

TRUE ECHO®

CR-S Radar Level Sensor, 80GHz FMCW

USER MANUAL



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Doc # 9006851

Part # 201141

Rev. A | 07/2026

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NOTE: Find additional product documents, specifications, accessories, and more on the TRUE ECHO CR-S online product page.
Go to: apgsensors.com/product/cr-s

INTRODUCTION

Thank you for purchasing a TRUE ECHO® CR-S Radar Level Sensor from APG. We appreciate your business! Please take a few minutes to familiarize yourself with your CR-S Radar and this manual.

The TRUE ECHO CR-S Radar is a Frequency Modulated Continuous Wave (FMCW) radar operating at 76-81 GHz. It brings the accurate level readings of radar sensors to industrial liquid and bulk solid measurements. It can accurately measure in many adverse environments. The narrow 3° or 8° beam angle can detect small targets and achieve precise positioning with high resolution. All TRUE ECHO CR-S sensors can be easily setup and field adjusted via the TRUE ECHO mobile app and onboard keypad.

KEY FEATURES

- Accurate level measurements in various adverse environmental conditions.
- Millimeter wave technology allows higher signal-to-noise ratio and a smaller blind zone.
- Measurement accuracy up to ± 2 mm
- Measures dielectric constants greater than 1.5.
- The antenna's 3° or 8° beam angle reduces side interference and allows for ease of installation.
- False echo suppression
- Robust IP68 housing
- 4-20 mA (2 wire) and RS-485 (4 wire) outputs.
- Keypad and mobile communication to facilitate on-site setup and optimization.
- Ideally suited for liquid and bulk solid measurement applications.
- Multiple mounting and chemical resistant options.

READING YOUR LABEL

Every APG instrument comes with a label that includes the instrument's model number, part number, serial number, and a wiring pinout table. Please ensure that the part number and pinout table on your label match your order.

WARRANTY STATEMENT

This product is covered by APG's warranty to be free from defects in material and workmanship under normal use and service of the product for 24 months. For a full explanation of our Warranty, please visit apgsensors.com/warranty-returns/.

Contact Technical Support to receive a Return Material Authorization (RMA) before shipping your product back.

If your product needs to be returned for evaluation, contact us via email, phone, or online chat on our website. We will issue you an RMA number with instructions. You can also find the form on our website by clicking "RMA" in the web footer, or go to apgsensors.com/RMA-form.

- Phone: (435) 753-7300
- Email: sales@apgsensors.com
- Online chat at apgsensors.com

Please have your part number and serial number available.

CERTIFICATIONS

FCC / ISED

FCC ID: VPK-APGCRS

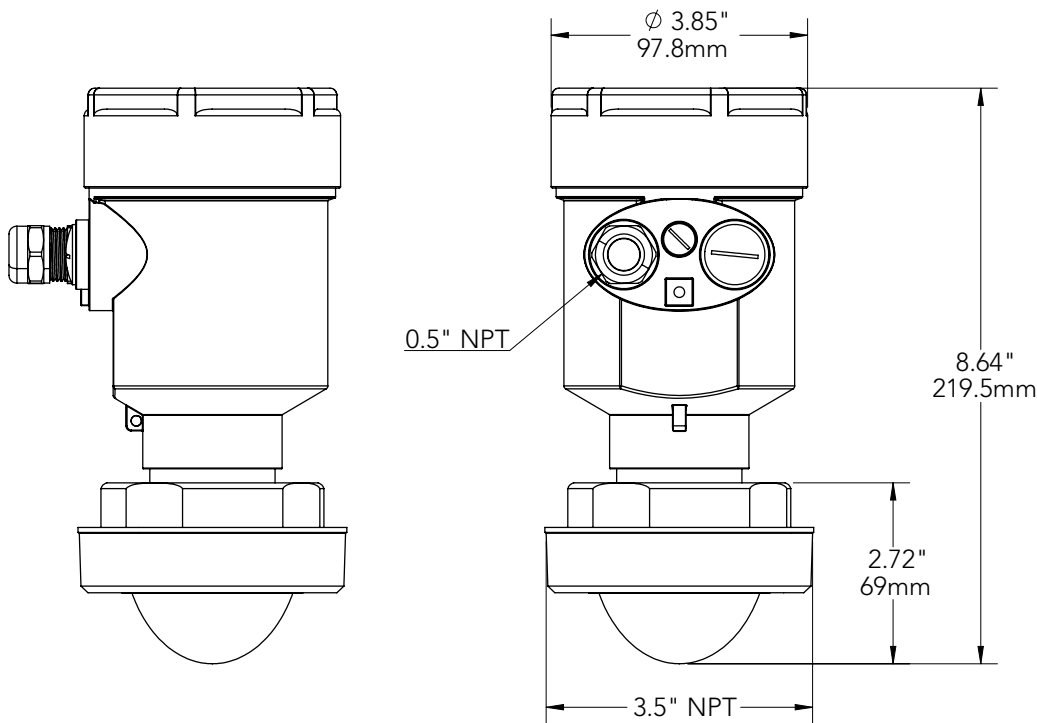
IC: 7385A-APGCRS

Please see Appendix C for FCC and ISED warnings.

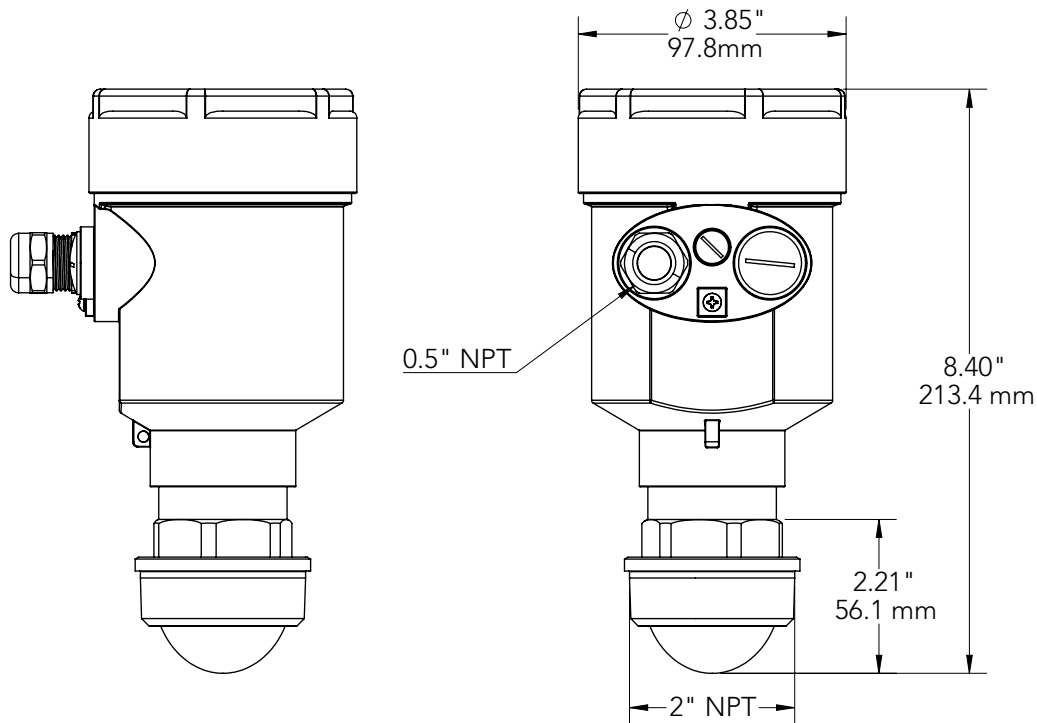
ⓘ IMPORTANT: FCC regulations require 75-85 GHz radars to be installed to ensure a vertically downward orientation at fixed locations only. They must not operate while being moved or while inside a moving container. Hand-held applications are prohibited as well as marketing to residential consumers.

CHAPTER 1: DIMENSIONS & WIRING

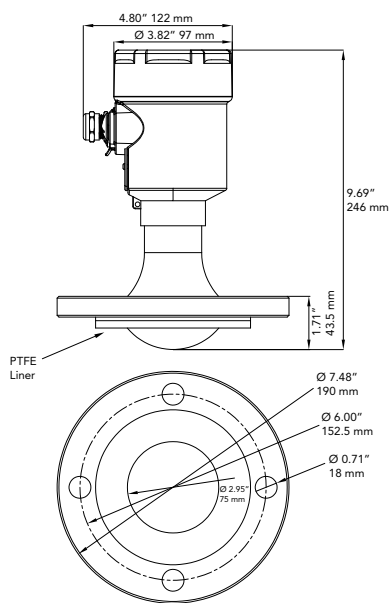
DIMENSIONS



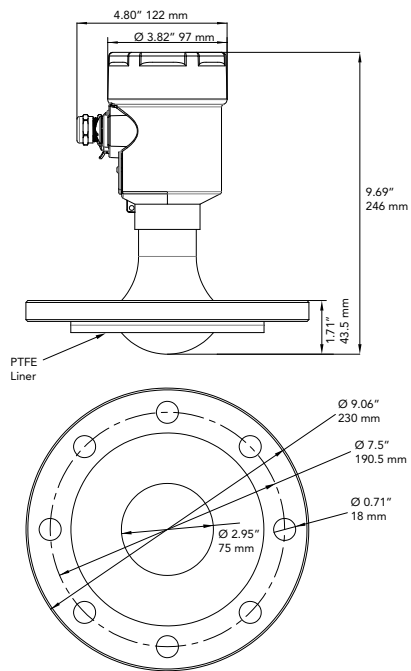
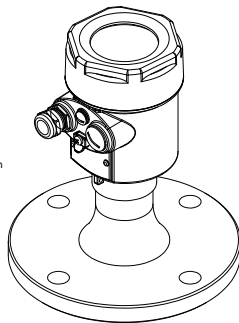
3.5" NPT Thread Mount, 3° Antenna Beam



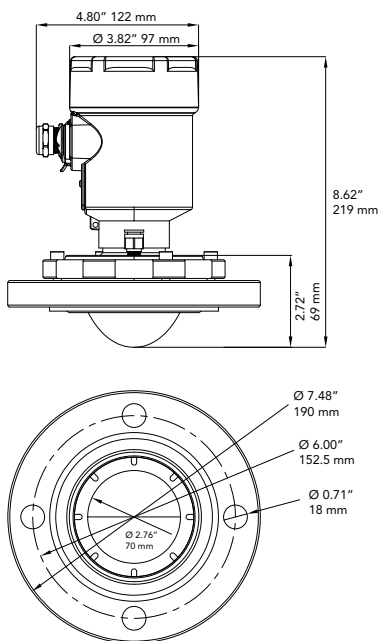
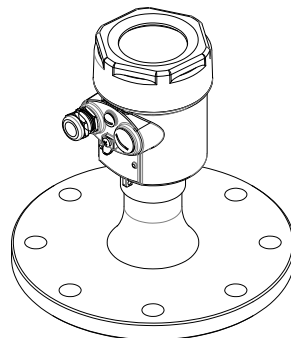
2" NPT Thread Mount 8° Antenna Beam



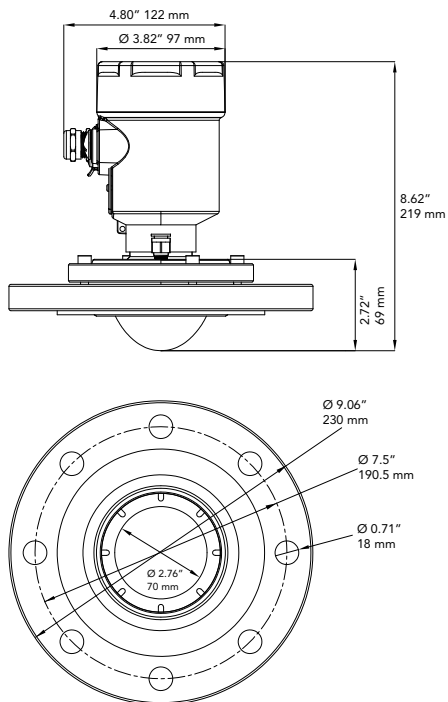
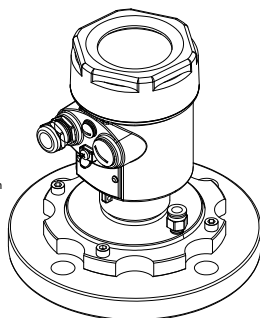
ANSI Flange with PTFE Liner, 3"



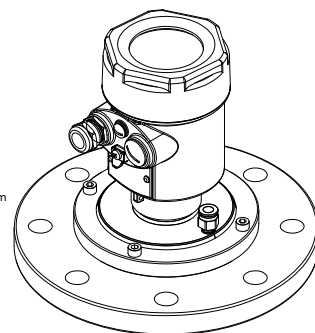
ANSI Flange with PTFE Liner, 4"



Swivel Flange with Air Purge, 3"

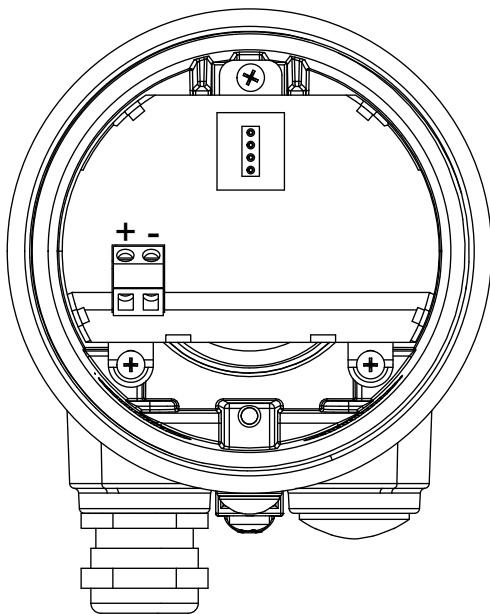


Swivel Flange with Air Purge, 4"

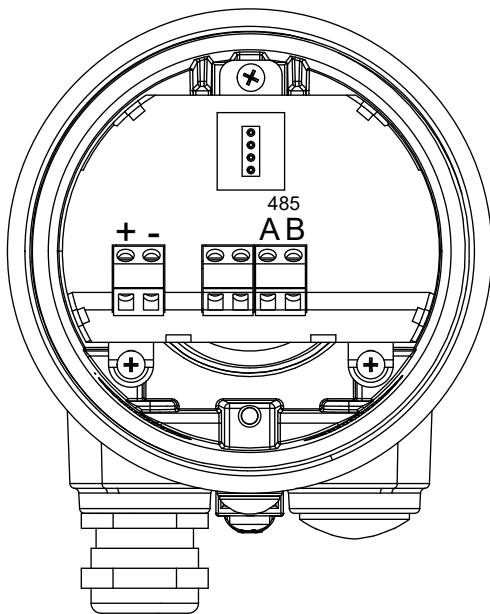


ELECTRICAL PINOUT AND SUPPLY POWER TABLES

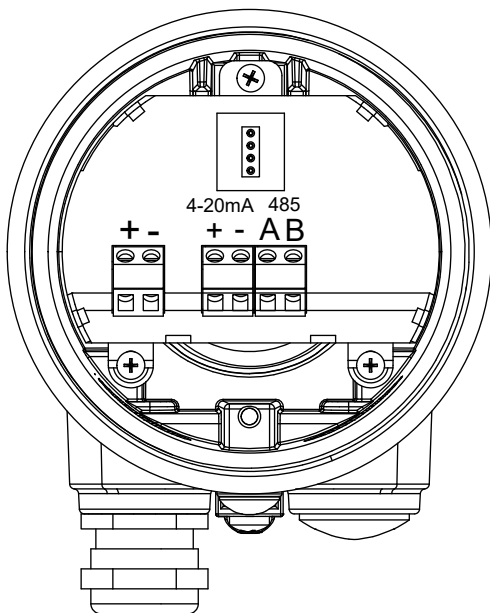
Remove the keypad and display module by gently twisting it counterclockwise to access the wiring connectors. Note the position of the keypad for reinstallation before removing.



