Process connection / flange reflection
3 Non-material reflection (e.g. mixer)
4 Material level reflection
5 Level threshold (with 6.5ft steps) Set in Fct. 1.5.1
6 Offset*
7 Distance measured as a function of time

* "Offset" is the distance measured as time for the signal to travel from the electronics to the process connection / flange face (the sensor's reference point).

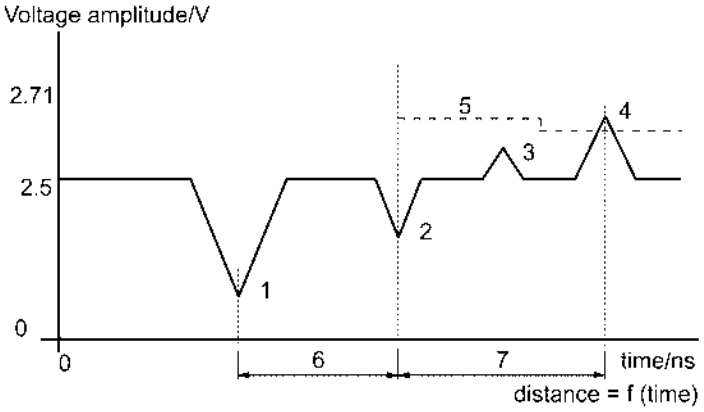


Figure 37

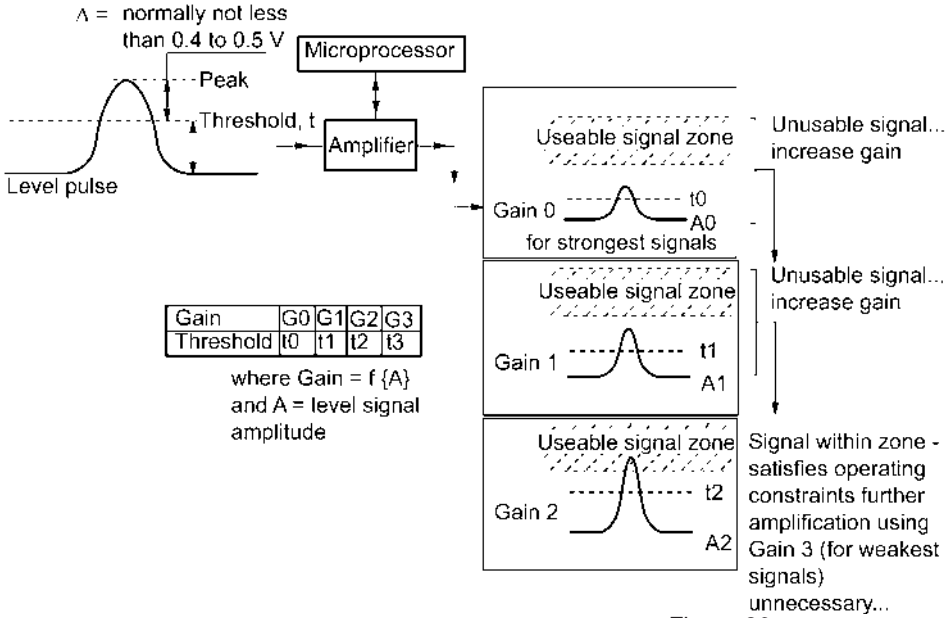


Figure 36

If difficulties are experienced finding the correct level, try the following solutions:

- Set Fct. 1.1.4 Window Frozen to "Yes":

  ⚠ **Critical Parameter: Consult with Monitor Technologies technical support personnel for advice before reconfiguring sensor.**

  This concentrates the search for material level in a small defined zone and ignores interference signals. The sensor will set up the "level window" on either side of the last reading with a plus/minus range equal to half of the value given in Fct. 1.1.5. The sensor will then ignore all other pulse reflections outside the "level window" as long as there is a reflection above the pre-set threshold. If no pulse is detected, the level sensor will change the Gain automatically as the pulse changes amplitude.
- Set Fct. 1.1.4 Window Frozen to "No":

  The level sensor will search along the entire length of the probe. **Warning: This may lead the level sensor to incorrectly identify a non-material reflection to be the material level.**
- Modify Fct. 1.5.1 Level Threshold:

  ⚠ **Critical Parameter: Consult with Monitor Technologies technical support personnel for advice before reconfiguring sensor.**

  The default threshold values do not normally need to be changed. However, the level threshold may need to be modified if level is hard to detect due to signals from non-material obstructions in the vessel (nozzles, beams, mixers, etc.) or the measurement of materials with very low dielectric constants. (See Situation 2A in Troubleshooting-Level Frozen.)

