

SEELEVEL II™

Holding Tank Monitor



709-N2K NLP / 709-N2KP NLP MANUAL

IMPORTANT OPERATOR INFORMATION

DATE INSTALLED: _____

SERIAL NUMBER: _____

GARNET

***SEEL* LEVEL II™**

Tank Monitor

MODEL 709-N2K NLP / 709-N2KP NLP


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SAFETY SYMBOLS INFORMATION

“Notes”, “Cautions”, and “Warnings” have been used throughout this manual to bring special matters to the immediate attention of the reader.


 **NOTE:** expands on information for any procedures.

 **CAUTION:** explains safety information that could cause damage to the product, including data loss.

 **WARNING:** explains dangers that might result in personal injury or death.

The **SEELVEL II**™ Tank Monitor represents a massive leap forward in level measurement technology for the Recreational Vehicle industry. The SEELVEL has a combination of features, accuracy, reliability, and diagnostic capability that have never been available before.

Garnet's 709-N2K series models will monitor the battery voltage, and the fresh water and sewer holding tanks. The information is displayed on a 3-digit alpha-numeric LED display. The 709-N2KP includes a pump switch. The 709-N2K series is also NMEA 2000 network compatible, the tank levels and capacity are available on the NMEA bus for the fresh, grey, and black tanks. In addition, the system can display the operating characteristics of each of the tank sending units, giving it unsurpassed diagnostic capability.

 **WARNING:** All power circuits must be fused. If a fuse is not provided with the system then it is the installer's responsibility to install a fuse with a maximum rating of 7.5 amps. A relay is required if more than 7.5 amps is needed for the pump.

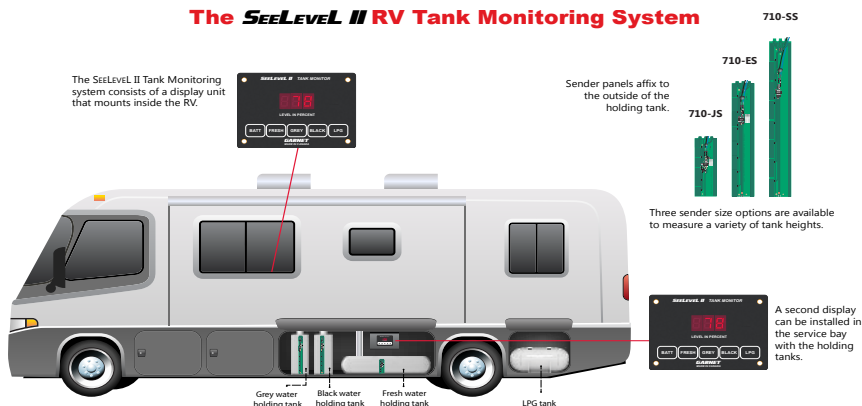
For more detailed information please refer to Chapter 7

"TROUBLESHOOTING GUIDE" and section **"How to avoid damaging the display or pump switch due to excessive current"**.

CHAPTER 2 - SYSTEM DESCRIPTION

The **SEELVEL II™** consists of a display unit that mounts inside the RV, and sender panels that stick to the side of the holding tank. A single 2 conductor wire is used to connect all the sender panels to the display.

The **SEELVEL II** RV Tank Monitoring System



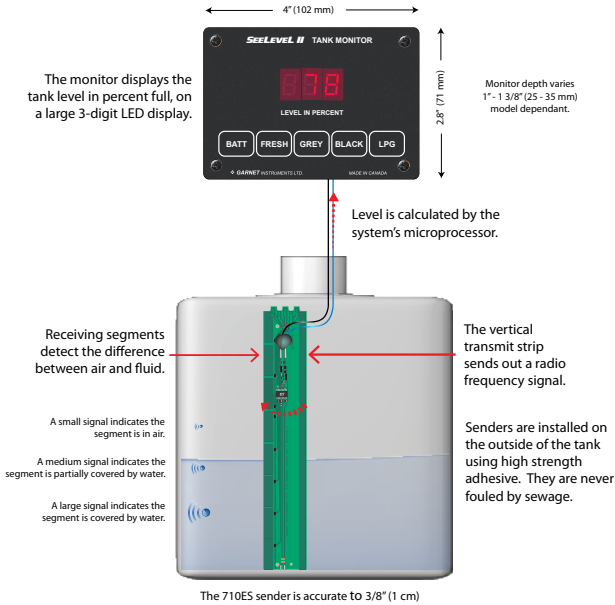
The Sender

Each sender panel is a flexible self-adhesive printed circuit board which is adhered to the side of the holding tank. The sender panel can be cut to length to match the height of the tank, and it auto-calibrates itself so that it can read from empty to full regardless of the height of the tank. Three different sender options (710JS, 710ES, and 710SS) are available with the ability to double-stack the senders to provide accurate level measurement for tank heights ranging from 4 ½" to 34".