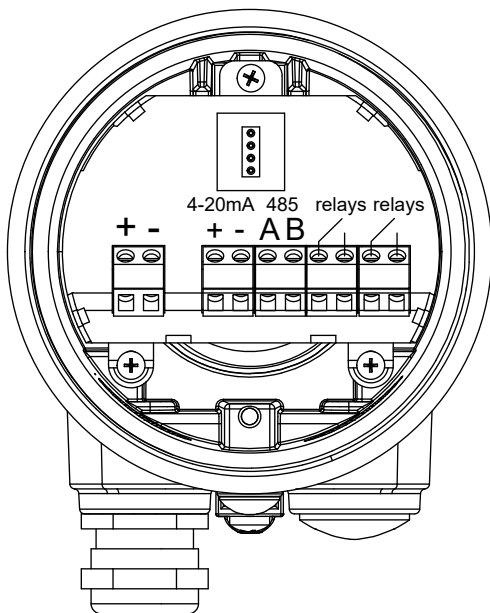
4-20 mA, 2-wire



RS-485, 4-wire



RS-485 + 4-20 mA, 4 wire



Dual Output and Relay Output Wiring

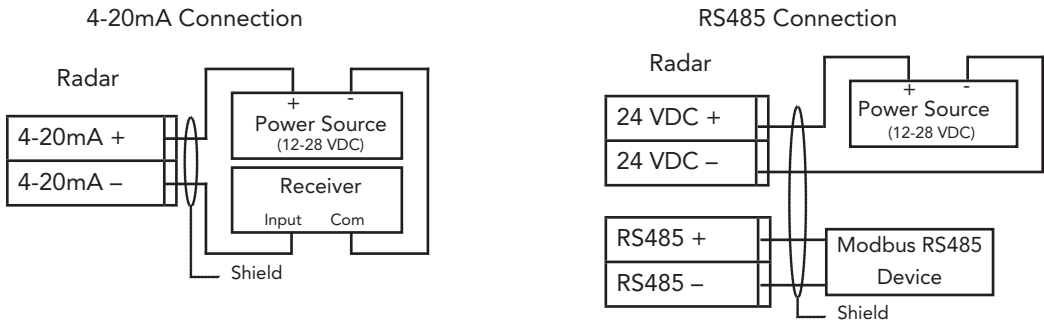
CR-S RADAR SUPPLY POWER TABLE

Output	Voltage (VDC)	RMS Current (mA)	Peak Current (mA)
4-20 mA	12 to 28 VDC	4 to 20 mA	4 to 20 mA
RS-485	12 VDC	53 to 70 mA	73 mA
	24 VDC	28 to 36 mA	41 mA
	28 VDC	24 to 31 mA	34 mA

IMPORTANT: Ensure that the supply voltage is within the specified range to avoid permanent damage to the instrument.

WIRING DIAGRAM

A single multi-core cable with an outer diameter of 6-10 mm is recommended for cable entry. The single-core conductor size should be 24-18 AWG, up to 0.82 mm². Use a 2-3 mm flat-head screwdriver, and tighten screws with a torque of 5.0 kgf.cm.



IMPORTANT: Connect Shield Wire to Power Supply Earth Ground.

When finished wiring, align the metallic strips on the back of the keypad with the pins inside the radar. Reattach the keypad by gently twisting clockwise. The keypad should be aligned with the APG logo centered and the buttons towards the cable entry.



CHAPTER 2: INSTALL & REMOVAL PROCEDURES & NOTES

PHYSICAL INSTALLATION NOTES

- The material to be measured must have a dielectric constant greater than 1.5.
- In areas with direct sunlight, it is recommended to install the instrument in a cool place or use a sun visor to avoid excessive temperature and to provide good ventilation and heat dissipation.
- Mount your TRUE ECHO sensor with a clear, perpendicular path to the surface being monitored.
- Install at least 8 inches (0.2 m) from a side wall.
- The radar path should be free from obstructions and as open as possible. Mount the sensor away from tank or vessel inlets.
- Wrap PTFE tape around threads before installing the radar into the tank opening. This will help it screw in easier. Do not over tighten.
- Be careful not to scratch or damage the radar face.

TOOLS NEEDED

- Tools necessary to make electrical connection.
- Mobile device

MOUNTING INSTRUCTIONS

STEP 1. Unscrew the lid. Remove the radar's keypad by twisting it counterclockwise.

STEP 2. Insert the cable through the conduit hole on the side of the radar.

STEP 3. Attach the wires from your control system to the radar according to the Wiring Diagrams in Chapter 1. Tighten the cable strain relief.

STEP 4. Reattach the radar's keypad by twisting it clockwise. Screw the lid back on.

STEP 5. Mount the radar using the NPT bottom threads. Do not over tighten.

STEP 6. Power on the radar.

STEP 7. Program the radar using the keypad or use the TRUE ECHO app to connect to the radar via short range wireless communication (see Chapter 5: TRUE ECHO App Programming). RS-485 units can also be programmed using Modbus commands.

REMOVAL INSTRUCTIONS

Removing your radar from service must be done with care.

STEP 1. Ensure power is turned off. If the radar was installed in a hazardous location, ensure that the cables will not energize while the sensor is disconnected.

STEP 2. Unscrew the lid. Remove the radar's keypad by twisting it counterclockwise.

STEP 3. Disconnect the radar wires.

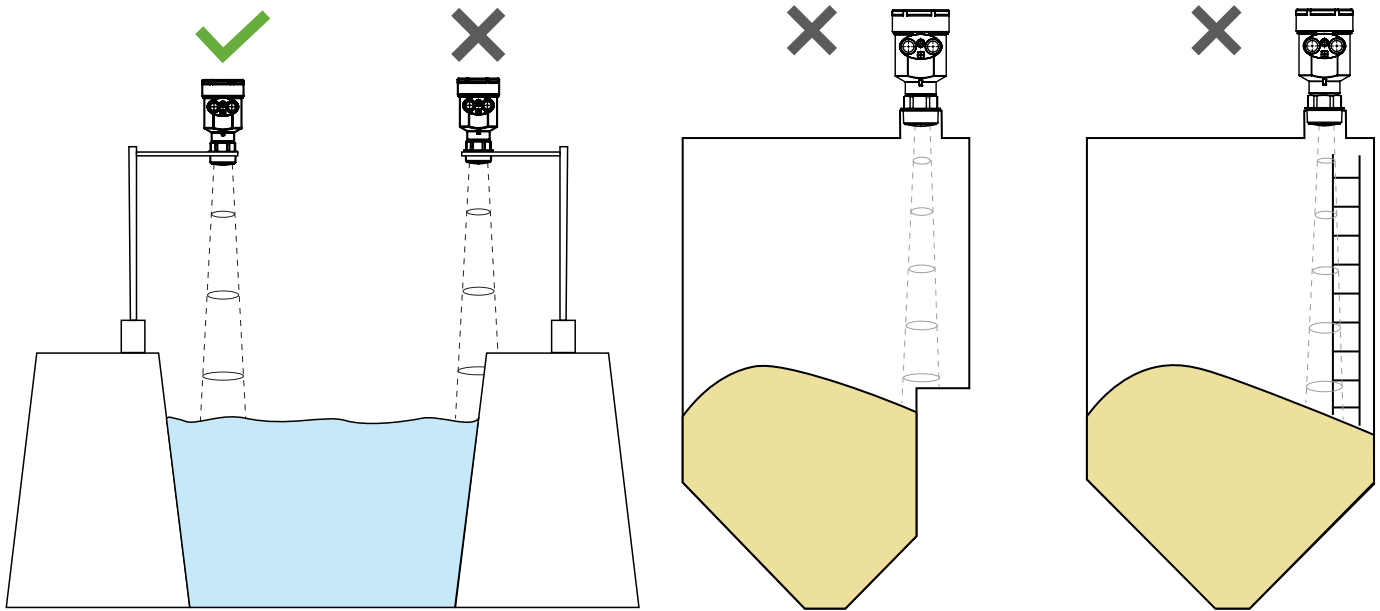
STEP 4. Reattach the radar's keypad by twisting it clockwise. Screw the lid back on.

STEP 5. Remove the radar from its mount.

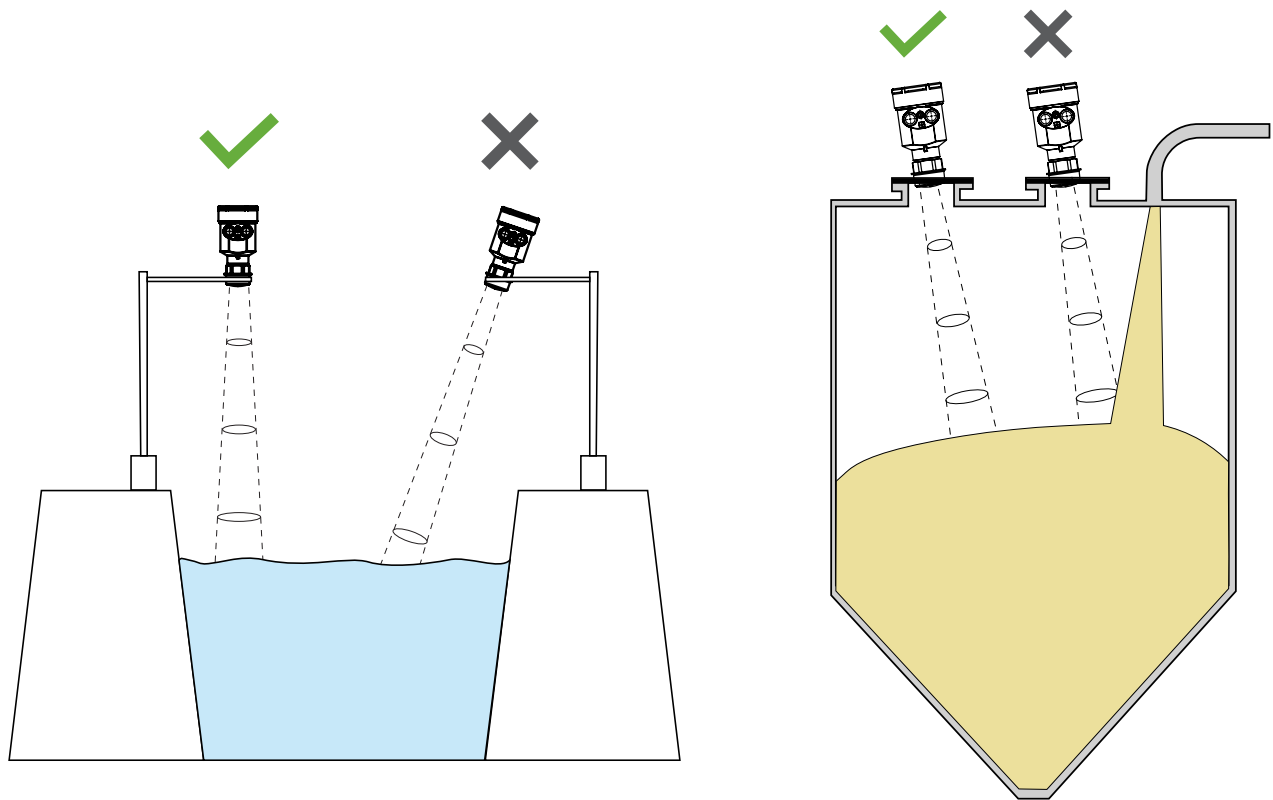
STEP 6. Store it in a dry place, at a temperature between -40° to 158°F (-40° to 70°C).

SENSOR PLACEMENT

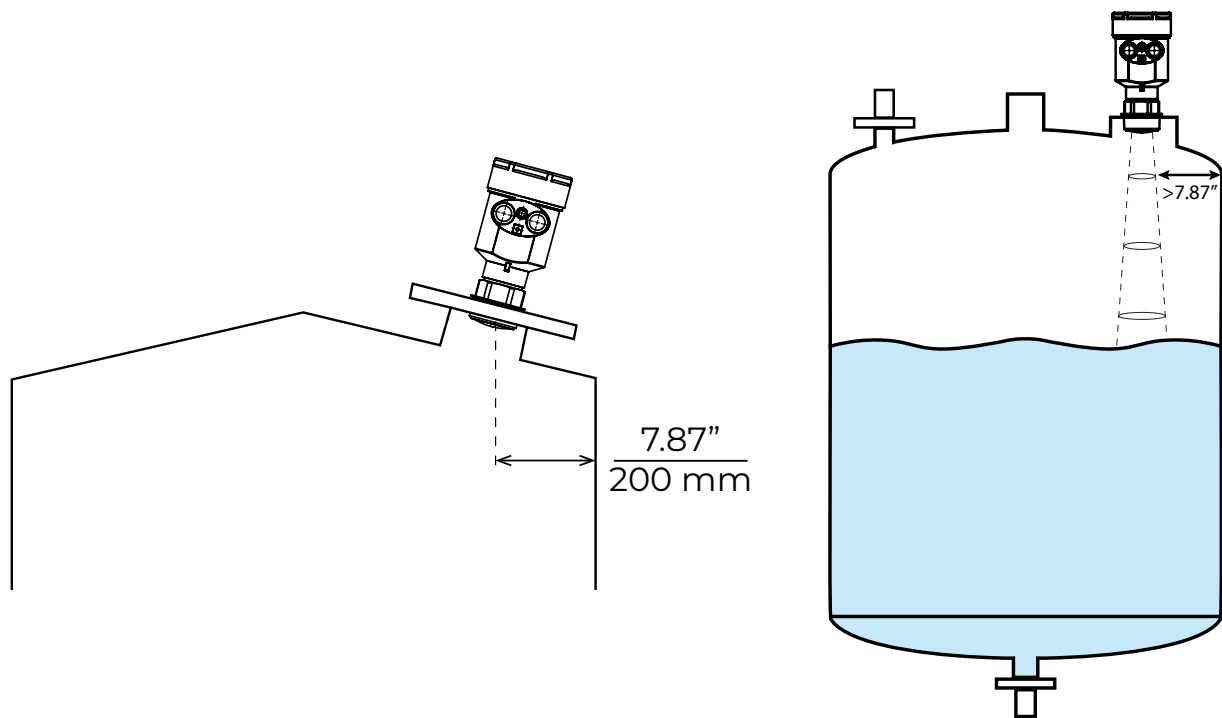
Ensure the antenna beam is free of any interference such as ladders, pipes, steps, etc. Avoid contact between the antenna beam and feeding flow.



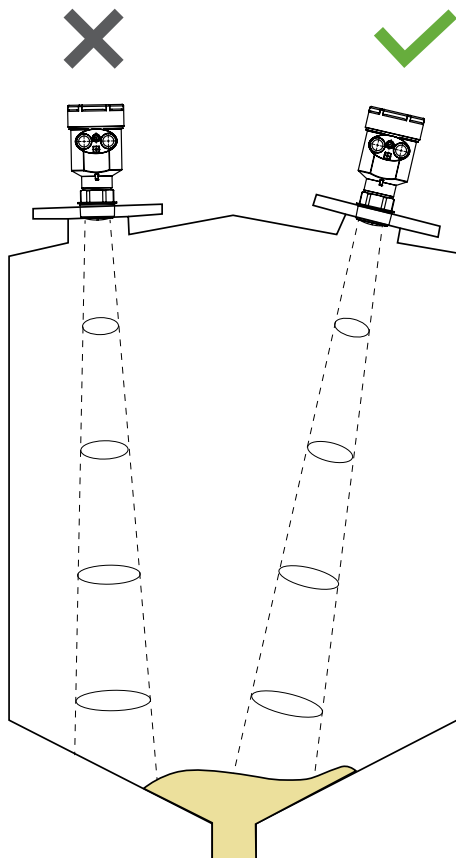
Ensure the radar level transmitter is installed perpendicular to the measured surface. For liquids, this means installing the radar vertically down. Avoid inlets and feeding flow.