If the level pulse is too high, two solutions are possible:

- Modify Fct. 1.5.3

  Detection Delay to ignore all signals near the process connection / flange. Increase the configured value. This will force the level sensor to ignore reflections in the distance set from the process connection / flange. Note that this will reduce the measurement range.
- Modify Fct. 1.5.1

  Level Threshold to reduce interference along the probe length. Increase the voltage amplitude manually in Fct. 1.5.1. The threshold descends in 6.5ft / 2m steps to take into account loss of pulse strength over distance so the correct level behind the obstruction may be detected. Refer to procedures below in Table 20.

If the measured level is too low compared to its real level:

The level sensor may have found that the short circuit gives off the strongest pulse and assigns this as being the current level. Lowering the gain and / or the voltage amplitude manually in Fct. 1.5.1 may help but too low a threshold value may result in conflicting non-material reflections and unstable readings. In the case of very low dielectric materials, contact Monitor Technologies technical support personnel.

Procedure (example shown for where the level measured is too low):

- Read off displayed peak amplitude
- Modify level threshold value

Solids Applications Notes:

Most dry solid applications, except powder or flakes with high dielectric constants such as charcoal and coal powder, are measured with a Gain of 3. If it is difficult to measure level at a certain point with the level sensor using a Gain from 0 to 2, then an internal vessel structure is most likely within the electromagnetic pulse field area. The level sensor will detect the largest signal and assume this to be the material level.

Table 20

Step	Action	Press buttons to finish step	Information displayed at the end of each step
1	Start from Operating Mode screen	N/A	"xxxx" "LEVEL ft"
2	From operating mode go to Fct. 1.5.1 Level Threshold	→ → ↑ ↑ ↑ ↑ →	"Fct. 1.5.1" "LEVEL"
3	Enter Fct. 1.5.1 to first read off peak amplitude. The top value gives the peak amplitude in volts.	→	"3.80" "GAIN2"
4	Press enter to see (and modify) configured level threshold in volts and the minimum gain used	↵	"3.80" "MIN G 2"
5	Modify the threshold value so that value is no less than 0.5V below the peak amplitude	→ ↑ ↑ ↑ ↑ ↑ ↑ → ↑ ↑ ↑ ↑	"3.44" "MIN G 2"
6	Exit data set field, function, submenu and menu. Store configuration and return to operating mode. Check that the gauge can measure in the required measuring range.	↵ ↵ ↵ ↵ "LEVEL	"xxxx" ft"

Note that the threshold drops every 6.5ft / 2m.

Test Functions: Refer to Table 21.
A series of test functions are available in the configuration submenu 2.0.0. This permits the local display and level sensor calibration to be checked.

Table 21

Test Function	Input range	Description
2.0.0 TEST		
2.1.0 TEST DISPL.		
(TEST DISPLAY)		**Gives full display of all segments of the LCD display.**
2.2.0 CUR OUTP.I		
(CURRENT OUTPUT I)		
2.2.1 VALUE I 1	N/A	Gives a reading of current from analog output .
2.2.2 TEST I 1	3.6, 4, 12, 20 or 22mA.	Forces the analog output to the selected value.
2.2.3 VALUE I 2	Not Used	
2.2.4 TEST I 2	Not Used	
2.3.0 COMM. TEST		**For factory use only.**

Parameter Error Messages: Refer to Table 22.
The below information should be should to assist you in determining the specific error condition when a Parameter Error occurs.

Table 22

Function	**Action to be taken**
4 PARAMETER ERROR	
4.1 CURRENT OUPUT	When a parameter error occurs, the digit “4” is displayed with the description “PARAMETER ERROR”.
4.1.1 SCALE I 1 MIN	
4.1.2 SCALE I 1 MAX	• The RIGHT key should be pressed until the function concerned is given. • Press the RIGHT key again to make the value appear for modification. • Follow the instructions for resetting the value in Section 3 and then press ENTER to exit. • If more than one error is reported, the procedure should be repeated.
4.1.3 SCALE I 2 MIN	
4.1.4 SCALE I 2 MAX	
4.2 STRAP TABLE	
4.2.1 STRAP TABLE INPUT	
4.2.2 STRAP TABLE SUPRESS	
4.2.3 DISPLAY MODE	
4.2.4 DISPLAY ITEM	
4.2.5 FUNCTION I 1	
4.2.6 FUNCTION I 2	
4.3 PARAMETERS ERRORS	
4.3.1 DEAD ZONE	
4.3.2 DETECTION DELAY	

Fuse Replacement

⚠ Flexar® servicing by the customer is limited by warranty to the removal and replacement of the power supply fuse and the electronics chassis, which needs to be removed in order to replace the fuse. Other repairs must be done by Monitor Technologies LLC authorized service staff. If required, consult Monitor Technologies technical support personnel for assistance.

Removing The Electronics Chassis:

⚠ Before changing the electronics chassis remember to save the current configuration of the instrument by using the chart supplied in the appendix of this manual.