The Display

The display receives the information from the three sender panels via a single 2 conductor wire and shows the level information in percent of full on a 3-digit LED display. When the button for a particular tank is pressed, the display shows the level for that tank.

How it works



The sender scans the water level through the tank wall using advanced digital techniques programmed into the sender microprocessor. When the sender transmits the water or sewer level information to the display, it sends a digital code that has built-in error detection, making it highly unlikely for the display to read an incorrect level, even if the wiring is marginal.

In addition to the level, the sender also transmits diagnostic information about its operation. This information can be used to determine if there is buildup of sludge on the inside of the tank or to determine if the sender is damaged or delaminating from the side of the tank. If sludge buildup in the tank becomes extreme the gauge will cease to operate properly, so by monitoring the signal power the tank can be cleaned before the buildup gets excessive.

The system also shows the RV battery voltage by measuring the voltage which powers the display. The voltage is shown with a resolution of 0.1 volt.

In order to keep the tank level and alarm information on the NMEA 2000 bus current, the display regularly scans the senders every 10-15 seconds. When a tank button is pressed, the information displayed is recalled from the most recent scan. A tank on hold is scanned more frequently. Systems with two displays are configured so that the primary display initiates the scanning and the secondary display passively listens to the sender information, this way both displays stay updated without interfering with each other.

The display is the only system component that is accessed by the user. All user input to the display is done using the four buttons along the bottom of the display. Operation of the display is as follows:

To read a water or sewer tank level:

1. Press the button corresponding to the tank to be checked and release it, the display will show the level in percent on the LED display. If no other button is pressed, then the display will shut off after about 5 seconds.
2. If another button (including **BATT**) is pressed before the 5-second time is up for the first button, the display will immediately switch to showing the new level or voltage. The 5-second timeout is restarted every time a button is pressed.
3. To continuously display a reading, press and release the desired button, and then press the same button a second time. When the button is released, the display will be in hold mode, which is indicated by the decimal point on the right-hand side turning on. While the display is in the hold mode it will recheck the held level every 2 - 3 seconds so the user can watch the level change while the tank is being filled or drained. The other tanks will continue to be scanned every 10 - 15 seconds. The display will automatically shut off after 5 minutes in hold mode. To end the hold mode before the 5 minutes is up, press any tank button, and the display will shut off.

To read the battery voltage:

1. Press the **BATT** button and release it, the display will show the battery voltage on the LED display.
2. If no other button is pressed, then the display will shut down after about 5 seconds. If the **BATT** button is held down, the display will continuously recheck the voltage and show the updated value. The reading may flicker back and forth between two values, for example, 12.6 and 12.7 volts. This is normal behavior for a digital voltage display.
3. If another button is pressed before the 5-second time is up for the **BATT** button, the display will immediately switch to showing the value for the new button. The 5 second timeout is restarted every time a button is pressed.
4. There is no hold mode for the battery voltage.

NMEA 2000 Bus Communication:

NMEA 2000 is a communications protocol based on CAN (controller area network) that is used for control, coordination, and diagnostics.

NOTE: Anyone that intends to connect to the NMEA 2000 bus should have a knowledge of the NMEA 2000 specification. For more information on NMEA 2000 protocol go to: www.nmea.org. never need to be changed.



The 709-N2K reports as NMEA device class 75 (sensor communication interface) with an NMEA function code of 150 (fluid level). Garnet Instrument's manufacturer code is 873, and the 709-N2K product code is 15197. The 709-N2K adheres to NMEA database version 2.200. By changing the FRESH/GREY/BLACK to zero senders, you are disabling that sender's updates over the NMEA bus as well.

Set display to be primary or secondary

Press **BATT** and **FRESH**

Press **BATT** + **FRESH** at power up = unit mode (primary/secondary) set. Display shows "5Cn". Once in that mode, **FRESH** = primary ("Pr i"), **GREY** = secondary ("5Ec"). Press **BATT** to save and exit.

Display firmware revision/visual alarm cue

Press **BATT** (1st), **FRESH** (2nd):

- + 5 seconds = version/revision. Display shows "r x.y" where x.y is the firmware revision, for example, "r 1.2". Release both buttons to exit.
- + 10 seconds = visual alarm cue. Display shows "c uE". Release both buttons to edit. Options are either "on" or "off". If set to on, the visual alarm cue will be the 3rd decimal point on the display. It will remain lit if any tank is in alarm status, even if the display is off/idle. **FRESH** toggles on/off, **BATT** saves new setting and exits. If the currently displayed tank is in alarm status, the 3rd LED will slowly blink while that tank is being displayed.