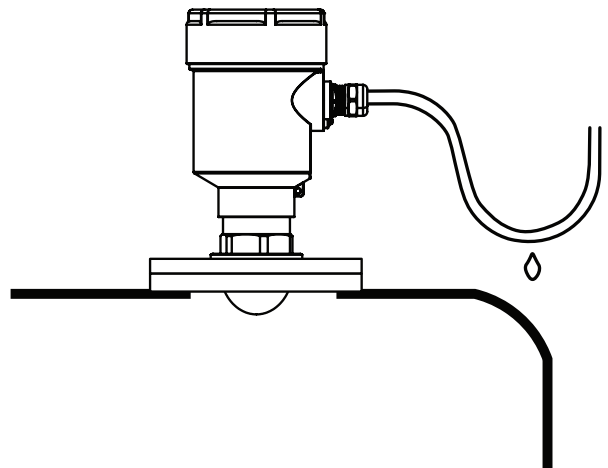
Install the radar at least 7.87 inch (200 mm) away from the wall to avoid false echoes.



In tapered vessels with solid material, aim the antenna beam at the bottom of the vessel to get an accurate measurement.



For instruments installed outdoors, in humid environments, or on cooling/heating tanks, moisture protection measures should be taken. Tighten the cable gland to prevent moisture ingress, and ensure the cable is bent downward at the entry point.



CHAPTER 3: CR-S PARAMETER LIST

The CR-S TRUE ECHO radar can be programmed using the Keypad, the TRUE ECHO app, or with RS485 commands. The table below lists the Keypad and corresponding app parameters. See Chapters 4 and 5 for more information about programming with the Keypad and App respectively.

KEYPAD MENU	CORRESPONDING TRUE ECHO APP MENU	PARAMETER RANGE	SHORT DESCRIPTION
Basic Settings			
Min adjustment	High Low Setting / Low Level	0.33 ft (0.1 m) to Max Range	The farthest distance to be measured; one range value for current output.
Max adjustment	High Low Setting / High Level	0.33 ft (0.1 m) to Max Range	The nearest distance to be measured; the other range value for current output.
Blind Zone	Blind Zone	0.33 ft (0.1 m) to Max Range	Area where measurement is not performed.
Measuring Range	Range Setting	1.64 ft (0.5 m) to Max Range	Maximum detection distance.
Damping	Damping Time	1–100 s	Longer Damping results in slower response speed.
Change Rate	Change Rate	Slow, Medium, Fast, Ultra-Fast	Select the changing speed of the measured material.
Fluctuation / Pile Angle	Fluctuation / Angle	None, Small, Medium, Large	Fluctuation used for optimizing liquid measurement Pile Angle used for optimizing solid measurement
Foam / Dust	Foam / Dust	None, Small, Medium, Large	Foam used for optimizing liquid measurement Dust used for optimizing solid measurement
Volume Meas	—	Container Type, Volume Unit, Mass Meas	Built-in various tank shapes for volume and mass calculation.
Sensor Tag	Radar Identification / Radar Name	Up to 9 characters	Sensor name. User changeable
Display			
Language	—	English, Spanish	Language selection.
LCD Contrast	—	40 to 100	Change the LCD contrast.
Temperature Unit	—	°C / °F / K	Temperature display unit selection.
Distance Unit	Unit Setting	ft / m / in / cm / mm	Display unit selection.
Display Content	Keypad Display Content	Distance / Space / Level / Volume / Current / Percentage	Select output displayed on keypad.

KEYPAD MENU	CORRESPONDING TRUE ECHO APP MENU	PARAMETER RANGE	SHORT DESCRIPTION
Diagnostics			
Echo Quality Peak	Diagnosis / Echo Quality	Echo Quality Max, Echo Quality Min	Historical extreme value of measured echo quality.
Echo Intensity Peak	Diagnosis / Echo Peak	Echo Intensity Max, Echo Intensity Min	Historical extreme value of measured echo strength.
Distance Peak	Diagnosis / Distance	Distance Max, Distance Min	Historical extreme value of measured distance.
Temperature Peak	Diagnosis / Temp	Temperature Max, Temperature Min	Historical extreme value of measured temperature.
Service			
In/Out Rate	In/Out Rate	0 to 196.85 ft/min (60 m/min)	Restrict large sudden changes.
False Echo Learn	—	—	—
False Echo New	False Echo Learning / Add	—	Suppress the influence of interference signals on normal measurements.
Edit False Echo	False Echo Learning / Edit	—	Manually edit and suppress interference signals.
Del. False Echo	False Echo Learning / Clear	—	Delete all modified false echoes.
mA Output	—	—	—
mA Output Mode	Current Output / Output Mode	4–20mA / 20–4mA	Select current output from low to high or high to low.
mA Simulate	Current Simulation	4-20 mA	Arbitrary current output.
mA Calibration	Current Calibration	4mA Calibration / 20mA Calibration	Eliminate deviation of current output.
Fault Current	Current Output / Failure Mode	20 mA, 20.2 mA, Keep, 3.8 mA, 4 mA	Set mA value that will be the output in a fault condition
Backup & Restore	Backup / Restore	—	Restore and restart, backup data.
Low DK Value	—	No, Yes	Used for material dielectric constants from 1.2 to 2
Distance Offset	Distance Offset	-0.75 to 3.28 ft (-0.229 to 1 m)	Reference offset.
TVT Amplitude	—	0–15	Set time varying threshold amplitude to mask out noise
False Echo Offset	—	0–15	Set false echo mask offset
Near Detection	—	Closed, Open	Factory setting

KEYPAD MENU	CORRESPONDING TRUE ECHO APP MENU	PARAMETER RANGE	SHORT DESCRIPTION
Information			
Serial Number	Production Information / Serial number	XXXXXXX	7-digit code, unique per device.
Software Version	Firmware Version	Vx.x.xx	Software identification.
Hardware Version	—	xx.xx.xx	Hardware version.
Sensor Model	—	XXXXXXX	Fixed value, cannot be modified.
Production Date	—	YYYY-MM-DD	Instrument production date.
Factory Setting (RS485 only)	Backup / Restore / Reset	—	Factory Setup
Serial Port Configuration (RS-485 only)			
RS485 Address	RS485 Setting / 485 Address	1–247	Server (slave) address for RS485 communication.
Baud Rate	RS485 Setting / Baud Rate	1200–921600	RS485 communication speed.
Parity	RS485 Setting / Parity Bit	None / Odd / Even	RS485 parity selection.
Stop Bits	RS485 Setting / Stop Bit	1 / 1.5 / 2	RS485 stop bit selection.
Alarm Settings (RS-485 + 2 Alarms only)			
Default Status	—	Normally Open / Normally Closed	Initial relay status
Alarm Mode	—	Off / High Limit / Low Limit	Alarm mode selection
Alarm Value	—	xxx.xxx	Alarm threshold setting
Hysteresis	—	xxx.xxx	Hysteresis setting
Alarm Parameter	—	Distance / Space / Level	Select the meaning of the alarm value

CHAPTER 4: KEYPAD PROGRAMMING

The TRUE ECHO CR-S Radar can be programmed and monitored via the Keypad. The Keypad is not required for the radar to function.

KEYPAD INTERFACE

The on-board Display Module consists of an LCD (128*64 dot matrix) with 4 push buttons. It facilitates the following functions:

- Displays measurement results.
- Displays the echo curve.
- Used to set up system parameters.
- Used to input value of parameters, numbers, or characters.

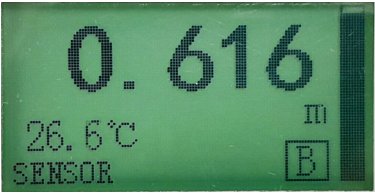
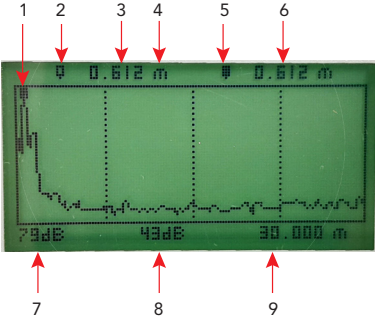
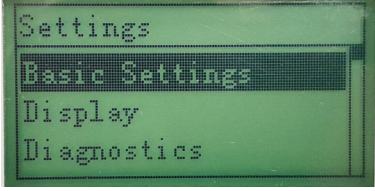


1. Measurement: The value of the selected measurement type with the damping filter applied.
2. Temperature: The temperature of the signal processing board.
3. Sensor Name: Serial Number or customer label
4. % Bar Graph: Visual level representation
5. Units: Measurement units.
6. Measurement Type: D = Distance, S = Space, L = Level, V = Volume, C = Current, % = Percentage, B = Mobile app connected
7. Fault Code: Error codes will appear here when a fault is present. See Appendix A for details.
8. Keypad: Used to navigate radar settings

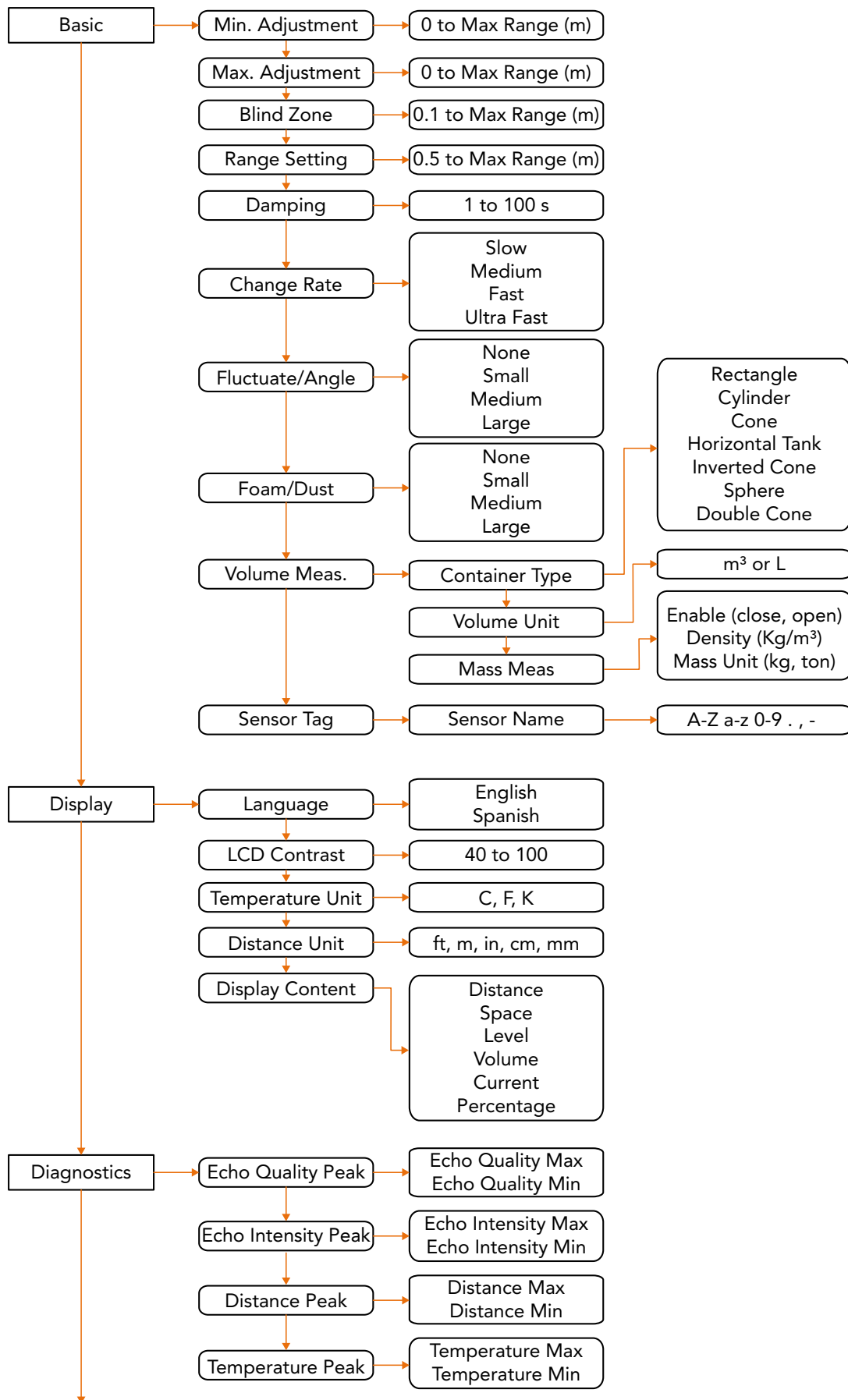
❗ IMPORTANT: The liquid crystal display gets sluggish below 32F (0 C) and will darken or freeze around -4 F (-20 C). Damage to the display can occur at temperatures below that. The radar will continue to work over its full temperature range.

KEYPAD FUNCTION

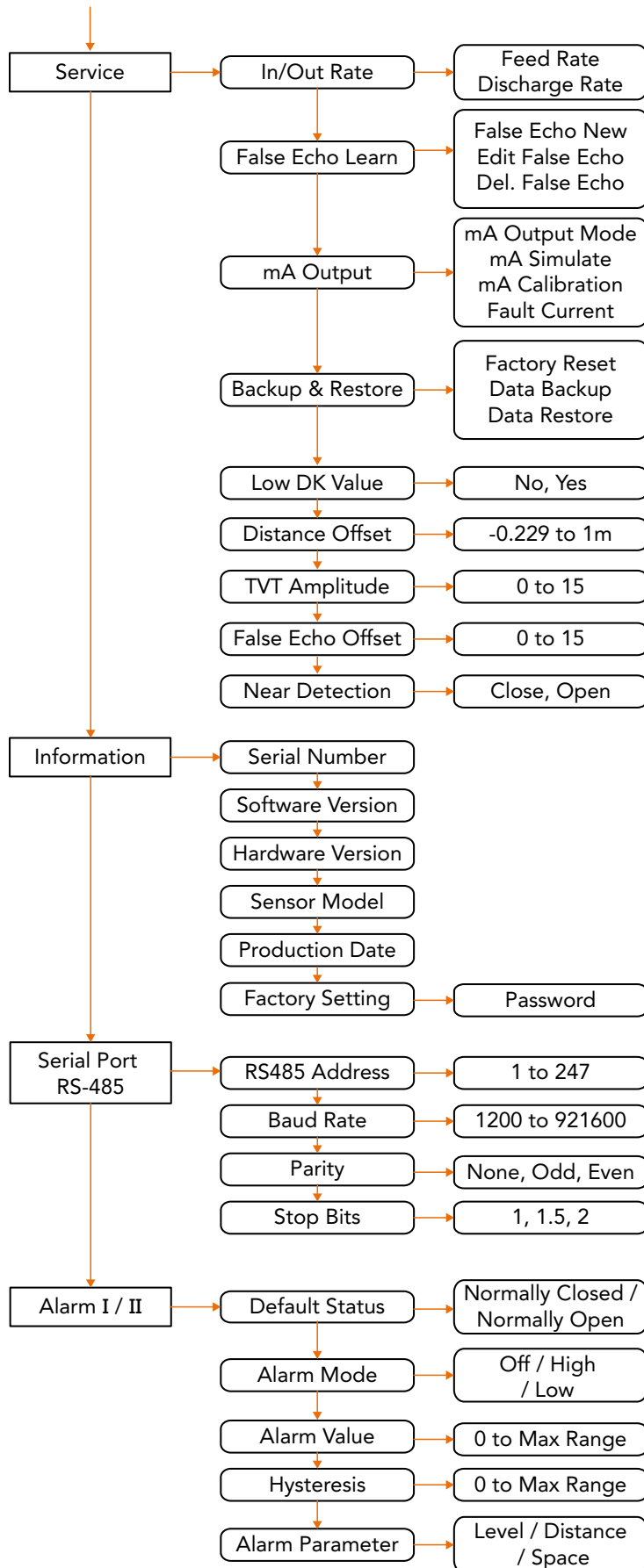
Key	From Measurement Display	From Echo Curve Display	From Setting Display
ESC	View Echo Curve Display	Return to Measurement Display	Return to Measurement Display
+	n/a	Toggle Time Varying Threshold (TVT) curve on and off	- Navigate up menu lists - Increment digit value
▶	n/a	Toggle Time Varying Threshold (TVT) curve on and off	- Navigate down the menu - Highlight next digit to the right
OK	Enter Settings Display	Enter Settings Display	- Select menu option - Confirm setting selection

MEASUREMENT DISPLAY	DESCRIPTION	KEYPAD FUNCTION
	Gives a quick view of the measurements.	ESC to view the Echo Curve Display. OK to enter the Settings Display.
ECHO CURVE DISPLAY		
	- Current echo, solid cursor represents real-time values after damping effect, which is current effective output value. - Hollow cursor represents real-time value without damping effect. - Real-time value without damping effect. - Units - Solid cursor represents real-time values after damping effect - Real-time values after damping effect - dB value of real-time output - Signal Noise Ratio (Signal Quality) of real-time output - Radar Range	ESC to return to the Measurement Display OK to enter the Settings Display
SETTINGS DISPLAY		
	Used to setup the radar for specific applications. Setting Menu: - Basic Settings - Display - Diagnostic - Service - Information - Serial Port (RS-485 only) - Alarm Settings (RS-485 + 2 Alarms only)	To navigate the Setup Menu: ▶ to move down the list of settings. + to move up the list of settings. OK to select a setting. ESC to go back. To change numeric settings: + to change digit value. ▶ to move to the next digit. OK to save the changes.