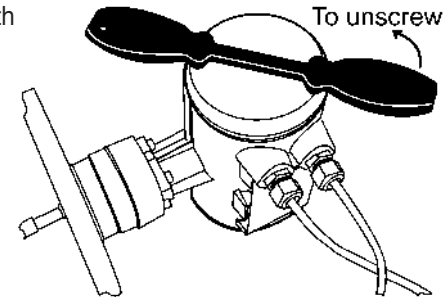
Please follow these instructions carefully. Disassembly is not intended for operator personnel and only a qualified technician should proceed according to these instructions. Consult Monitor Technologies technical support personnel for assistance.

Step 1

Disconnect the level sensor from the power supply. If the sensor is equipment category 1 2 GD (ATEX) / hazardous location classification Division 1 area, please refer to instructions in this manual regarding Hazardous Location Precautions in the section entitled Electrical Installation for more information.

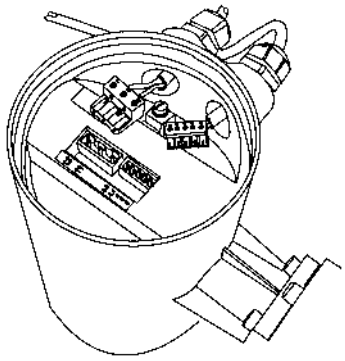
Step 2

Remove back cover with supplied wrench.



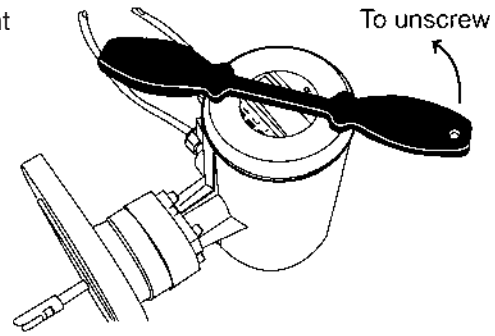
Step 3

Unplug terminal blocks from electronics chassis.



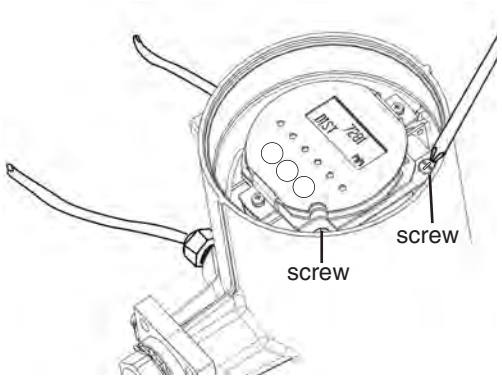
Step 4

Remove the front cover with wrench.



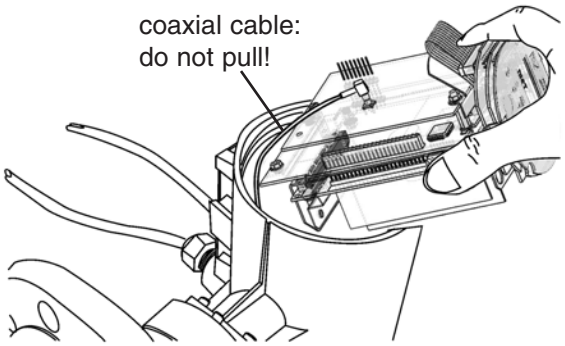
Step 5

Undo the two screws holding block in the housing.



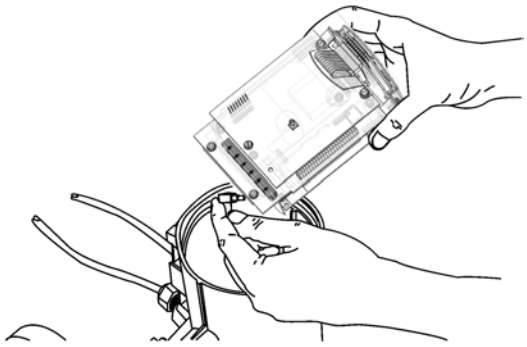
Step 6

Remove the electronics chassis carefully.



Step 7

Disconnect the coaxial cable.

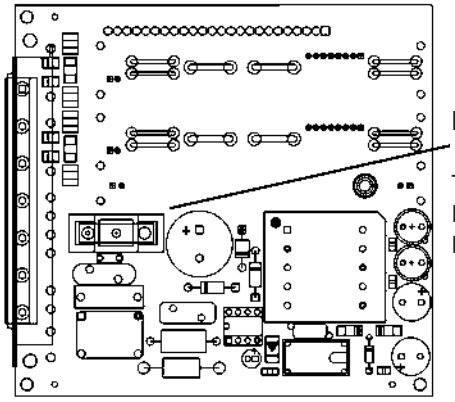


Step 8

Use these instructions to mount the new chassis. Care should be taken when putting the electronics package back into the housing to avoid trapping the coaxial cable between the housing and the rear cover. Load the old configuration settings as recorded on the chart in the appendix of this manual.