Set LED brightness

Press **BATT** (1st), **GREY** (2nd):

- + 5 seconds = brightness menu. Display shows "br i". Release both buttons to edit. Allowable levels are "b- i" (dimmiest) to "b-5" (brightest). **FRESH** = dimmer, **GREY** = brighter. **BATT** to save and exit.

Press **BATT** (1st), **BLACK** (2nd):

- + 5 seconds = primary/secondary indication. Display shows either "Pr i" or "5Ec" depending on whether the display is set to be a primary or a secondary. Release both buttons to exit.

FRESH Tank Menus

Press **FRESH** (1st), **BATT** (2nd):

Set diagnostic option (no delay)

- Diagnostic option displayed for 5 seconds (no hold delay to enter this mode). "d R" displayed. Release either button to enter this mode. After this mode is entered, the sensor's relative power will be displayed for 5 seconds ("Pxx" displayed, for example "P58"), then the sensor's height (the number of active pads) will be displayed for the next 5 seconds. "Hy" displayed, for example "H 12". Display clears when this mode exits.

Set alarm option (+5 seconds)

- Alarm option displayed for the next 5 seconds. "RLr" displayed. Release either button to enter alarm simulation mode. Press **BATT** to exit.

Alarm simulator

- Display will initially be either "FH i" or "FLo". This simulates an alarm condition (either high or low). **FRESH** toggles high <-> low. Press and hold **FRESH** for 3 seconds to enter the alarm edit mode. Display will change to "FR5" = fresh alarm set. Press **BATT** to exit.

Edit alarm level

- The display will change to, for example, "L 20". L = low alarm triggers when tank level falls below the set value, which in this case is 20%. H = high alarm triggers when tank level rises above the set value. If the 1st decimal point is on, for example "L 20.", that means "treat a failed sensor as 100% full". If the 1st decimal point is not on, that means "treat a failed sensor as empty (0% full)". If the 3rd decimal point is on, that means that alarm conditions on this tank will also set the master alarm (if equipped).
 - Press and hold **BLACK** and the display will cycle through "Lo", "Lo i", "Hi", and "Hi i" with each press. "Lo" = low alarm, "Hi" = high alarm. The 3rd letter means either "i" for not included in the common alarm or "n" for included in the common alarm.
 - GREY** increases the alarm setpoint (press and hold to go fast) and **FRESH** decreases the alarm setpoint (press and hold to go fast).
 - BATT** to store settings and exit back to the alarm simulation mode. "5Lo" briefly displayed, then "FLo" or "FH i".

Edit connected senders (+10 seconds)

- Number of senders edit mode is displayed for next 5 seconds. Display shows "F 5". Release either button to enter the number of senders edit mode. Display will show either "0" (disabled, one or two senders) "5E0", "5E 1", or "5E2". Press **FRESH** to cycle through. **BATT** to save and exit.

Set tank capacity (+15 seconds)

- Tank capacity edit mode is displayed thereafter. "F cR" is displayed (fresh capacity). Release either button to enter the tank capacity edit mode. The unit will display the tank's capacity, in US gallons. Press **FRESH** to decrease and **GREY** to increase. Press and hold either button to go fast. **BATT** to store and exit.

Follow the same steps for GREY and BLACK menus except for the following:

GREY Tank Menus

Press **GREY** (1st), **BATT** (2nd):

- Same structure as for fresh tank. Instead of "F" above, "G" will be displayed.

BLACK Tank Menus

Press **BLACK** (1st), **BATT** (2nd):

- Same structure as for fresh tank. Instead of "F" above, "b" will be displayed.

Continuous display mode

Press FRESH (1st), **FRESH** (again, within 5 seconds of first press):

Press GREY (1st), **GREY** (again, within 5 seconds of first press):

Press BLACK (1st), **BLACK** (again, within 5 seconds of first press):

- Enables rapid tank read mode. Normal scan of a tank happens approximately every 10 seconds. In continuous display mode, the selected tank is scanned approximately every 2.5 seconds. Times out after 10 minutes or until any button is pressed. 3rd decimal point remains lit to indicate continuous tank display mode is active. If the tank is in alarm status and the visual cue option has been turned on, the 3rd decimal point will slowly blink.



NOTE: If there are any errors during setup go to the "TROUBLESHOOTING GUIDE" chapter for display error codes.