KEYPAD FULL ACCESS MENU



KEYPAD FULL ACCESS MENU (CONT.)



BASIC

The Basic menu options contain the necessary settings to quickly set up the radar.

MIN ADJUSTMENT

Used to define the furthest point to be measured from the sensor’s zero reference point. Set the Min. Adjustment to the lowest point in the tank. Min. Adjustment must be less than or equal to the sensor range.

Range: 0 to max sensor range

Default: max sensor range

MAX ADJUSTMENT

Used to define the closest point to be measured from the sensor’s zero reference point. Set the Max. Adjustment value to the max fill point in the tank. Max. Adjustment must be less than the Max. Adjustment value.

Range: 0 to max sensor range

Default: 0

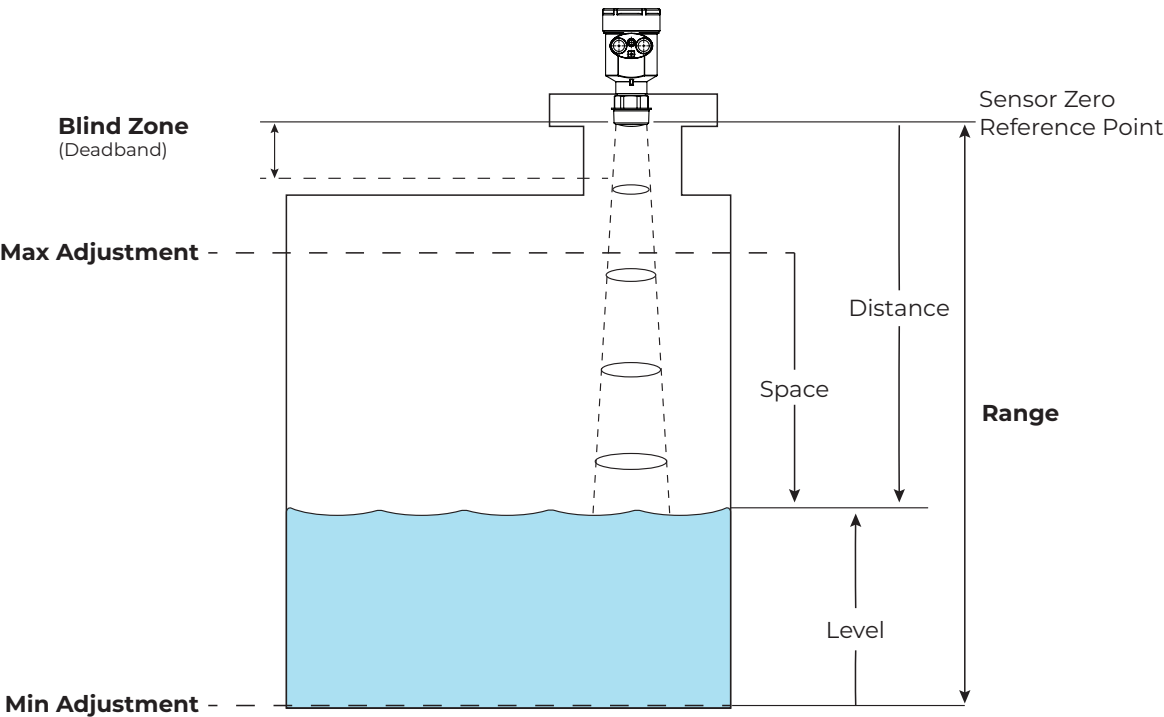
BLIND ZONE

Used to set the minimum distance (deadband) the sensor will look for a target. The sensor will ignore the echo wave within the deadband when processing the signal. Typically, the Blind Zone is set at or a little before the desired measuring range to achieve a fast and stable measurement and avoid near field signals.

Range: 0.33 ft (0.1 m) to max sensor range

Default: varies by max sensor range

Max Radar Range	Default Blind Zone Value
32.8 ft, 65.6 ft, 98.4 ft (10 m, 20 m, 30 m)	0.33 ft (0.1 m)
196.85 ft, 393.7 ft (60 m, 120 m)	0.98 ft (0.3 m)



RANGE SETTING

Used to set the maximum processing range of the sensor. Typically, the Range Setting is set at or a little beyond the desired measuring range or tank bottom to avoid false echoes and achieve a fast and stable measurement.

Range: 1.64 ft (0.5 m) to max sensor range

Default: varies by max sensor range

DAMPING

Damping sets the time that is applied to a filter used to smooth sudden changes in the liquid level. A longer *Damping* time will provide more smoothing. A shorter *Damping* time will provide a quicker response with less stability in agitated conditions that may be undesirable.

- Range: 0 to 100 seconds
- Default: 5 seconds

If *Damping* is greater than 0, the following damping filter is applied:

$$D_{t+1} = \left[D_t + \frac{(D_{target} - D_t)}{k} \right]$$

Where... D_{t+1} = Distance at the next second

D_t = Current distance

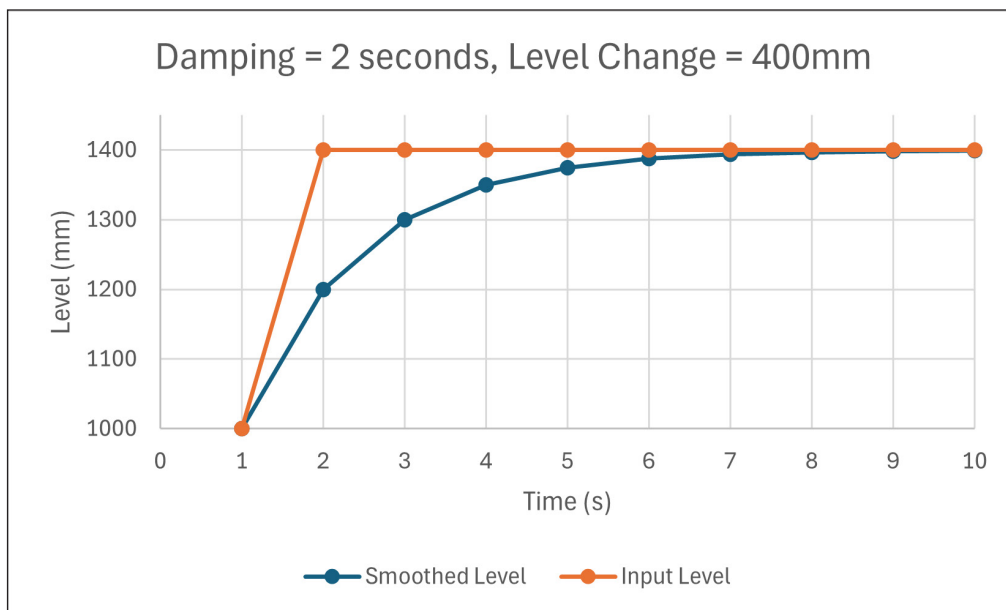
D_{target} = Target distance (distance without damping)

k = Damping time

In other words:

$$\text{New Damped Level} = \text{Current Damped Level} + ((\text{Current Level} - \text{Current Damped Level})/\text{Damping})$$

The following graph shows the smoothing applied with the *Damping* = 2.



CHANGE RATE

Used to set the measurement speed and damping for the fill and empty rate of the material being measured. It is particularly important when the liquid in the tank is under agitation or when material interferes with the radar beam during the filling process. The Change Rate will also affect the time from power on to valid first reading.

Options: Slow, Medium, Fast, Ultra Fast

Default: Medium

Change Rate	Filling Speed	Emptying Speed	Damping	4-20 mA Power on to valid data	RS-485 Power on to valid data	Description
Slow	1.64 ft/min (0.5 m/min)	1.64 ft/min (0.5 m/min)	10 s	20 s	28 s	Suitable for slow material in/out applications where measurement stability is required
Medium	3.28 ft/min (1 m/min)	3.28 ft/min (1 m/min)	5 s	11 s	15 s	Suitable for most general applications
Fast	6.56 ft/min (2 m/min)	6.56 ft/min (2 m/min)	2 s	5 s	9 s	Suitable for applications requiring fast response
Ultra Fast	32.8 ft/min (10 m/min)	32.8 ft/min (10 m/min)	1 s	4 s	5 s	Suitable for applications requiring ultra-fast response, such as hoppers and anti-collision scenarios

FLUCTUATION / ANGLE

Used to adjust the measurement algorithm for specific conditions in liquids and solids.

- For liquid media: If the surface of the liquid in the tank fluctuates significantly (e.g., boiling liquid, vortex or turbulent conditions), this parameter should be enabled.
- For solid media: When the solid material in the tank forms a large inclination, such as a heap angle or concave surface, during filling or emptying, this parameter should be enabled.

This adjustment is especially recommended for applications involving high-viscosity solids, granular materials, or stone-like materials. Test different settings to optimize the measurement.

Options: None, Small, Medium, Large

Default: None

FOAM / DUST

Used to adjust the measurement algorithm for foam and dust.

- Foam: If a light foam layer is present on the surface of the liquid in the tank, this parameter should be enabled. The thickness of the foam layer can significantly affect the accuracy and stability of radar measurement.
- Dust: If there is a large amount of dust, airborne dust, or vapor in the solid material inside the tank, this parameter should be enabled.

Test different settings to optimize the measurement for different thicknesses of foam or dust.

Options: None, Small, Medium, Large

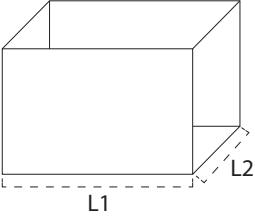
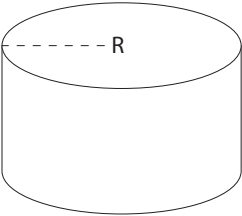
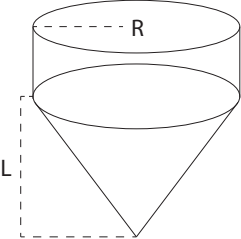
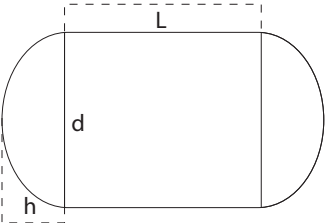
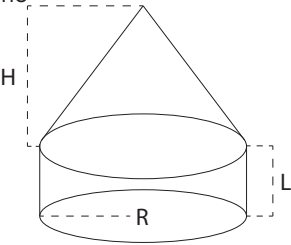
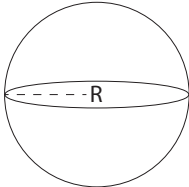
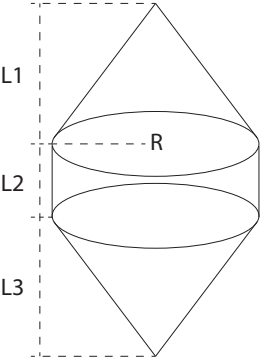
Default: None

VOLUME MEAS.

Used to set up tank types for volume measurements. The level measurement is used for the tank height calculation.

Container Types: Rectangle, Cylinder, Cone, Horizontal, Inverted Cone, Spherical, Double Cone

Default: Rectangle

Rectangle 	Cylinder 	Cone 
Horizontal Tank 	Inverted Cone 	Spherical 
Double Cone 		

Volume Unit: m³, L

Mass Meas: When Mass Meas is enabled, the mass will be calculated based on volume and density.

Enable: Close = Yes, Open = No

Density: 0 to 9,999.99 Kg/m³

Mass Unit: Kg, ton (t)

SENSOR TAG

Used to change the radar’s name. The name can be up to 9 characters. For simplicity, use the TRUE ECHO app to change the radar’s name.

DISPLAY

LANGUAGE

Used to set the language on the keypad display.

Options: English, Espanol

Default: English

LCD CONTRAST

Used to set the brightness and darkness of the LCD liquid crystal background. To recover from a setting that is too dark or light, perform a Factory Reset from the TRUE ECHO app.

Range: (light) 40 to (dark) 200

Recommended range: 50 to 120

Default: 75

TEMPERATURE UNIT

Used to set the temperature unit displayed on the main keypad screen.

Options:

- Celsius (C) (Default)
- Fahrenheit (F)
- Kelvin (K)

DISTANCE UNIT

Used to set the distance unit displayed on the main keypad screen and all related menus.

Options: ft, m, in, cm, mm

Default: m

DISPLAY CONTENT

Used to set the type of measurement that will be displayed on the main keypad screen.

Options:

- Distance: The distance from the sensor zero reference point to the measured surface.
- Space: The distance from Max Adjustment to the measured surface.
- Level: The distance from Min Adjustment to the measured surface. (Default)
- Volume: (Setup in the Volume Meas menu)
- Current: Display the mA output
- Percentage: Level reading / Low level value

DIAGNOSTICS

ECHO QUALITY PEAK

Records the highest and lowest echo quality values since power-up. Echo quality peak refers to the difference between the peak echo intensity minus the TVT curve (signal to noise).

ECHO INTENSITY PEAK

Records the highest and lowest echo strength values since power-up.

DISTANCE PEAK

Records the highest and lowest measured distance values since power-up.

TEMPERATURE PEAK

Records the highest and lowest internal temperature measured by the core temperature sensor since power-up. The internal temperature to ambient temperature margin is +/- 2 degrees.

SERVICE

IN/OUT RATE

Used to set the response speed of the radar to the fill/empty rate of the material. This parameter corresponds to the Change Rate under Basic Settings. When the Change Rate setting changes, Feed and Discharge rates change automatically as shown in the table below. It can also be changed manually to fine tune the application.