Replacing The Fuses:
As indicated in Figure 38 and 39, the power supply is protected by a fuse, F1. This will be visible when the electronics chassis is removed from the housing. The fuse rating is dependent on the type of power supply used and is given in Figure 38.

Power Supply Board 100 – 240VAC

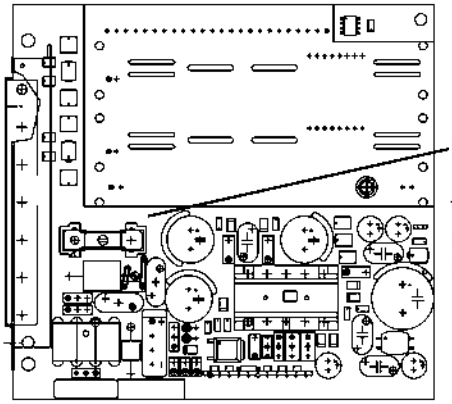


Power supply fuse F1

T400 mA / 1500 A (250V) IEC127-2/V Time Lag Fuse

Figure 38

Power Supply Board 24VDC/AC



Power supply fuse F1

T1.25 A / 1500 A (250V) IEC127-2/V Time Lag Fuse

Figure 39

The Troubleshooting information section is broken into four sections. Immediately following here is a list of Troubleshooting tips categorized into two sections, 1) General Operation and 2) Electrical Connections and Communication Output. Subsequent to these two Troubleshooting Tip categories is a section on Test Functions and Parameter Errors.

TROUBLESHOOTING

Troubleshooting – General Operation:

PROBLEM: Status Marker Flag 1 is displayed. (No Int Pulse)
CAUSE/SOLUTION:

1) The High Frequency board is not sending a pulse. It may have been damaged by ESD (electrostatic discharge). Contact Monitor Technologies technical support personnel. The electronics package may need to be replaced.

PROBLEM: Status Marker Flag 2 is displayed. (No Level)
CAUSES/SOLUTION: The level sensor has lost the level signal, has searched in a pre-defined zone and has not yet found the return pulse.

1) The material may have risen into the dead zone and has dropped below the threshold due to readings from the process connection / flange. Empty the tank below the dead zone and check the measurement.
2) The material level may be at zero (tank empty). Refill the tank above minimum level and check the measurement

PROBLEM: Status Marker Flags 3 and/or 5 are displayed. (Level / Interface Frozen)
CAUSE/SOLUTION:

1) The display is frozen. The pulse has dropped below the threshold, whereupon the level sensor opens a search win dow/zone. If no reflection is found, Status Marker Flag 2 will be displayed. Empty the tank below the dead zone and check the measurement. If the signal is not detected then modify the threshold as shown in Fct. 1.5.1.
   (For more details see Troubleshooting - Level Frozen.)

PROBLEM: Level Sensor Is Not Accurate In Direct Mode With High Dielectric Material.
CAUSE/SOLUTION:

1) Tank height is not correct. Check and re-enter tank height in Fct. 1.1.1 if required.
2) If electronics package has been replaced, verify that the factory calibration parameters are restored. Contact Monitor Technologies technical support.

Troubleshooting – Electrical Connections and Communication Output:

PROBLEM: The display does not work.

1) The level sensor is wired incorrectly to the wrong voltage and the fuses have blown. Check and replace the power supply fuse, F1, as shown in the Maintenance section of this manual.
2) Ambient temperature may be below -4° F (-20° C), the LCD does not work. Consider using an RS485 “smart” output unit and interface with the sensor using SiloTrack™ software.

Troubleshooting section is continued on the next page. >>>

Troubleshooting – Level Frozen Condition:

PROBLEM: The Level Frozen Error Message (Error Flag 2-3) is displayed.

CAUSE/SOLUTION:

The Level Frozen error message (error flags 2-3 indicated) is due to either the loss of the measurement reflection or the reflection is coming from an area outside of the defined measurement range. Adjustment(s) to the Flexar® operating program will be necessary to resolve these errors.

Before proceeding further it is recommended to navigate to program parameter 1.5.8 and change the CIP setting from 'NO' to 'YES'. This change allows the Flexar program to consider the entire cable as an acceptable zone from which suitable reflection can be realized. If CIP is set to 'NO' the Flexar program will search only a limited zone (as defined in Operating Window parameter 1.1.5) for a suitable refection. The Operating Window parameter is a zone within which reflections will be considered – all other reflection will be excluded. However, it can often be advantageous to adjust the Flexar to search the entire cable rather than a limited area.

Level Frozen can occur; **Situation 1)** when the vessel is empty, or **Situation 2)** vessel partially full, or **Situation 3)** vessel completely filled with the material level nearing the Flexar mounting connection.