To program the 710ES or 710SS sender for the correct tank:

1. Since the senders are all connected in parallel to save wiring and to simplify installation, the senders must be programmed so they know which tank they are on. The senders can be programmed for either the fresh, grey, or black tank. This is done with the two tabs on the top corners of the sender. See the following diagram.
2. The senders default to fresh tank operation if the programming is not altered. Consequently, if the sender is for the fresh tank, nothing further needs to be done to it.
3. If the sender is for the grey tank, remove the tab that says "**GRY**" next to it.
4. If the sender is for the black tank, remove the tab that says "**BLK**" next to it.
5. This is all that is required to program the senders for the correct tank. However, if you make an error, you have one chance to correct it, as described below.
6. If the "**GRY**" tab has been removed and it should be a black tank sender, or if the "**BLK**" tab has been removed and it should be a grey tank sender, then cut out the recessed grey-black correction tab that says "**GBC**" next to it. This reverses the effect of the grey and black tabs.
7. If either the "**GRY**" or "**BLK**" tabs have been removed and it should be for a fresh tank, then remove the other "**GRY**" or "**BLK**" tab. When both the "**GRY**" and "**BLK**" tabs are removed, it is equivalent to neither of them being removed.
8. If the sender is single, no further programming is required.
9. If double stacked senders are used, the top sender must have additional programming, as described below.
10. Refer to the 710ES and 710SS sender programming diagram.

To program the 710ES or 710SS sender as top or bottom:

1. Since the senders are all connected in parallel to save wiring and to simplify installation, the senders must be programmed so they know whether they are a single, top, or bottom sender. This is done with the tab at the top center of the sender. See the following diagram.

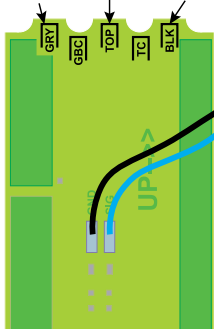
2. The senders default to single or bottom operation if the programming is not altered. Consequently, if the sender is for single or bottom operation, nothing further needs to be done to it (beyond programming it for the correct tank).
3. For a top sender, remove the tab that says **"TOP"** next to it.
4. This is all that is required to program the senders for single, top, or bottom use. However, if you make an error, you have one chance to correct it, as described below.
5. If the **"TOP"** tab has been removed and it should be a single or bottom sender, then cut out the recessed top correction tab that says **"TC"** next to it. This reverses the effect of the top tab.
6. Verify that both the top and bottom senders have been programmed for the correct tank.

To program the 710JS sender for the correct tank:

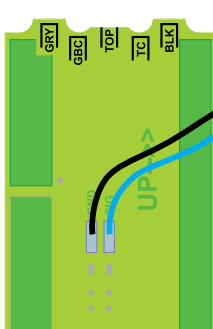
1. Since the senders are all connected in parallel to save wiring and to simplify installation, the senders must be programmed so they know which tank they are on. The senders can be programmed for either the fresh, grey, or black tank. This is done with the two tabs on the top corners of the sender. See the following diagram.
2. The senders default to fresh tank operation if the programming is not altered. Consequently, if the sender is for the fresh tank, nothing further needs to be done to it.
3. If the sender is for the grey tank, remove the tab that says **"GRY"** next to it.
4. If the sender is for the black tank, remove the tab that says **"BLK"** next to it.
5. This is all that is required to program the senders for the correct tank. However, if you make an error, you have one chance to correct it, as described below.
6. If the **"GRY"** or **"BLK"** tab has been removed by mistake, the sender can be changed to a fresh tank sender by cutting the other corner tab (**"BLK"** or **"GRY"**).
7. Refer to the 710JS sender programming diagram.

There are no tab cuts for FRESH SINGLE or BOTTOM sender programming

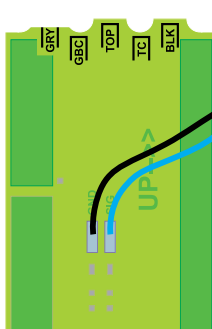
Cut for TOP sender
Cut for GREY tank Cut for BLACK tank



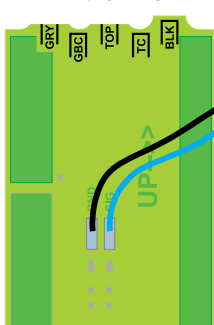
Tab cut for FRESH TOP sender programming



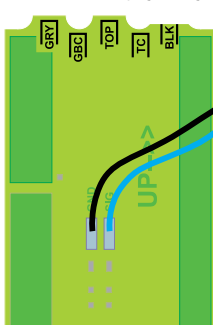
Tab cut for GREY SINGLE or BOTTOM sender programming



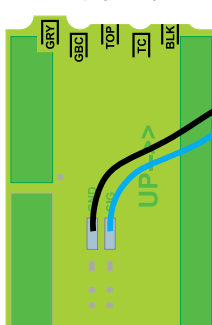
Tab cuts for GREY TOP sender programming



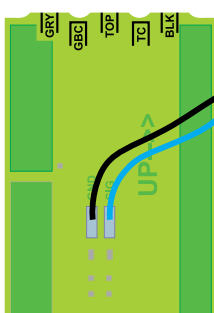
Tab cut for BLACK SINGLE or BOTTOM sender programming