Options: Feed Rate, Discharge Rate

Range: 0 to 196.85 ft/min (60 m/min)

Change Rate	Feed Rate	Discharge Rate	Description
Slow	1.64 ft/min (0.5 m/min)	1.64 ft/min (0.5 m/min)	Suitable for slow material in/out applications where measurement stability is required
Medium	3.28 ft/min (1 m/min)	3.28 ft/min (1 m/min)	Suitable for most general applications
Fast	6.56 ft/min (2 m/min)	6.56 ft/min (2 m/min)	Suitable for applications requiring fast response
Ultra Fast	32.8 ft/min (10 m/min)	32.8 ft/min (10 m/min)	Suitable for applications requiring ultra-fast response, such as hoppers and anti-collision scenarios

FALSE ECHO LEARN

Used to mask out known obstacles in the measuring range. In practical applications, internal tank structures may generate reflected echoes, called false echoes, that interfere with recognition of the real level echo. To ensure normal measurement, these false echoes should be masked and suppressed by defining their shape and position on the echo curve.

False Echo Learn defines a suppression area from distance A to distance B and is suitable for applications with significant clutter. After setting the starting and ending distance values the radar will establish the shielding zone based on the current statistical background noise of the echo signals in this area.

❗ IMPORTANT: The learning area must not cover the real target.

Options:

False Echo New: Start, End, Ok	Define the start and end positions of the mask for the false echo that is to be suppressed. Multiple masks can be defined.
Edit False Echo: Start, End, dB, Ok	Edit existing false echo intervals. dB allows the amplitude of the mask to be defined for the Start and End positions.
Del False Echo: Start, End, Ok	Delete all false echo masks in the defined region.

Range: 0 to max sensor range

Example using "False Echo New"

Mask out an obstacle 3 meters from the sensor face. The mask BEGIN point will be set to 2 m and the mask END point will be set to 4 m.

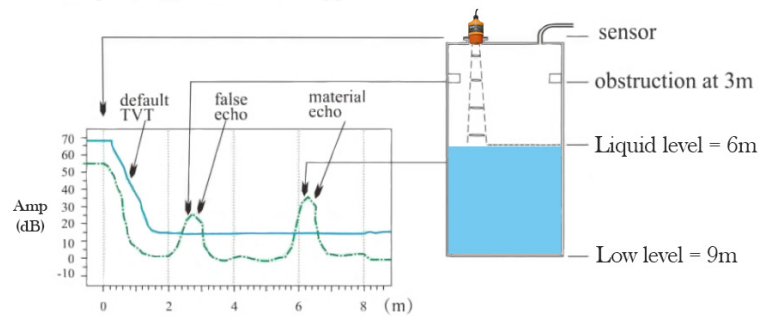
Select: /Service/False Echo Learn

Select: False Echo New

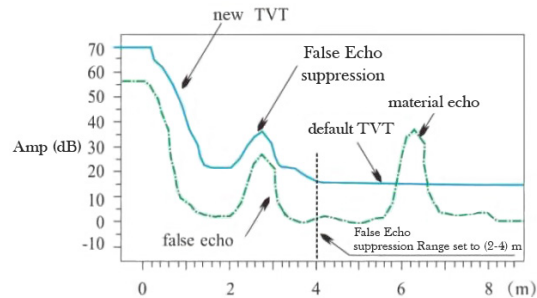
Enter: Start = 2, End = 4

Press: Ok to enter mask

Example before False Echo Suppression



Example after False Echo Suppression



Example using "Edit False Echo"

Mask out the echo from 2 to 4 m and set a level dB of 80.

Select: /Service/False Echo Learn

Select: Edit False Echo

Enter: Start = 2, End = 4, dB = 80

Press "Ok" to enter mask

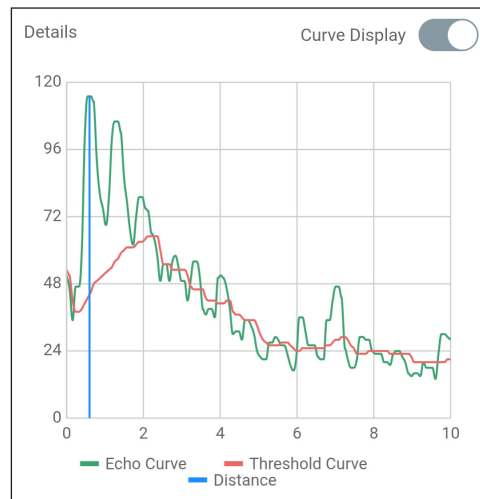
To delete the False Echo mask:

Select: /Service/False Echo Learn

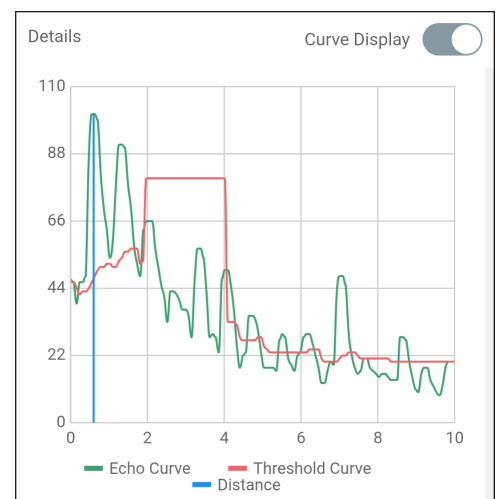
Select: Del False Echo

Enter: Start = 2, End = 4

Press "Ok" to enter mask



No False Echo Mask



False Echo Mask

mA OUTPUT

mA Output Mode

Used to setup the output mode of the 4-20 mA signal. With 4-20 mA selected, an empty tank outputs 4 mA and a full tank outputs 20 mA. With 20-4 mA selected, an empty tank outputs 20 mA and a full tank outputs 4 mA.

mA Simulate

Used to force the loop current to the value set in the option. This allows testing of the radar's mA output with the user's equipment. The mA value will return to the measured value when the option is exited.

Range: 4 to 20 mA

mA Calibration

Used to correct output current deviation. Initial calibration is performed at the factory.

Fault Current

Used to define the 4-20 mA loop current value the sensor will go to when a fault condition occurs. "Keep" holds the value of the last valid reading.

- Options: 20 mA, 20.2 mA, Keep, 3.8 mA, 4 mA
- Default: Keep

BACKUP & RESTORE

Factory Reset: Used to restore parameters back to the factory defaults. The screen will jump to the Measurement Display automatically.

Data Backup: Used to back up parameters to the display module.

Data Restore: Used to restore parameters from the display module back to the radar. The display module can also be moved to other radars to configure them in identical applications.

Example of using Data Backup to save settings to the keypad and Data Restore to transfer the settings to another radar:

STEP 1. Set the parameters to the desired values. Navigate to Backup & Restore setting in the keypad menu.

STEP 2. Press "Data Backup." The parameters are now saved in the keypad display module.

STEP 3. Remove the programmed keypad display. Connect the keypad to another radar unit.

STEP 4. Navigate to Backup & Restore setting in the keypad menu.

STEP 5. Press "Keypad Restore." The parameters are now saved to the radar. The programmed keypad can be removed and the original keypad can be replaced and the saved parameters will be intact.

The following parameters are affected by the reset and backup/restore commands:

Keypad Parameters:

Basic Settings	Display	Service
Min Adjustment	LCD Contrast	In/Out Rate
Max Adjustment	Temperature Unit	False Echo Learn
Blind Zone	Distance Unit	mA Output Mode
Measuring Range	Display Content	Low DK Value
Damping		Distance Offset
Change Rate		TVT Amplitude
Fluctuate / Pile Angle		False Echo Offset
Foam / Dust		Near Detection
Volume Meas		

TRUE ECHO App Parameters:

- Unit Setting
- Range Setting
- High Low Setting
- Damping Setting
- Blind Area Setting
- Distance Offset
- Change Rate
- Current Output
- False Echo Learning
- False Echo Edit
- Foam / Dust
- Fluctuation / Angle
- Filling / Emptying Rate

LOW DK VALUE

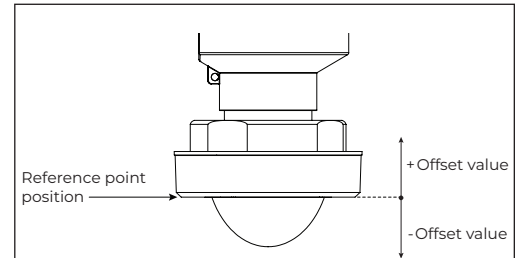
Used to indicate if the material has a low dielectric constant in the range of 1.2 to 2.0.

Options:

- Yes: Material has a dielectric constant between 1.2 and 2.0.
- No: Material has a dielectric constant greater than or equal to 2.0 (default)

DISTANCE OFFSET

Used to correct the deviation between the measured value and the actual value. The instrument is factory calibrated by default, with the reference point set at the end face of the thread. Suitable for small fine-tuning adjustments.



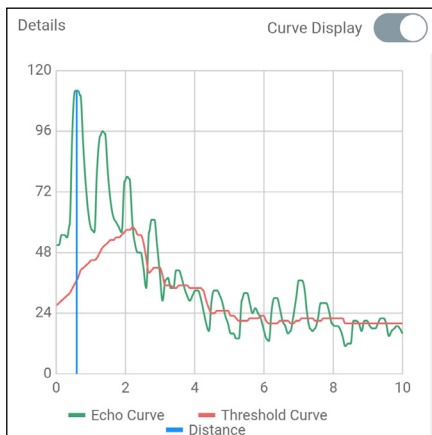
TVT AMPLITUDE

Used to change the time varying threshold curve level (red line on the curve graph) to suppress field interference. All noise below the threshold will be masked out.

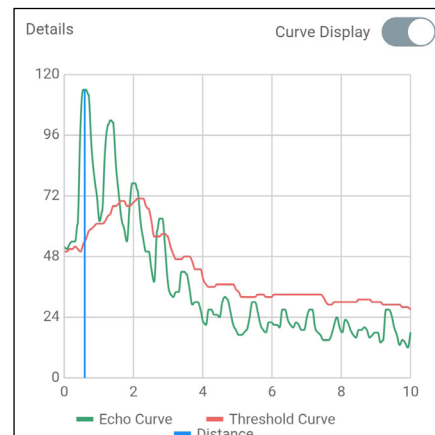
Range: 0 to 15

Default: 6

TVT Amplitude = 6



TVT Amplitude = 15

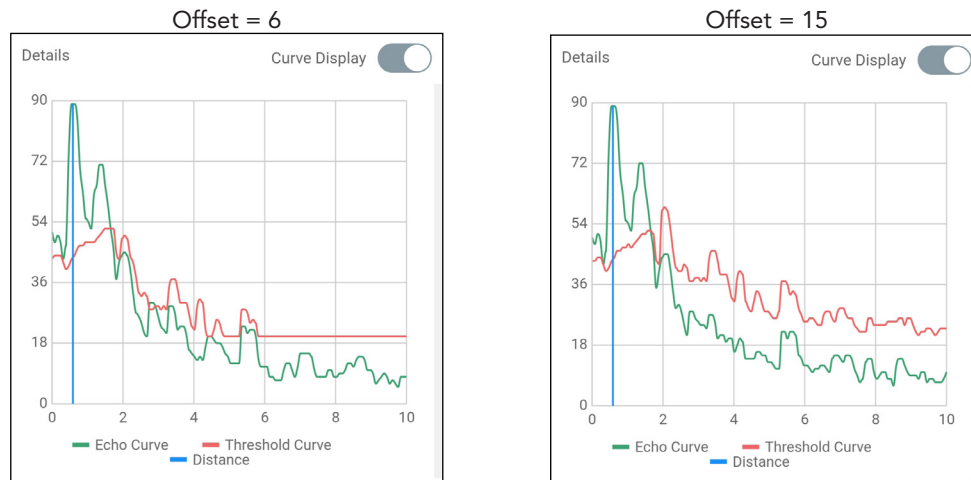


FALSE ECHO OFFSET

Used to globally offset Added or Edited threshold amplitudes for all defined false echo masks.

Range: 0 to 15

Default: 6



NEAR DETECTION

Factory parameter.

INFORMATION

This menu allows the viewing of basic device information such as serial number, software version, hardware version, sensor model, and production date.

SERIAL PORT (RS-485 ONLY)

Used to set up the RS-485 communication settings.

485 Address, also known as Bus Address.

Options: Address 1 to 247

Default: Address 1

Baud Rate:

Options: 2400, 4800, 9600, 14400, 19200, 38400, 56000, 115200, 256000, 460800, 500000, 512000, 600000, 750000, 921600

Default: 9600

Parity Bit:

Options: None, Odd, Even

Default: None

Stop Bit:

Options: 1, 1.5, 2

Default: 1

ALARM SETTINGS

This menu allows the setting of alarms using the relay option. Alarm options are only available with 4-20 mA + RS485 + relays radar units. See the datasheet for more information. Go to: apgsensors.com/product/cr-s

DEFAULT STATUS

The relay contact is Single-Post Single-Throw (SPST). This parameter selects whether the initial relay state is normally open or normally closed.

ALARM MODE

Used to select the alarm off, high alarm, or low alarm.

ALARM VALUE

Used to set a preset key value to trigger the alarm.

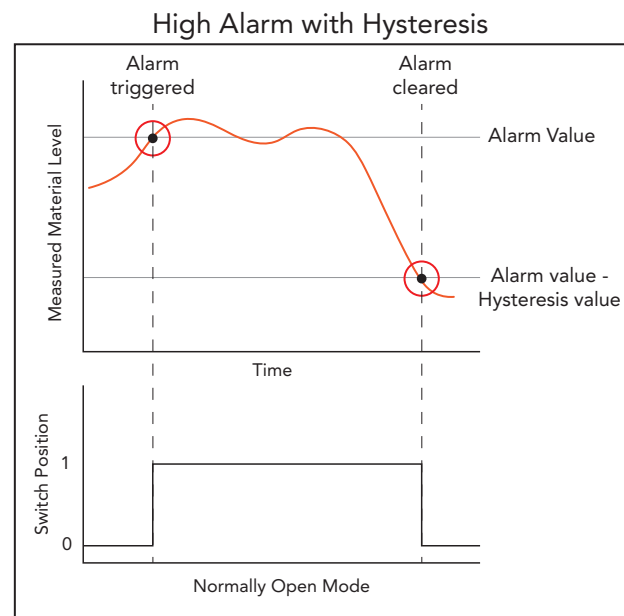
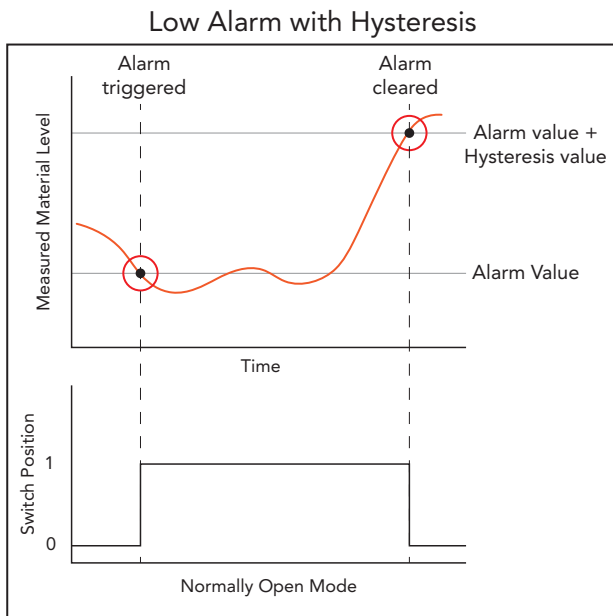
Alarm Value: 0 to max range

HYSTERESIS

The alarm hysteresis value refers to the amount by which the monitored parameter must change in the opposite direction after it has exceeded the alarm setpoint and triggered an alarm before the alarm is cleared. In simple terms, it is the difference between the alarm trigger value and the alarm recovery value.

The parameter settings for the two alarm channels are the same, so they will not be listed one by one.