Situation 1 - Vessel is Empty

When the silo is empty the proper measurement reflection will emanate from the top of the cable antenna's counter weight. If the Flexar cable antenna has stretched the measurement may now be coming for a distance slightly beyond the preprogrammed acceptable maximum distance. Such a reflection will be categorized as an errant reflection and the Level Frozen condition will result. To resolve:

Navigate to parameter 1.1.7 Probe Length and increase entry by 0.5ft. Next, navigate to parameter 1.5.2 and enter the same value as entered at 1.1.7. Back out of the program mode and saving change.

Situation 2 - Vessel is Partially Full

2A) If the Flexar is mounted flush to the vessel roof;

Navigate to parameter 1.5.2 and enter a distance value which roughly equals (+/- 5ft) the distance between the material surface and the vessel roof. Back out of program mode into operating mode and view LCD to see error clears.

If the error flags 2 & 3 did not clear it may be necessary to lower the 'sensitivity' threshold of the Flexar instrument below the factory setting. To do so:

Navigate to 1.5.1. When at 1.5.1 press the RIGHT arrow key once. This will display the gain level: gain level (G 0,1,2,3) on the lower data line with the voltage displayed on the upper data line. The automatic gain function most likely will be in operation and the gain level will be continuously cycling: 0 - 1 - 2 - 3 - 0 - 1 - 2 ….

Anticipate as best you can and press the RETURN key to capture G3. If successful Min G3 will be displayed below a three digit number. If you miss and capture/display G1, G2 or G0, press RETURN, RETURN, and RIGHT (displaying a flashing 1 at parameter 1.5.1) to make another attempt.

When at the captured G3 press RETURN key once. The first digit in the upper data line will be flashing. Use the RIGHT key to shift the flashing cursor over to the desired digit. When at the desired digit use the UP key to scroll up to select the desired value. Repeat the RIGHT and UP key stroke routine until the desired value is displayed. The value at G3 is factory set to 3.70. Reduce this to 3.5 at first and return the sensor to operation. If flags 2 & 3 still present further reduce the value a slight bit more. This can be repeated as necessary but do not reduce below 3.10

Press RETURN multiple times to back out of menu, saving the parameter changes.

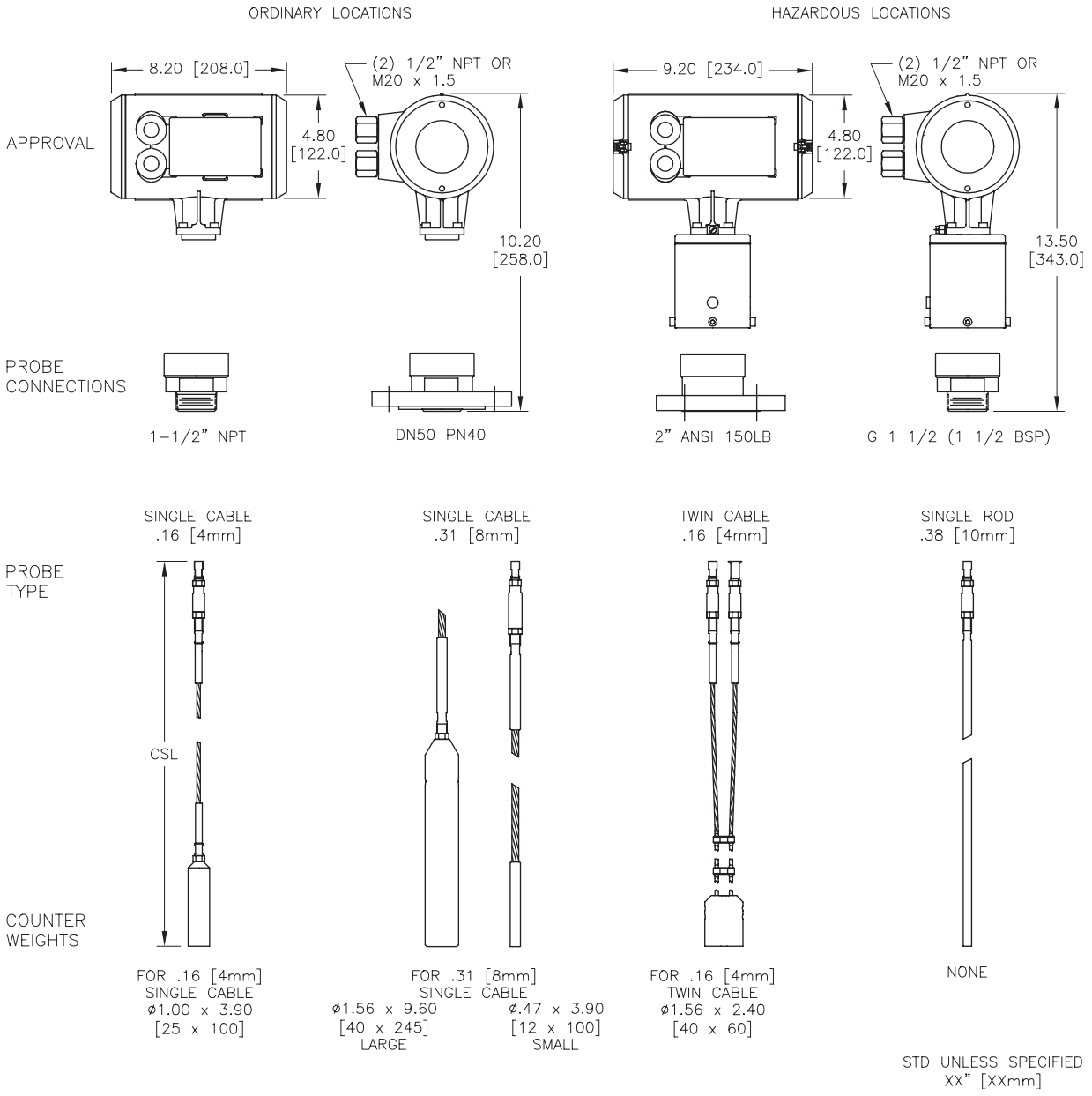
2B) If the Flexar cable antenna is mounted through a nozzle pipe or spout a Level Frozen error can sporadically develop regardless of the amount of material within the silo. If the cable shifts to one side and closely approaches or contacts the inside edge of the nozzle an errant reflection from within the upper dead zone will be created. Increasing the upper dead zone parameter Hold Dist 1.1.2. by 0.25ft increments may resolve a Level Frozen error. Individual mountings characteristics (e.g. nozzles, stand pipes, etc…) will affect the extent to which the Hold Distance value must be increased. In absolutely terrible situations (tall nozzles) a dead zone of 4 or 5 ft have been required. Relocation of the Flexar sensor to a more compatible mount should be considered if a minimal dead zone is desired.