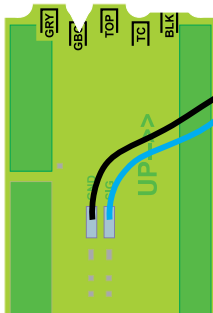
Tab cuts for BLACK TOP sender programming



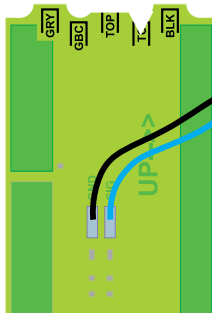
Example of corrected FRESH TOP sender programming (GRY or BLK tab cut by mistake)



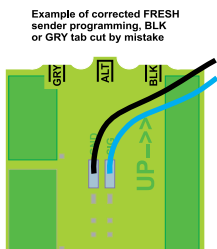
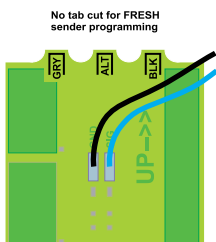
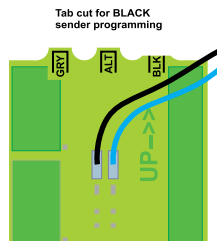
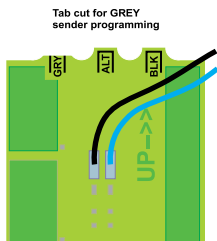
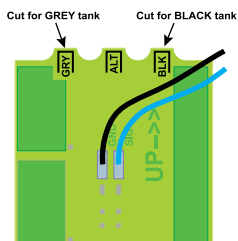
Example of corrected GREY SINGLE or BOTTOM sender programming (BLK tab cut by mistake)



Example of corrected FRESH SINGLE or BOTTOM sender programming (TOP tab cut by mistake)



710ES AND 710SS SENDER PROGRAMMING



710JS SENDER PROGRAMMING

1. Please refer to the **"Troubleshooting and Installation Tips"** section in Chapter 7 for details on avoiding installation issues.
2. The installation consists of mounting the display inside the RV, cutting and fastening the senders to the sides of the holding tanks, connecting wiring, and programming the display. When wiring DO NOT use spade connectors to join wires, only use crimp on butt connectors or solder the wires together.
3. Mount the display by cutting a hole in the wall 3" wide by 1 7/8" high and bringing the wiring out through the hole to connect to the display panel connector.
4. Connect the wiring according to the following table. It is easier to connect the wiring to the display connector first, and then plug the connector into the display panel. The senders need to be grounded to a single ground wire from the display. Make sure that the system ground is connected to the breaker panel ground.

Wire Colours on Connector

Wire Color	Function
White 18 gauge	Pump LED
Red 18 gauge	+12V
Black 18 gauge	Ground
Blue 18 gauge	Tank Senders
Orange 18 gauge	Common Alarm Output

5. Determine where to mount the senders on the tanks. They will need to have a flat area on the side of the tank large enough so the whole width of the sender is in contact with the side of the tank, all the way from the top to the bottom of the tank. Make sure that any metal is at least 1" away from either side or the top and bottom of the sender, and at least 2" away from the face of the sender. Clean the area well so that there is no dust, grease, oil, water, etc., that would prevent the adhesive on the sender from sticking.
6. Measure the height of the tank to determine which sender configuration to use and how long the senders should be. Refer to the following table.

 **CAUTION:** DO NOT mix sender types when stacking senders.

Tank Height	Sender Options	
	Best Resolution	Other Acceptable
4½" - 5"	JS	-
5" - 7"	JS	ES
7" - 13"	ES	SS
13" - 17"	stacked ES	SS
17" - 25"	stacked ES	stacked SS
25" - 34"	stacked SS	-

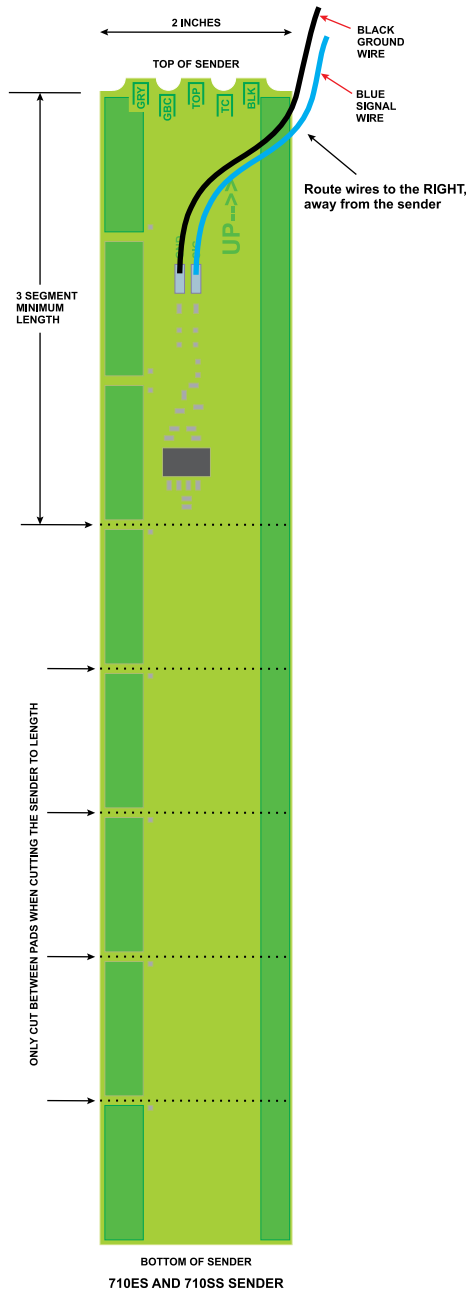
For single sender applications:

The sender ends should be ¼" to ½" away from the top and bottom of the tank, to allow for the thickness of the tank top and bottom and any bows in them (see the diagrams). The senders are calibrated to account for this distance from the bottom of the tank. The SS sender is cut to the nearest even 2" in length. The ES sender is cut to the nearest even 1.5" in length, for example, for a system with a tank height of 11.75", cut the sender to be 10.5" long, this allows ⅝" at each end when the sender is centered vertically on the tank. The JS sender is cut to the nearest 1.0" in length.

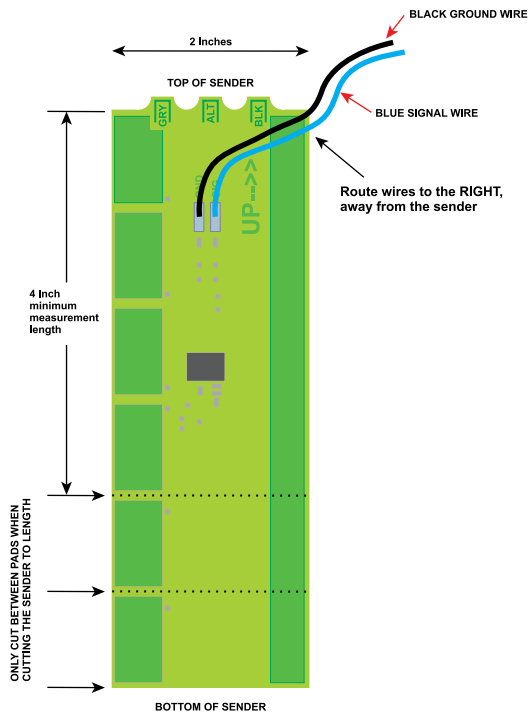
⚠ CAUTION: DO NOT cut the 710SS sender shorter than 6". This sender will not work if it is cut shorter than 6". DO NOT cut the 710ES sender shorter than 4 1/2". This sender will not work if it is cut less than 4 1/2". DO NOT cut the 710JS sender shorter than 4". This sender will not work if it is cut less than 4".

For double stacked sender applications:

For tall tanks, double stacked 710ES or 710SS senders are used. The sender ends should be ¼" to ¾" away from the top and bottom of the tank, to allow for the thickness of the tank top and bottom and any bows in them (see the diagrams). The senders are calibrated to account for this distance from the bottom of the tank. In addition, there needs to be a gap of ⅙" to ⅛" in between the double senders. Therefore the total length of both senders will be: tank height - ¼" - ¼" - ⅛", then rounded down to the nearest 1.5" (ES sender) or 2" (SS sender). The top and bottom senders should be approximately the same length for best results. For example, if the tank height is 22", then $22" - \frac{1}{4}" - \frac{1}{4}" - \frac{1}{8}" = 21 \frac{3}{8}"$, so the total length of both ES senders will be 21". Make both senders 10.5" long.




710ES AND 710SS SENDER




710JS SENDER

7. To make the senders the right length (assuming they are too long) they will need to cut off with a pair of scissors. The end to be cut is the bottom end, which is the opposite end from the top where the wires come out (see the diagrams).

 **CAUTION:** DO NOT cut the sides, and DO NOT cut the 710ES sender shorter than 4 ½". The cut must be in between the sensor pads, and the cut must be made parallel to the existing bottom end. Double check your measurements, if the sender is cut too short, it cannot be lengthened.