Hysteresis Value: 0 to max range



ALARM PARAMETER

Selects the meaning of the configured alarm value.

Options: Level, Distance, Space

CHAPTER 5: TRUE ECHO MOBILE APP PROGRAMMING

All TRUE ECHO radar sensors are compatible with our TRUE ECHO app. To change settings and parameters easily with your mobile device, download the free TRUE ECHO Radar App by searching “TRUE ECHO” in the Apple or Google Play Store.



Please ensure that your mobile device meets the following operating system conditions:

- IOS 13 or higher
- Android 10 or higher

CONNECT SHORT-RANGE WIRELESS COMMUNICATION

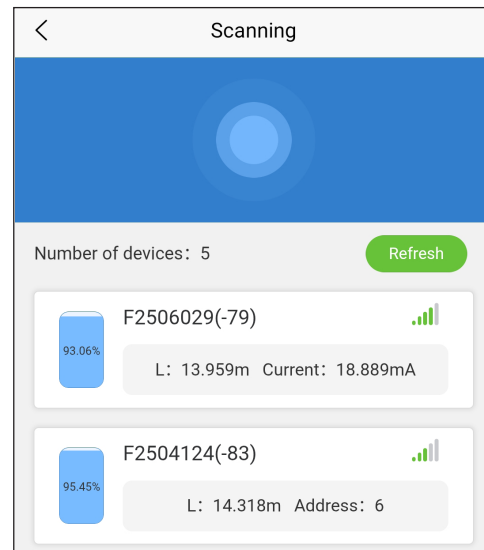
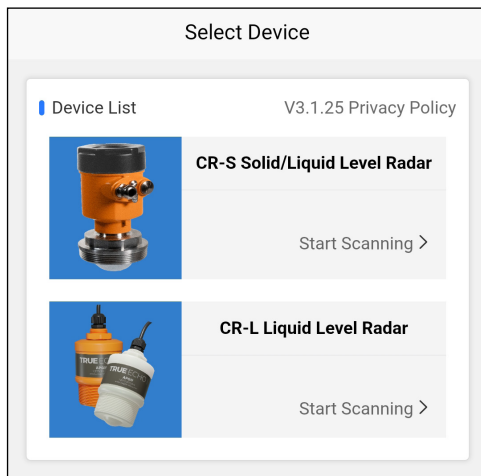
STEP 1. Install the TRUE ECHO app from the app store.

STEP 2. Open the TRUE ECHO app. On the Select Device screen, press “CR-S Solid/Liquid Level Radar.”

STEP 3. Each radar’s wireless communication name is displayed with its Level and either the Current for 4-20 mA units or the Modbus Address for RS-485 units. Press the radar’s name to access it.

STEP 4. Enter the password. The factory default password is 000000. This can be changed in the app settings. In the case of a forgotten password, contact APG with the serial number on the label or in the keypad to receive an unlock password.

NOTE: When opening the app for the first time after installation, the app will prompt users to accept the Privacy Policy and will request Location and Relative Position permissions. These permissions are required to connect to the radar.



NOTE: If you don’t see the device on the scanning screen, make sure the radar is wired correctly and powered on. Press “Refresh” to scan for devices. Location must be enabled on the mobile device.

NOTE: Parameter changes made in the keypad will be reflected in the app but will not update in real time. Reboot the app to see changes made on the keypad.

The message “Reading all Settings” will be seen while the radar parameters are loaded into the TRUE ECHO app. The Range, Level, Distance, Current or RS-485 Address, and Reliability information are displayed at the top of the screen. Reliability indicates the strength of the signal in dBs.

TRUE ECHO App Parameter	Parameter Range	Default
Unit Setting	ft, m, in, cm, mm	m
Range Setting	0 to max range	Max range
High Low Setting	0 to max range	Max range
Damping Setting	0 to 100 s	5 s
Blind Area Setting	0.33 ft (0.1 m) to max range	0.33 ft (0.1 m)
Distance Offset	-0.75 to 3.28 ft (-0.229 to 1 m)	Factory set
Change Rate	Slow, Medium, Fast, Ultra Fast	Medium
Current Output (mA output only)	Output Mode, Failure Mode	4-20 mA, Keep
Current Simulation (mA output only)	4-20 mA	n/a
Current Calibration (mA output only)	4 mA, 20 mA	n/a
False Echo Learning	Start, End	n/a
False Echo Edit	Start Level dB, End Level dB, Start, End	n/a
Foam / Dust	None, Small, Medium, Large	None
Fluctuation / Angle	None, Small, Medium, Large	None
Filling / Emptying Rate	0 to 196.85 ft/min (60 m/min)	3.28 ft/min (1 m/min)
Diagnosis	Echo Quality Min/Max, Echo Intensity Min/Max, Temp Min/Max, Distance Min/Max	n/a
Keypad Display Content	Distance, Empty Height, Level, Volume, Current, Percentage	Distance
Backup/Restore	Factory Reset, Keypad Backup/Restore, Mobile Backup/Restore	n/a
Radar Identification	Radar name changeable by user. 9 characters.	Radar serial number
RS-485 Settings (RS-485 output only)	485 Address, Baud Rate, Parity Bit, Stop Bit	1, 9600, No Parity, 1 bit

Press “Details” to see setting values.

Unit	m
Range	30 m
Low Level	30 m
High Level	0 m
Damping Time	5 s
Blind Zone	0.1 m
Distance offset	0 m
Change Rate	Medium
Foam / Dust	None
Fluctuation / Angle	None
Feed Rate	1 m/min
Discharge Rate	1 m/min
Display Content	Distance
Firmware Version	V2.1.4
Production Date	2026-03-24
Serial Number	2409016

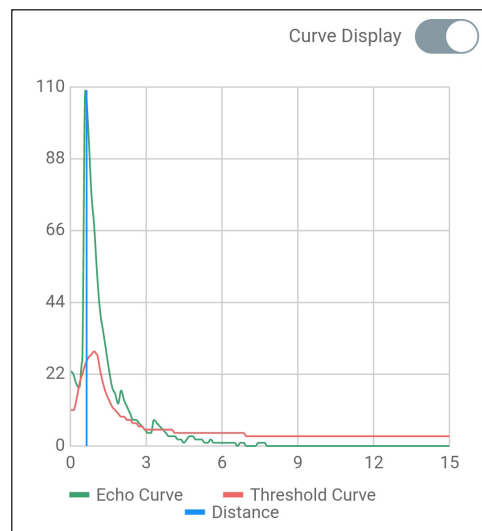
CURVE DISPLAY

Used to view the Echo Curve Graph. This is a visual representation of the echoes the radar is sensing from the target.

The vertical axis is the echo strength in dBs. The horizontal axis is the distance range in the selected unit starting at the sensor face at 0.

The green line is the echo curve and the red line is the threshold curve. The blue vertical line is the distance location of the current reading.

Use the Curve Display to validate the radar is sensing the target correctly during installation and setup.



SETTING DESCRIPTIONS

These settings are used to optimize the radar for the specific application it is used in.

NOTE: Press “Read” to view the current settings in each tab. Press “Write” to save changes.

UNIT SETTING

Used to set the units displayed in the TRUE ECHO app.

Options:

- mm (millimeters)
- cm (centimeters)
- m (meters)
- in (inch)
- ft (feet)

Default: m (meters)

RANGE SETTING

Used to set the maximum distance the sensor will look for a target measured from the sensor zero reference point. Typically Range is set at or a little beyond the desired measuring range to achieve a fast and stable measurement and avoid false echoes.

Range: Dependent on radar model: 32.81 ft, 65.61 ft, 98.43 ft, 196.85 ft, 393.7 ft (10 m, 20 m, 30 m, 60 m, 120 m)

Default: max range

HIGH AND LOW SETTING

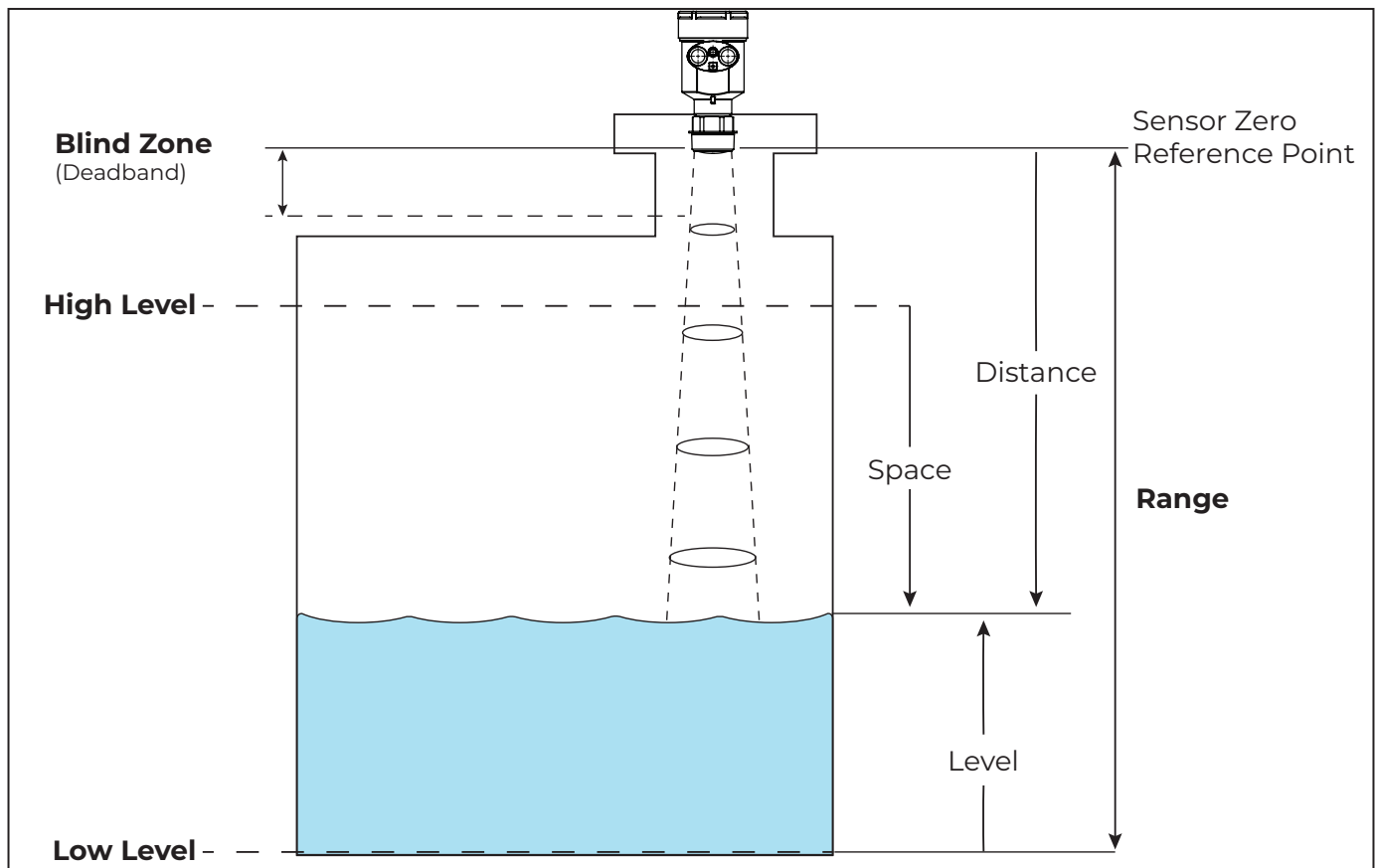
Used to set the measurement range of the radar level transmitter. The 4-20 mA current output is mapped proportionally to the high and low level settings.

Low Level sets the furthest distance to be measured from the sensor zero reference point to the lowest point of the tank. Low level must be less than or equal to the lowest point of the tank. Low Level must be less than or equal to the sensor Range. For 4-20 mA sensors, the Low Level will define either the 4 mA or 20 mA point (determined by Current Output Mode setting).

- Range: 0.656 ft (0.2 m) to max range
- Default: max range

High Level sets the closest point to be measured from the sensor zero reference point to the max fill point in the tank. The High Level value must be less than the Low Level value. For 4-20 mA sensors, the High Level will define either the 20 mA or 4 mA point (determined by the Current Output Mode setting).

- Range: 0 to max range
- Default: 0



DAMPING

Used to set the time that is applied to a filter used to smooth sudden changes in the liquid level. A longer *Damping* time will provide more smoothing. A shorter *Damping* time will provide a quicker response with less stability in agitated conditions that may be undesirable.

- Range: 0 to 100 seconds
- Default: 5 seconds

If *Damping* is greater than 0, the following damping filter is applied:

$$D_{t+1} = \left[D_t + \frac{(D_{target} - D_t)}{k} \right]$$

Where... D_{t+1} = Distance at the next second

D_t = Current distance

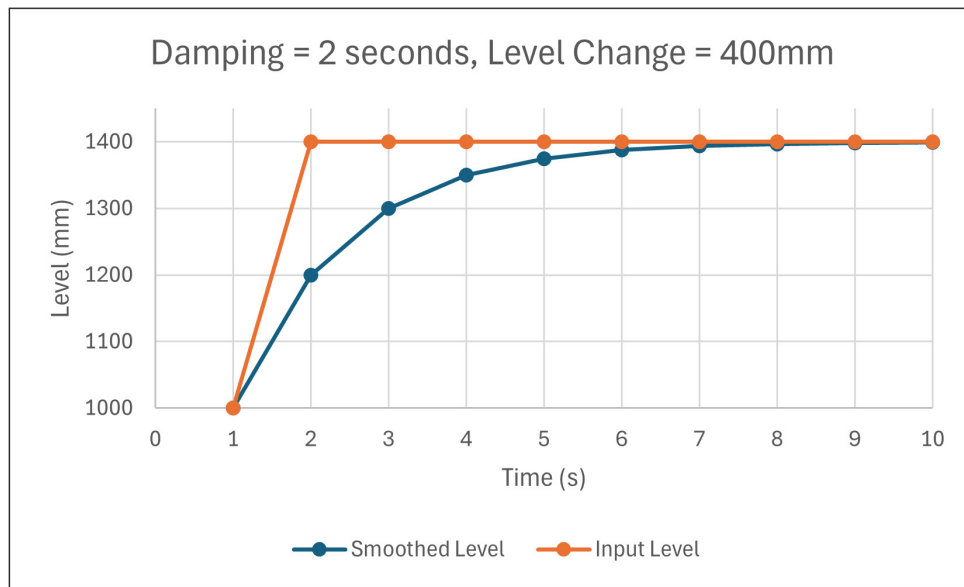
D_{target} = Target distance (distance without damping)

k = Damping time

In other words:

$$\text{New Damped Level} = \text{Current Damped Level} + ((\text{Current Level} - \text{Current Damped Level})/\text{Damping})$$

The following graph shows the smoothing applied with the *Damping* = 2.



BLIND AREA SETTING

Used to set the minimum distance (deadband) the sensor will look for a target. The sensor will ignore the echo wave within the deadband when processing the signal. Typically, the Blind Area is set at or a little before the desired measuring range to achieve a fast and stable measurement and avoid near field signals.

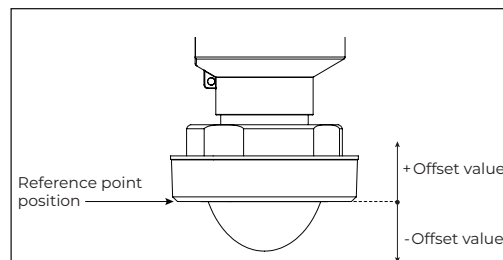
Range: 0.1 m (0.33 ft) to max range

Max radar range	Default Blind Zone value
32.81 ft, 65.61 ft, 98.43 ft (10 m, 20 m, 30 m)	0.33 ft (0.1 m)
196.85 ft, 393.7 ft (60 m, 120 m)	0.98 ft (0.3 m)

NOTE: The Blind Area and Range determine the processing bounds of the application. They should be set to avoid interference and false echoes and to achieve a fast and stable measurement.