Along with the 1.1.2. Hold Dist parameter the 1.5.3. Delay Detection parameter should be adjusted. It is recommend that the 1.5.3. entry be set to a value which is 0.5 ft less that the value entered at 1.1.2. Press RETURN multiple time to back out of menu and save changes. Together the Hold and Delay parameters may allow the Flexar to disregard reflection(s) which occur near the mounting point.

Situation 3 - Target too close to the Flexar mounting point will not allow adequate development of a measurable reflection. The poorly developed reflection cannot be profiled and Flexar will begin to search for a more suitable reflection. If none can be found the error is reported. Target material present within the 1.1.2. Hold Dist dead zone will cause such a problem. Short of disabling the error reporting function and freezing the measurement-before-reflection-loss value not much can be done to eliminate this condition. Unfortunately this is characteristic behavior common with nearly all types of non-contact distance measuring technologies.

Tech Tip

Parameter 1.5.2. allows the operator to force the Flexar program to search an area on the cable antenna that may be in contact with the material. This action unlocks the Flexar from ruminating on a close-in or far-end errant reflection. The operator inputs a distance-to-product estimate at parameter 1.5.2. and when the operator exits the program menu the Flexar will begin searching for a suitable reflection in the area of the input distance.


ORDINARY LOCATIONS
HAZARDOUS LOCATIONS
APPROVAL
8.20 [208.0]
(2) 1/2" NPT OR M20 x 1.5
4.80 [122.0]
10.20 [258.0]
9.20 [234.0]
13.50 [343.0]
PROBE CONNECTIONS
1–1/2" NPT
DN50 PN40
2" ANSI 150LB
G 1 1/2 (1 1/2 BSP)
SINGLE CABLE .16 [4mm]
SINGLE CABLE .31 [8mm]
TWIN CABLE .16 [4mm]
SINGLE ROD .38 [10mm]
PROBE TYPE
CSL
COUNTER WEIGHTS
FOR .16 [4mm] SINGLE CABLE ø1.00 x 3.90 [25 x 100]
FOR .31 [8mm] SINGLE CABLE
ø1.56 x 9.60 [40 x 245] LARGE
ø.47 x 3.90 [12 x 100] SMALL
FOR .16 [4mm] TWIN CABLE ø1.56 x 2.40 [40 x 60]
NONE
STD UNLESS SPECIFIED XX" [XXmm]

APPENDIX: CONFIGURATION RECORD

Fct.Nbr.	Function	Configuration
1.1.0 Basic parameters		
1.1.1	Tank Height	
1.1.2	Hold Distance	
1.1.3	Time Constant	
1.1.4	Window Frozen	
1.1.5	Level Window	
1.1.6	Interface Window	
1.1.7	Probe Length	
1.2.0 Display Functions		
1.2.1	Display Mode	
1.2.2	Display item	
1.2.3	Cycle Time	
1.2.4	Length Unit	
1.2.5	Volume Unit	
1.2.6	Error Message	
1.3.0 Current Functions		
1.3.1	Function I 1	
1.3.2	Range I 1	
1.3.3	Scale I 1 Min	
1.3.4	Scale I 1 Max	
1.3.5 *	Function I 2	
1.3.6 *	Range I 2	
1.3.7 *	Scale I 2 Min	
1.3.8 *	Scale I 2 Max	
1.4.0 User Data Functions		
1.4.1	Language	
1.4.2	Entry Code 1	
1.4.3	Code 1	
1.4.4	Device Number	
1.4.5	Serial Number	
1.4.6	French Comm No.	
1.4.7	German Comm No.	
1.4.8	Option	
1.4.9	Sensor Type	
1.5.0 Application Functions		
1.5.1	Level - first reading from display = reflection amplitude	
	Gain	Amplitude
	Level - second reading from display = threshold	
	Gain	Amplitude
1.5.3	Detection Delay	
1.5.4 **	Interface - first view from display = reflection amplitude	
	Gain	Amplitude
	Interface - second reading from display = threshold	
	Gain	Amplitude