8. The senders need to be programmed so they know which tank they are on. This is done by selectively cutting off the tabs on the top of the sender. See the chapter entitled "**SENDER PROGRAMMING**" for details.
9. For double stacked sender systems, the senders also need to be programmed so they know whether they are being used as top or bottom senders. See the chapter entitled "**SENDER PROGRAMMING**" for details.
10. Once the sender is cut to length and programmed, do a test by taping the sender to the tank wall. Make sure there are no air gaps between the sender and the tank. Verify operation before permanently sticking the sender to the tank wall. Once proper operation has been confirmed, carefully peel the backing paper off the adhesive. Do this slowly to prevent the adhesive from being ripped off the sender, and to prevent the backing paper from ripping. Be careful not to bend the sender sharply in the process. Position the sender over the side of the tank and carefully stick it down.

 **CAUTION:** Make sure that the end with wires is pointing up!!

Position the bottom of the sender at least ¼" above the bottom of the tank, or slightly higher if required to equalize the space at the top and bottom of the tank. Make sure that the sender is square with the tank. You only have one shot at this, if you try to peel it off the tank once it is stuck the sender may be damaged by the sharp bending. Carefully press the sender down to the tank so that all of the adhesive is contacting the tank wall.

11. Do steps 5 to 10 for the other two holding tanks.
12. Connect all the blue wires from the senders together, and to the blue wire from the display. Connect the black wire from each sender to ground at the display. It is very important that the display and the senders have the same ground. Use crimp on butt connectors to fasten the wires together.

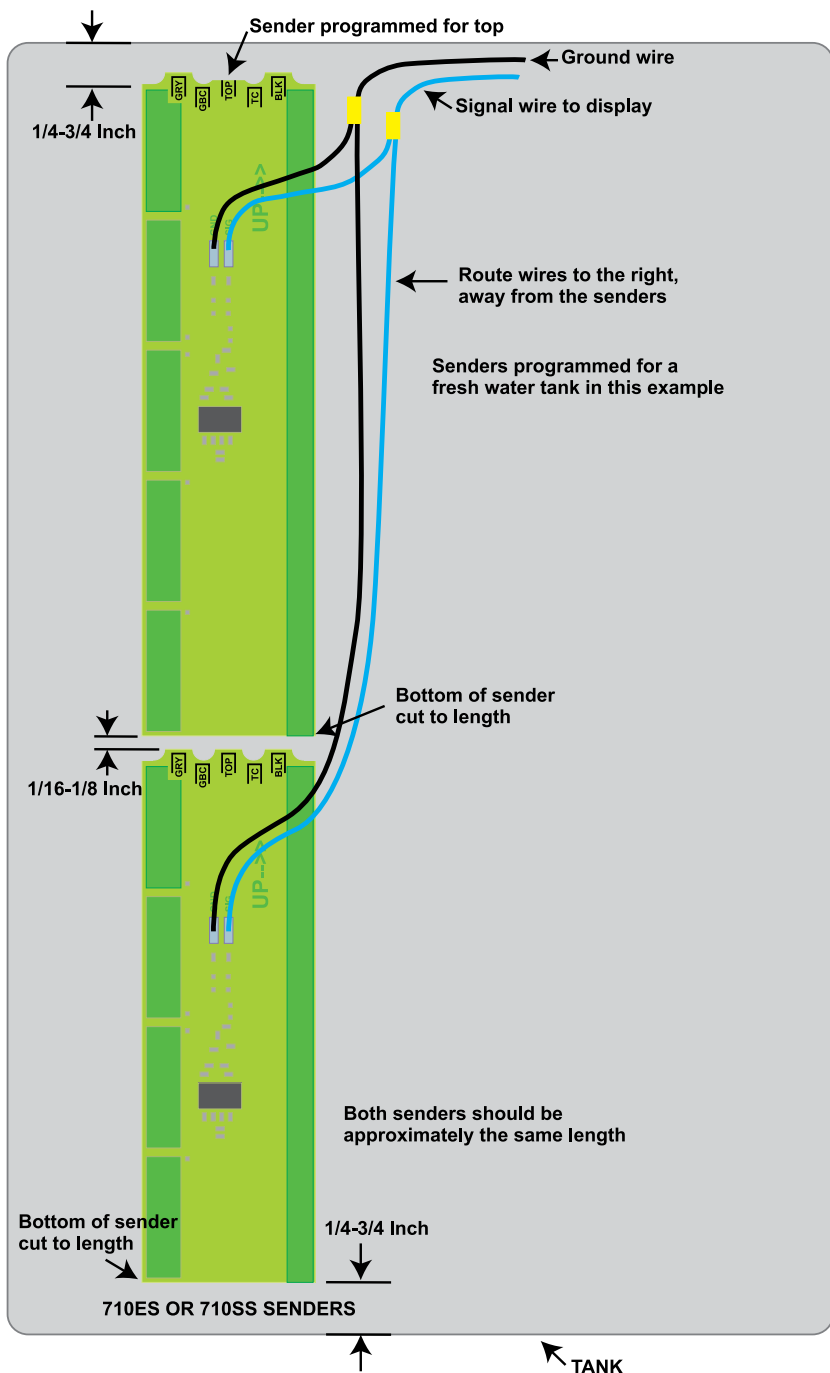
⚠ CAUTION: Make sure that the wires from the sender are routed to the RIGHT side of the sender, away from the sender. NEVER route the wires to the left of the sender. If they drape over the sender they could affect the reading.