DISTANCE OFFSET

Used to correct the difference between the measured value and the actual value. The instrument is factory calibrated by default, with the reference point set at the end face of the thread.



NOTE: Some digital keyboards do not include a minus (-) key. A different digital keyboard may be needed to enter negative values in the app.

CHANGE RATE

Used to set the measurement speed and damping for the fill and empty rate of the material being measured. It is particularly important when the liquid in the tank is under agitation or when material interferes with the radar beam during the filling process. The Change Rate will also affect the time from power on to valid first reading.

Options: Low, Medium, Fast, Ultra Fast

Default: Medium

Change Rate	Filling Speed	Emptying Speed	Damping	4-20 mA Power on to valid data	RS-485 Power on to valid data	Description
Low	1.64 ft/min (0.5 m/min)	1.64 ft/min (0.5 m/min)	10 s	20 s	28 s	Suitable for slow material in/out applications where measurement stability is required
Medium	3.28 ft/min (1 m/min)	3.28 ft/min (1 m/min)	5 s	11 s	15 s	Suitable for most general applications
Fast	6.56 ft/min (2 m/min)	6.56 ft/min (2 m/min)	2 s	5 s	9 s	Suitable for applications requiring fast response
Ultra Fast	32.8 ft/min (10 m/min)	32.8 ft/min (10 m/min)	1 s	4 s	5 s	Suitable for applications requiring ultra-fast response, such as hoppers and anti-collision scenarios

CURRENT OUTPUT (4-20MA OUTPUT ONLY)

Output Mode is used to define the mA values at the Low and High level settings.

Options:

- 4 mA low to 20 mA high (default)
- 20 mA low to 4 mA high

Failure Mode is used to define the output level when a loss of echo or a fault occurs.

Options:

- 3.8 mA
- 4 mA
- 20 mA
- 20.2 mA
- Hold Last Value (default)

CURRENT SIMULATION (4-20mA OUTPUT ONLY)

Used to temporarily output a specific mA value for system testing. The output will return to a normal level when Current Simulation is pressed again to close the option.

Range: 4 mA to 20 mA

Resolution: 0.001 mA

CURRENT CALIBRATION (4-20mA OUTPUT ONLY)

Used to calibrate the 4 mA and 20 mA current for system tuning.

Example: If the output is 4.010 mA but should be 4.000 mA, it can be corrected as follows: Press the "4 mA" button. Enter the incorrect value (4.010) and press "Set." The output will change to 4.000 mA.

Options: 4 mA, 20 mA

Resolution: 0.001 mA

FALSE ECHO LEARNING

Used to mask out known obstacles in the measuring range. In practical applications, internal tank structures may generate reflected echoes, called false echoes, that interfere with recognition of the real level echo. To ensure normal measurement, these false echoes should be masked and suppressed by defining their position on the echo curve.

After setting the starting and ending distance values the radar will establish the shielding zone based on the current statistical background noise of the echo signals in this area. Multiple masks can be added.

Options: Add, Clear

Range: 0 to max sensor range

IMPORTANT: The learning area must not cover the real target.

Example using "Add"

Mask out an obstacle 3 meters from the sensor face. The mask START point will be set to 2 m and the mask END point will be set to 4 m.

Enter: Start = 2, End = 4

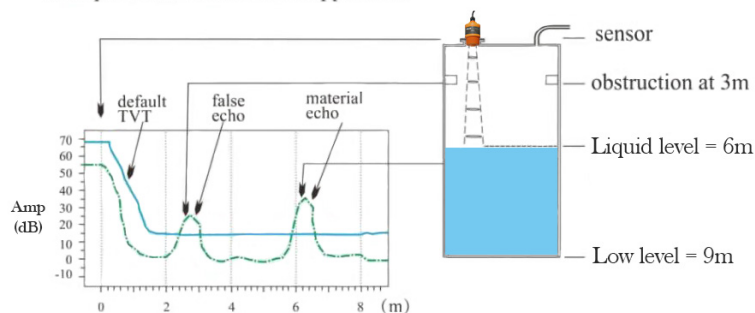
Press "Add" to enter mask

To clear the mask:

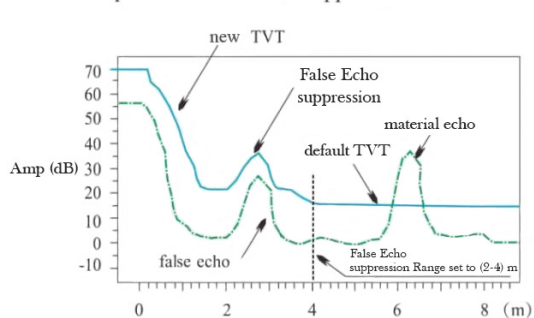
Enter: Start = 2, End = 4

Press "Clear" to clear mask

Example before False Echo Suppression



Example after False Echo Suppression



FALSE ECHO EDIT

Used to define custom masks with both the shape and the position of the masks. Multiple masks can be added.

Options: Edit, Clear

Range: 0 to max sensor range.

Example using "Edit"

Mask out the echo from 2 to 4 m and set a level dB of 80.

Enter: Start = 2, End = 4, dB = 80

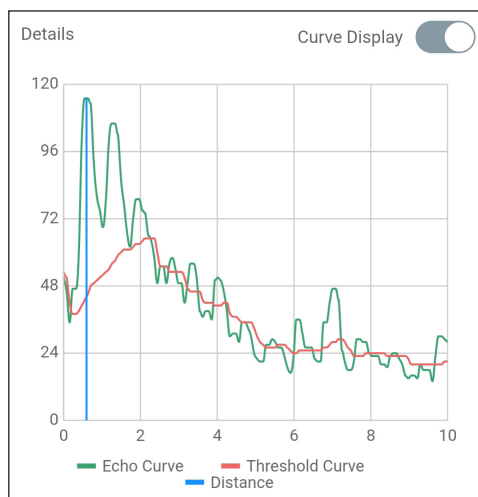
Press "Edit" to enter mask

To clear the mask:

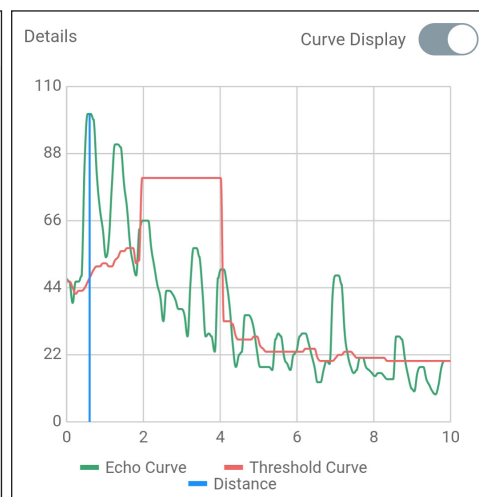
Enter: Start = 2, End = 4, dB = 80

Press "Clear" to enter mask

- To clear all masks: Set Start = 0 and End = Range setting.



No False Echo Mask



False Echo Mask

FOAM/DUST

Used to adjust the measurement algorithm for foam and dust. Test different settings to optimize the measurement.

- For liquid mediums: Adjust this parameter if a light foam layer is present on the surface of the liquid in the tank. The thickness of the foam can significantly affect the accuracy and stability of radar measurement.
- For solid mediums: Adjust this parameter if a large amount of dust, airborne dust, or vapor is inside the solid material tank.

Options: None, Small, Medium, Large

Default: None

FLUCTUATION / ANGLE

Used to adjust the measurement algorithm for specific conditions in liquids and solids. This adjustment is especially recommended for applications involving high-viscosity solids, granular materials, or stone-like materials. Test different settings to optimize the measurement.

- For liquid media: If the surface of the liquid in the tank fluctuates significantly (e.g. boiling liquid, vortex, or turbulent conditions), this parameter should be enabled
- For solid media: When the solid material in the tank forms a large inclination, such as a heap angle or concave surface, during filling or emptying, this parameter should be enabled.

Options: None, Small, Medium, Large

Default: None

FILLING / EMPTYING RATE

Used to manually adjust the response rate for tracking the actual liquid level and discharge rate. Updates to the Change Rate setting will overwrite the values entered here.

Options: Feed Rate, Discharge Rate

Range: 0 to 196.85 ft/min (60 m/min)

Change Rate	Feed Rate	Discharge Rate	Description
Slow	0.5 m/min	0.5 m/min	Suitable for slow material in/out applications where measurement stability is required
Medium	1 m/min	1 m/min	Suitable for most general applications
Fast	2 m/min	2 m/min	Suitable for applications requiring fast response
Ultra Fast	10 m/min	10 m/min	Suitable for applications requiring ultra-fast response, such as hoppers and anti-collision scenarios

DIAGNOSIS

Diagnosis is used to show the max/min values of the following parameters since power on:

- **Echo Quality Max/Min:** Records the highest and lowest echo quality values since power-up. Echo quality refers to the difference between the peak echo intensity minus the TVT curve (signal to noise).
- **Echo Intensity Max/Min:** Records the highest and lowest echo strength values since power-up.
- **Temp Max/Min:** Records the highest and lowest internal temperature measured by the core temperature sensor since power-up. The internal temperature to ambient temperature margin is +/- 2 °C.
- **Distance Max/Min:** Records the highest and lowest measured distance values since power-up.

KEYPAD DISPLAY CONTENT

Keypad Display Content is used to define the type of measurement that will be displayed on the keypad screen.

Options:

- **Distance:** The distance from the sensor zero reference point to the measured surface. (Default)
- **Space:** The distance from High Level to the measured surface.
- **Level:** The distance from the Low Level to the measured surface.
- **Volume:** Setup in the Volume Meas menu
- **Current:** Display the mA output
- **Percentage:** Level reading divided by Low Level value.

BACKUP / RESTORE

Factory Reset:

Used to reset parameters back to the factory defaults. The app will automatically close. Reopen the app to see the default settings.

Keypad Backup / Restore:

Used to back up parameters to the display module. The parameters can be restored to the same unit, or the display module can be moved to other radars to copy the settings.

STEP 1. While the radar is connected to the TRUE ECHO App, set the parameters to the desired values.

STEP 2. Press "Keypad Backup." The parameters are now saved in the keypad display module.

STEP 3. Remove the programmed keypad display. Connect the keypad to another radar unit.

STEP 4. In the TRUE ECHO App, connect to the second radar unit with the programmed keypad attached.

STEP 5. Press "Keypad Restore." The parameters are now saved to the radar. The programmed keypad can be removed and the original keypad can be replaced and the saved parameters will be intact.

Phone Backup / Restore:

Used to backup parameters to the phone. The parameters can be restored to the same unit or can be restored to other radars.

STEP 1. While the radar is connected to the TRUE ECHO App, set the parameters to the desired values.

STEP 2. Press "Mobile Backup." The parameters are now saved to the phone's local storage.

STEP 3. To copy settings to other radars: Disconnect app communications from the first radar. Use the app to connect to a second radar.

STEP 4. Press "Mobile Restore." The parameters are now saved to the radar.

The following parameters are affected by the reset and backup / restore commands:

Keypad Parameters:

Basic Settings	Display	Service
Min Adjustment	LCD Contrast	In/Out Rate
Max Adjustment	Temperature Unit	False Echo Learn
Blind Zone	Distance Unit	mA Output Mode
Measuring Range	Display Content	Low DK Value
Damping		Distance Offset
Change Rate		TVT Amplitude
Fluctuate / Pile Angle		False Echo Offset
Foam / Dust		Near Detection
Volume Meas		

TRUE ECHO App Parameters:

- Unit Setting
- Range Setting
- High Low Setting
- Damping Setting
- Blind Area Setting
- Distance Offset
- Change Rate
- Current Output
- False Echo Learning
- False Echo Edit
- Foam / Dust
- Fluctuation / Angle
- Filling / Emptying Rate

RADAR IDENTIFICATION

Radar Tag Name allows the 16-character Keypad Tag name to be changed. The radar Password must be entered to make this change.

Radar App Name allows the 9-character App radar name to be changed. Exit and re-enter the app to see the modified name in the app. The radar Password must be entered to make this change.

Radar Password allows the 6-digit password to be changed from the factory default password (000000). The new password will be required the next time the app is opened. Entering an incorrect password will close the app.

NOTE: If the radar password is forgotten, contact APG for help. Please have the unit's serial number available.

RS-485 SETTINGS (RS-485 OUTPUT ONLY)

Using the TRUE ECHO app to change the RS-485 settings simplifies installation as units do not have to be isolated to change the Bus Address, Baud Rate, Parity Bit, and Stop Bit settings. See Chapter 4: Modbus Programming for more information about RS-485 programming.

485 Address, also known as Bus Address:

- Options: Address 1 to 247
- Default: Address 1

Baud Rate:

- Options: 1200, 2400, 4800, 9600, 14400, 19200, 38400, 56000, 115200, 156000, 460800, 500000, 512000, 600000, 750000, 921600, 1000000, 1500000, 2000000
- Default: 9600

Parity Bit:

- Options: No Parity, Odd Parity, Even Parity
- Default: No Parity

Stop Bit:

- Options 1 bit, 1.5 bits, 2 bits
- Default: 1 bit

CHAPTER 6: MODBUS PROGRAMMING

RS-485 (4-WIRE) UNITS ONLY

TRUE ECHO Radar sensors use standard RS-485 Modbus RTU protocol. The sensors can only operate as server devices. Sensor default transmission settings are 9600 Baud, 8 Bits, 1 Stop Bit, No Parity, and require a minimum delay of 100 ms between transactions. The default bus address is 1. The bus address can be changed using the keypad or the TRUE ECHO app.

Modbus communication may override app communication. Using both simultaneously may result in slower app response times.

READ INPUT REGISTERS

Parameter	Function Code	Register Address	Decimal	Quantity	CRC	Type
Space, cm	0x03	0000	0	0001	840A	Uint, 16
Space, mm	0x03	0001	1	0001	D5CA	Uint, 16
Level, cm	0x03	0002	2	0001	25CA	Uint, 16
Level, mm	0x03	0003	3	0001	740A	Uint, 16
Temp, C/100	0x04	9001	36865	0001	4D0A	Uint, 16
Current, uA	0x04	900A	36874	0001	3CC8	Uint, 16
Distance, m	0x04	9015	36885	0002	4D0F	Float 32, CDAB
Space, m	0x04	9022	36898	0002	FCC1	Float 32, CDAB
Level, m	0x04	9026	36902	0002	BD00	Float 32, CDAB

READ HOLDING REGISTERS

For explanations about specific settings, go to Chapter 5: Mobile App Programming.