Fct.Nbr.	Function	Configuration
1.5.5	Epsilon R**	
1.5.7	Settling	
1.5.8	Cleaning In Place	
1.5.9	Application Mode	
1.6.0 Serial Input /Output		
1.6.1	Baud Rate	
1.6.2	Address (networks)	
1.7.0 Volume Strap Table		
1.7.1	Volume Unit	
1.7.2	Strap Table Input	

Comments

* if second output ordered

** for interface applications

Strapping Table values (specify units) :

Pt	Level	Volume	Pt	Level	Volume
1			26		
2			27		
3			28		
4			29		
5			30		
6			31		
7			32		
8			33		
9			34		
10			35		
11			36		
12			37		
13			38		
14			39		
15			40		
16			41		
17			42		
18			43		
19			44		
20			45		
21			46		
22			47		
23			48		
24			49		
25			50		

SAFETY

General Safety
CAUTION: It is essential that all instructions in this manual be followed to ensure proper operation of the equipment and safety of operating personnel. Use of equipment not specified herein, may impair protection provided by equipment. The use of this symbol is used throughout this manual to highlight important safety issues. Please pay particular attention to these items.

Electrical Shock Caution
Certain Flexar® guided wave radar level sensors are powered with HIGH VOLTAGE. No operator serviceable parts are inside. All servicing is to be performed by qualified personnel. Each Flexar unit is provided with a "protective conductor terminal" which shall be terminated to earth ground potential (Refer to Electrical Installation section).

Hazardous Location Caution
Certain Flexar® models can be used in Hazardous Locations (Refer to Specifications). These models shall only be used in applications covered by stated ratings or those considered non-hazardous. Failure to comply could result in damage to personnel and property. The following must be maintained to assume safe operation:
1) Enclosure integrity – The dimensions of the housing, covers and probe shall not be altered.
2) Electrical integrity – Substitution of electrical components are prohibited.
3) Maintenance – Power to all circuits must be disconnected before conducting any investigation or maintenance.

Electromagnetic Compatibility
The Flexar® guided wave radar level sensor was tested and found to comply with the standards listed below. The sensor should not be used in residential or commercial environments. Compliance to the EMC standards was demonstrated by means of a test setup using the following installation methods.
1) Flexar enclosure was connected to earth ground (protective earth). (ground symbol)
2) No specific wiring convention was used to supply power or retrieve an output signal.

EMC Emissions:

Meets	EN 61326-1	Electrical Equipment for Control Use, EMC
	EN 55011	Radiated and conducted emissions (Class A – industrial)
	EN 61000-3	Fluctuation/Flicker
Meets	FCC Part 15B	RF Devices, Unintentional Radiators
	CISPR 11	Radiated and conducted emissions (Class A – industrial)

EMC Immunity:

Meets	EN 61326-1	Electrical Equipment for Control Use, EMC
	IEC 1000-4-2	Electrostatic Discharge (industrial)
	IEC 1000-4-3	RF Radiated EM Fields (industrial)
	IEC 1000-4-4	Electrical Fast Transients (industrial)
	IEC 1000-4-5	Electrical Surges (industrial)
	IEC 1000-4-6	RF Conducted EM Energy (industrial)
	IEC 1000-4-8	Power Frequency Magnetic Fields (industrial)
	IEC 1000-4-11	Source Voltage Deviation

SPECIFICATIONS

Power Requirements:	100-240VAC (+10%/- 15%); 9VA; 50/60Hz or 24VAC/VDC (+10%/- 15%); 9VA/W
Altitude:	6562ft (2000m) maximum
Installation Category:	II
Pollution Degree:	4 (reduced to 2 by enclosure) Suitable for indoor/outdoor use
Process Temperature:	
Ordinary Location Units	-20˚F to +300˚F (-30˚C to +150˚C);
Hazardous Location Units	-20˚F to +392˚F (-30˚C to +200˚C)
Ambient Temperature:	-5˚F to +120˚F (-20˚C to +50˚C)
Operating Pressure:	
1-1/2" NPT:	-14.5psig to +580psig (-1bar to +40bar)
G 1-1/2 (1-1/2" BSP):	-14.5psig to +580psig (-1bar to +40bar)
2" ANSI:	-14.5psig to +150psig (-1bar to +10bar)
DN50PN40:	-14.5psig to +580psig (-1bar to +40bar)

Specifications are continued on the next page. >>>

Measurement Range[††]:	
Single Cable 0.16” (4mm):	150ft (45m)
Single Cable 0.31” (8mm):	100ft (30m)
Twin Cable 0.16” (4mm):	200ft (60m)
Single Rod 0.38” (10mm):	10ft (3m)
Accuracy:	
Direct Mode	
Solids	± 0.8” (20mm)
Liquids	< 20ft (6m): ± 0.2” (5mm) ≥ 20ft (6m): ± 0.2” (5mm) + 0.02% of distance measured
TBF Mode (All)	± 0.8” (20mm) when Dielectric is constant
Repeatability:	± 0.04” (1mm)
Resolution:	± 0.012” (0.3mm)
Minimum Dielectric Constant[†]:	
Direct Mode	Twin Cable ≥ 1.8; Single Cable/Rod ≥ 2.1
TBF Mode	All Probe Styles ≥ 1.4
Process Mounting Connection:	
Single Cable/Rod Only	1-1/2” NPT; G 1-1/2 (1-1/2” BSP)
All probe Styles	2” ANSI 150lb Flange; DN50PN40 Flange
Conduit/Cable Entry:	
NPT/ANSI Process Connections	(2) 1/2” NPT
BSP/DN Process Connections	(2) M20 x 1.5 cable connectors
Probe Styles:	
Single Cable	
0.16” (4mm)	316SS
0.31” (8mm)	316SS
Single Rod	316SS; 0.38” (10mm) diameter;
Twin Cable	316SS; Two 0.16” (4mm) cables; FEP spacers
Weight:	
Enclosure	18lb (8kg) without probe for ordinary location; 20lb (9kg) without probe for hazardous location;
Single Cable	
0.16” (4mm)	0.08lb/ft (0.12kg/m)
0.31” (8mm)	0.28lb/ft (0.41kg/m)
Single Rod	0.42lb/ft (0.62kg/m)
Twin Cable	double weight of 4mm cables above for twin cable
Maximum Traction Loading:	
0.31” (8mm) Single Cable	7,700lbs/3.9 tons (3.5 metric tons)
0.16” (4mm) Single Cable	2,250lbs/1.1 tons (1.02 metric tons)
Minimum Separation From Objects:	
Single Cable/Rod	12” (300mm)
Twin Cable	4” (100mm)
Output Signal:	
“Smart”:	RS-485, half-duplex, isolated, proprietary protocol
Analog:	4-20mA; 350ohms maximum load, isolated output
Wiring Distance (“smart” output):	4,000ft (1,220m)
Local Display:	3-line; Backlit LCD; 3 pushbuttons; 3 magnetic sensors for setup without cover removal
Materials of Construction:	
Enclosure:	Aluminumm, powder coated
Threaded/Flange Connection:	316 Stainless Steel
Process Insulator:	Teflon (PTFE)
O-Ring Seal:	Viton
Probes:	316 Stainless Steel
Remote Electronics:	16.4’ (5m) pre-wired interconnection cable
Dead Zones:	
Single Cable/Rod	
Dielectric = 80 (water)	Top = 15.75” (400mm) Bottom = 0.8” (20mm)
Dielectric = 2.4 (oil)	Top = 19.7” (500mm) Bottom = 3.9” (100mm)
Twin Cable	
Dielectric = 80 (water)	Top = 9.8” (250mm) Bottom = 0.8” (20mm)
Dielectric = 2.4 (oil)	Top = 13.0” (330mm) Bottom = 0.8” (20mm)
Enclosure Rating:	NEMA 4, IP66
Approvals:	
Integral Electronics Only	
Ordinary Location	CE Mark
Hazardous Location	$CSA_{US/C}$ Class I, Div 1,2, Groups B, C, D; Class II, Div 1,2, Groups E, F, G; Class III
Remote Electronics	
Ordinary Location	CE Mark

[†] Overall measuring range effects the minimum dielectric constant that can be measured.

[††] Maximum measuring range is also limited by the dielectric constant of the material being measured.

WARRANTY

Monitor Technologies LLC warrants each Flexar® guided wave radar continuous level measurement system it manufactures to be free from defects in material and workmanship under normal use and service within two (2) years from the date of purchase. The purchaser must give notice of any defect to Monitor within the warranty period, return the product intact and pre-paid transportation charges. The obligation of Monitor Technologies LLC under warranty is limited to repair or replacement at its factory. This warranty shall not apply to any product which is repaired or altered outside of the Monitor Technologies LLC factory, or which has been subject to misuse, negligence, accident, incorrect wiring by others or improper installation.

Monitor Technologies LLC reserves the right to change the design and/or specifications with our prior notice.