Parameter	Function Code	Register	Decimal	Data Type
Change Rate Speed 0-3: Low, Medium, Fast, Ultra-Fast	0x03, 0x10	0x9305	37637	uint16
Damping, s	0x03, 0x10	0x930B	37643	uint16
Blind Zone Setting, m	0x03, 0x10	0x9344	37700	Float32, CDAB
Range Setting, m	0x03, 0x10	0x9346	37702	Float32, CDAB
Low Level Setting, m	0x03, 0x10	0x9348	37704	Float32, CDAB
High Level Setting, m	0x03, 0x10	0x934A	37706	Float32, CDAB
Distance Offset, m	0x03, 0x10	0x934E	37710	Float32, CDAB
Baud Rate 1200-921600	0x03, 0x10	0x924E	37454	Uint32, CDAB
RS-485 Address 1-247	0x03, 0x10	0x9301	37633	uint16, Lower 8 bits

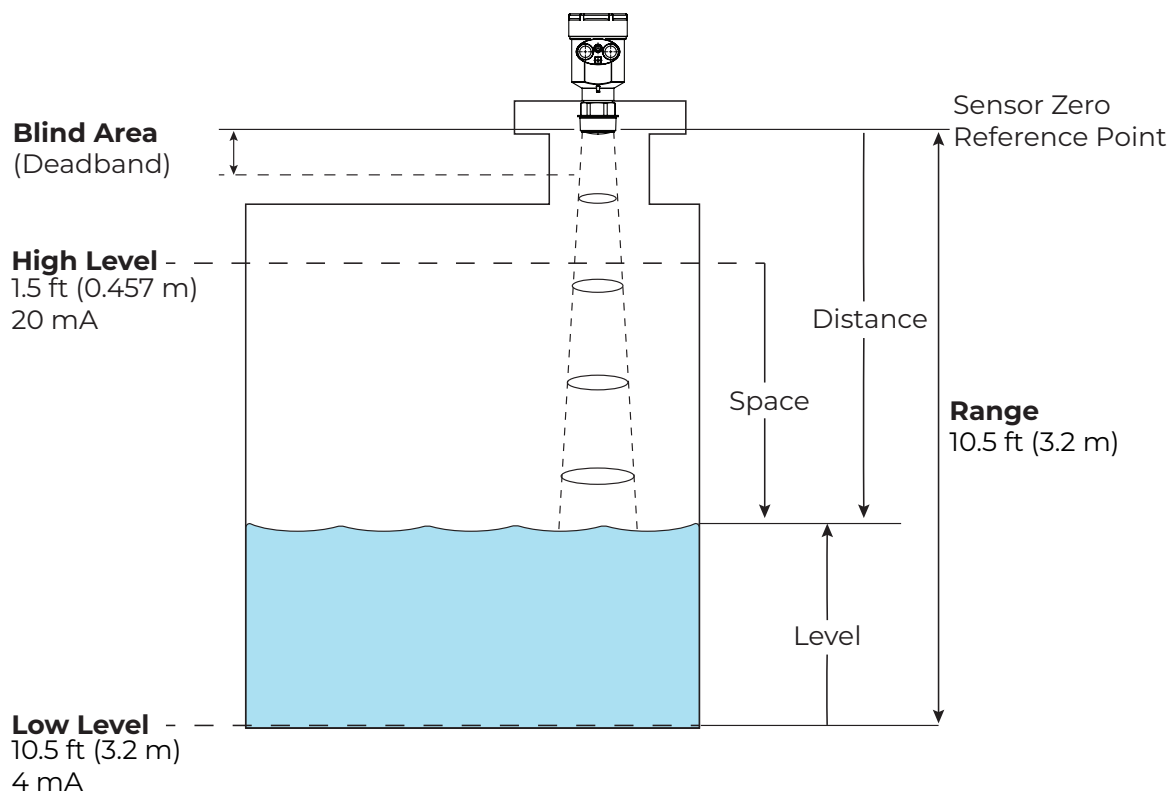
CHAPTER 7: APPLICATION EXAMPLES

LIQUID TANK LEVEL MANAGEMENT

Tank Height: 10.5 ft (3.2 m)

Sensor Placement in tank:

- Zero reference to tank bottom: 10.5 ft (3.2 m)
- Max Liquid Height Measured from zero reference: 1.5 ft (0.457 m)
- Min Liquid Height Measured from zero reference: 10.5 ft (3.2 m)



KEYPAD SETTING	VALUE
Basic: Measuring Range	10.5 ft (3.2 m)
Basic: Blind Zone (Deadband)	0.33 ft (0.1 m)
Basic: Max Adjustment	High: 1.5 ft (0.457 m)
Basic: Min Adjustment	Low: 10.5 ft (3.2 m)
Service: mA Output / mA Output Mode	4-20mA

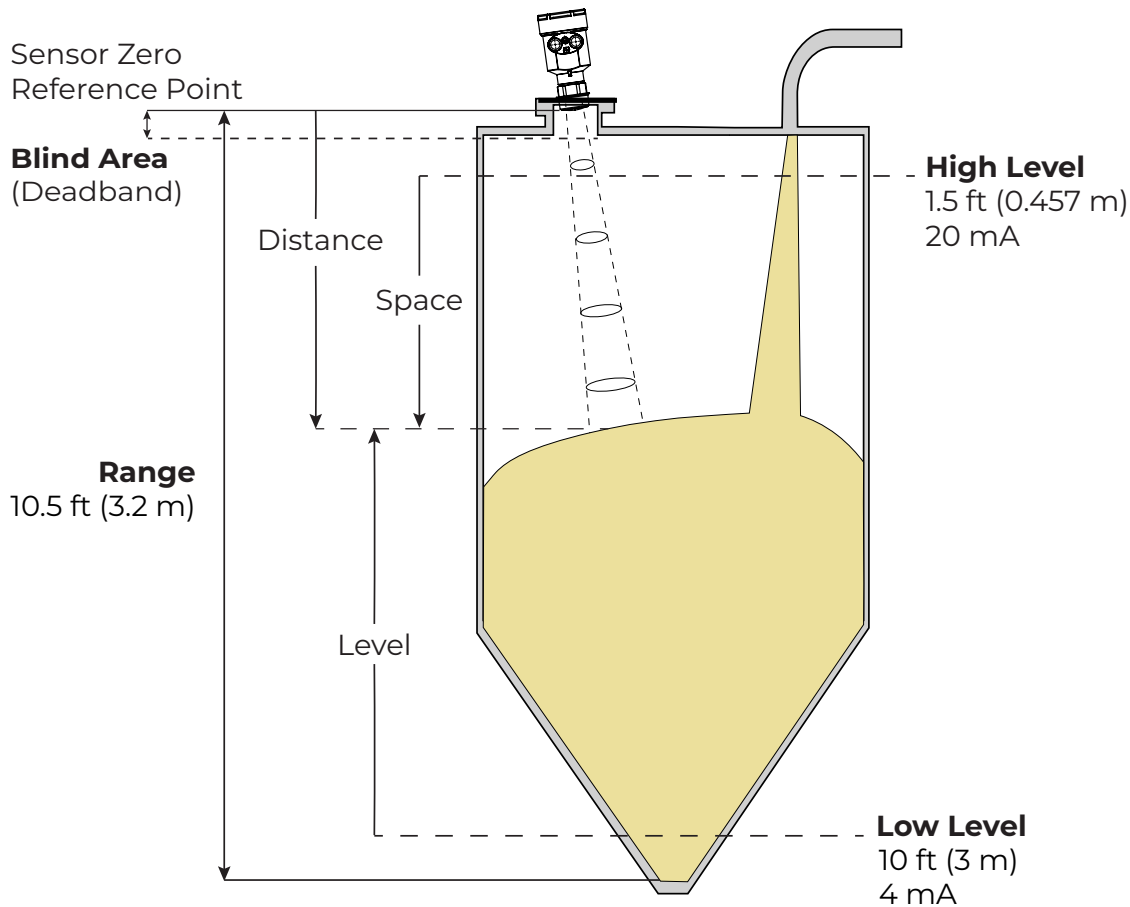
TRUE ECHO APP SETTING	VALUE
Range	10.5 ft (3.2 m)
Blind Area (Deadband)	0.33 ft (0.1 m)
High Low Setting / High Level	1.5 ft (0.457 m)
High Low Setting / Low Level	10.5 ft (3.2 m)
Current Output / Output Mode	4-20 mA

SOLIDS TANK LEVEL MANAGEMENT

Tank Height: 10.5 ft (3.2 m)

Sensor Placement in tank:

- Zero reference to tank bottom: 10.5 ft (3.2 m)
- Max Liquid Height Measured from zero reference: 1.5 ft (0.457 m)
- Min Liquid Height Measured from zero reference: 10.5 ft (3.2 m)



KEYPAD SETTING	VALUE
Basic: Measuring Range	10.5 ft (3.2 m)
Basic: Blind Zone (Deadband)	0.33 ft (0.1 m)
Basic: Max Adjustment	High: 1.5 ft (0.457 m)
Basic: Min Adjustment	Low: 10 ft (3 m)
Service: mA Output / mA Output Mode	4-20mA

TRUE ECHO APP SETTING	VALUE
Range	10.5 ft (3.2 m)
Blind Area (Deadband)	0.33 ft (0.1 m)
High Low Setting / High Level	1.5 ft (0.457 m)
High Low Setting / Low Level	10 ft (3 m)
Current Output / Output Mode	4-20 mA

CHAPTER 8: MAINTENANCE

GENERAL CARE

Your radar is very low maintenance and will need little care as long as it is installed correctly. However, in general, you should:

- Avoid applications for which the transmitter was not designed, such as extreme temperatures, contact with incompatible corrosive chemicals, or other damaging environments.
- Inspect the threads when moving or removing the unit.

REPAIR AND RETURNS

Should your CR-S Radar Level Sensor require service, please contact the factory via phone, email, or online chat. We will issue a Return Material Authorization (RMA) number with instructions.

- Phone: 888-525-7300
- Email: apgsensors.com
- Online chat at apgsensors.com

Please have your part number and serial number available. See Warranty Statement for more information.

APPENDIX A: TROUBLESHOOTING & FAULT CODES

TROUBLESHOOTING

ISSUE	POSSIBLE CAUSE	RECOMMENDED ACTION
Display screen is off	1. Abnormal power supply 2. Poor contact of keypad display	1. Check the power supply and measure the loop current. 2. Remove keypad and check condition of contact pins and pads. Properly reinstall keypad or replace if damaged.
PLC (DCS) level display differs from radar display	Instrument range settings do not match PLC range settings	Modify the instrument High Level and Low Level Adjustment values so they match the PLC range.
Measured value jumps towards 100% during filling	Condensation or buildup on the antenna	Perform interference suppression and carry out false echo learning after condensation or buildup occurs. If measurement is not affected, appropriately increase the blind zone.
Measured value jumps toward 0% during filling	Obstacles in the measured path prevent the instrument from distinguishing interference echoes from the true level echo	Fine tune the radar installation angle to weaken the interference signal, or select a more favorable mounting position.
Measured value fluctuates by 10% to 20%	1. Liquid surface fluctuation 2. Uneven medium surface, such as in a conical silo	1. Check the Change Rate parameter. If necessary, manually increase the Damping parameter. 2. Choose a more favorable installation position and optimize the mounting direction.
Measured value does not change during filling	Measured value is tracking an interference signal; excessive foam affects signal quality; filling speed is too fast, range setting is incorrect	Suppress interference signals; clean the antenna; select a suitable Change Rate speed; reconfigure the High Level and Low Level Adjustment values.

FAULT CODES

FAULT CODE (HEX)	DESCRIPTION
0x0001	No echo found within range
0x0008	Warning: No-current device output
0x0010	Warning: Current simulation / current calibration state
0x0080	Warning: Low operating voltage
0x0200	Warning: No temperature sensor

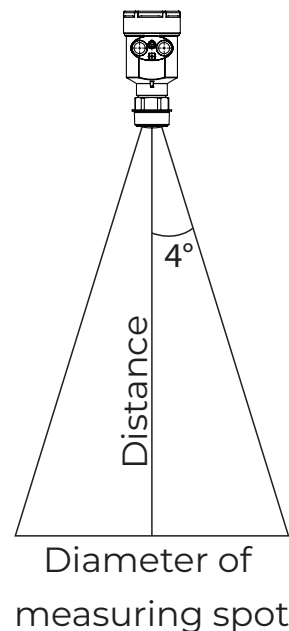
APPENDIX B: BEAM ANGLE REFERENCE TABLES

The TRUE ECHO CR-LA Radar with a 2" NPT has a 4° half angle beam. The diameter of the measuring spot can be calculated using:

$$\text{Distance} * \tan(4) * 2$$

DISTANCE (FT)	DIAMETER OF MEASURING SPOT (FT)
1	0.140
2	0.280
3	0.420
4	0.559
5	0.699
10	1.399
15	2.098
20	2.797
25	3.496
30	4.196
35	4.895
40	5.594
45	6.293
50	6.993
60	8.391
70	9.790
80	11.188
90	12.587
100	13.985
110	15.384
120	16.782
130	18.181
140	19.580
150	20.978
160	22.377
170	23.775
180	25.174
190	26.572
200	27.971
225	31.467
250	34.963
275	38.460
300	41.956
325	45.452
350	48.949
375	52.445
400	55.941

DISTANCE (M)	DIAMETER OF MEASURING SPOT (M)
1	0.140
2	0.280
3	0.420
4	0.559
5	0.699
6	0.839
7	0.979
8	1.119
9	1.259
10	1.399
11	1.538
12	1.678
13	1.818
14	1.958
15	2.098
20	2.797
25	3.496
30	4.196
35	4.895
40	5.594
45	6.293
50	6.993
60	8.391
70	9.790
80	11.188
90	12.587
100	13.985
110	15.384
120	16.782

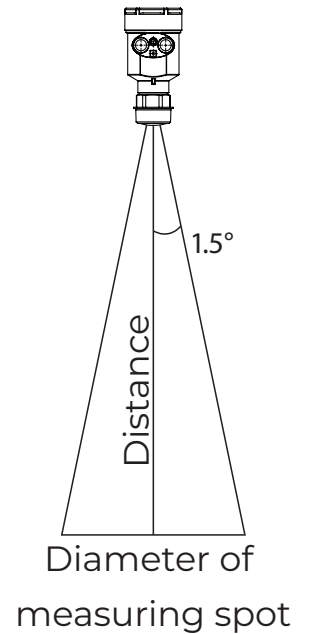


The TRUE ECHO CR-LA Radar with a 3.5" NPT has a 1.5° half angle beam. The diameter of the measuring spot can be calculated using:

$$\text{Distance} * \tan(1.5) * 2$$

DISTANCE (FT)	DIAMETER OF MEASURING SPOT (FT)
1	0.052
2	0.105
3	0.157
4	0.209
5	0.262
10	0.524
15	0.786
20	1.047
25	1.309
30	1.571
35	1.833
40	2.095
45	2.357
50	2.619
60	3.142
70	3.666
80	4.190
90	4.713
100	5.237
110	5.761
120	6.285
130	6.808
140	7.332
150	7.856
160	8.379
170	8.903
180	9.427
190	9.951
200	10.474
225	11.784
250	13.093
275	14.402
300	15.712
325	17.021
350	18.330
375	19.639
400	20.949

DISTANCE (M)	DIAMETER OF MEASURING SPOT (M)
1	0.052
2	0.105
3	0.157
4	0.209
5	0.262
6	0.314
7	0.367
8	0.419
9	0.471
10	0.524
11	0.576
12	0.628
13	0.681
14	0.733
15	0.786
20	1.047
25	1.309
30	1.571
35	1.833
40	2.095
45	2.357
50	2.619
60	3.142
70	3.666
80	4.190
90	4.713
100	5.237
110	5.761
120	6.285



APPENDIX C: REGULATORY WARNINGS

FCC WARNING

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE 1: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

NOTE 2: Any changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

RF Exposure Statement

To maintain compliance with FCC'S RF Exposure guidelines, This equipment should be installed and operated with minimum distance of 20 cm the radiator your body.

This device and its antenna(s) must not be co-located or operation in conjunction with any other antenna or transmitter.

ISED WARNING

This device complies with Innovation, Science and Economic Development Canada License exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d' Innovation, Sciences et Développement économique Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes:

- (1) l'appareil n' doit pas produire de brouillage, et
- (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

The device is compliance with RF exposure guidelines, users can obtain Canadian information on RF exposure and compliance.

Le présent appareil est conforme

Après examen de ce matériel aux conformité ou aux limites d'intensité de champ RF, les utilisateurs peuvent sur l'exposition aux radiofréquences et compliance d'acquérir les informations correspondantes.

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