13. Secure the wires with tie wraps or something similar so that the wires do not rattle or press against the sender, this may result in sender damage or wires breaking over time. Refer to the enclosed wiring diagrams.
14. All that remains now is calibration and testing. The tank senders will self calibrate to whatever length they are cut, so they will always read from 0% to 100%. The display needs to be set to a single or double sender system for each tank. See the chapter entitled **“DISPLAY CALIBRATION”** and the section **“To program the number of senders for each tank”** for details. Make sure you do it for each tank.
15. For the initial test, have the tank at least $\frac{1}{4}$ full of water or sewage, and verify that the percent level reading looks correct (see the chapter entitled **“OPERATING INSTRUCTIONS”** and the section **“To read a water or sewer tank level”** for details). Check to see that the signal power is at least 20% (see the chapter entitled **“TROUBLESHOOTING GUIDE”** and the section **“To review the sender diagnostics”** for details). If the signal power is too low, make sure that the sender(s) is well stuck to the side of the tank and that the tank is reasonably clean inside, as a large buildup will reduce signal strength. The gauge will work with maximum signal strengths as low as 20%, but it is good to have at least 50% to 60% at installation so that there is some margin available for buildup in the tank. Note that the system “learns” about the characteristics of the tank with use, so the readings may be inaccurate when the tank is empty or almost empty when the system is first tested. Once the tank has been filled at least $\frac{1}{4}$ full the system will be properly “taught” and should read correctly after that.
16. If equipped, connect the pump switch as required.

⚠ WARNING: All power circuits must be fused. If a fuse is not provided with the system then it is the installer’s responsibility to install a fuse with a maximum rating of 10 amps. A relay is required if more than 7.5 amps is needed for the pump.

17. Verify that the battery voltage reads correctly. If it appears low, make sure you have good wiring for the 12 volt power and the ground.







18. The common alarm output provides a connection to ground when the alarm is active. The maximum current that can be put through the alarm output is 100mA, be sure to use a relay if more current is required. Program and test the alarm output to ensure that it functions as desired.



Typical Double Stacked 710ES or 710SS Sender Installation

CHAPTER 7 - TROUBLESHOOTING GUIDE

If a sender or its wiring is not operating properly, the following codes are shown on the display:

DISPLAY CODE	POSSIBLE CAUSE	SOLUTION
Open circuit  <small>LEVEL IN PERCENT</small>	<ol style="list-style-type: none"> 1. If a sender is unresponsive. 2. There is an open circuit in the wiring so the sender is not connected. 	See "Wiring Diagnostics" section.
Short circuit  <small>LEVEL IN PERCENT</small>	<ol style="list-style-type: none"> 1. A sender is shorted or there is a short in the wiring. 	See "Wiring Diagnostics" section.
Error  <small>LEVEL IN PERCENT</small>	<ol style="list-style-type: none"> 1. Senders have not been programmed correctly. 2. The sender is sending bad data. 3. There is damaged wiring. 4. There is electrical interference. 	Check all the senders to make sure they are programmed correctly. If they are, replace the sender that is creating the error.
Stacked senders  <small>LEVEL IN PERCENT</small>	<ol style="list-style-type: none"> 1. The display has been programmed for a single sender where double-stacked senders have been connected. The display has not been set to look for two senders 	Change the senders or reprogram the display as required.
No top sender  <small>LEVEL IN PERCENT</small> No bottom sender  <small>LEVEL IN PERCENT</small>	<ol style="list-style-type: none"> 1. The display has been programmed for a single sender and double stacked senders have been connected. 2. The display has been programmed for double-stacked senders and one of these error codes are showing: <ul style="list-style-type: none"> • ntP - only the top sender is working and the bottom is not. • nbo - only the bottom sender is working and the top one is not. 	Correct the programming on the sender.

The diagnostics can be used to check the wiring and the senders:

1. If a short circuit is showing, disconnect the senders one at a time at the sender location. If the short circuit indication goes away when a sender is removed, then that sender is bad. If all the senders are removed but a short circuit still shows, then the wiring may be shorted. Disconnect the sender wire at the display, the short indication should go away. If it doesn't, the display is bad.
2. If an open circuit for all the senders is showing, it is most likely a wiring open circuit or display failure, since it is unlikely that all three senders are bad. Try shorting the wiring together at the display, the display should indicate a short circuit. If it doesn't, the display is bad. If it does, then remove that connection and short the wires together at the sender locations. If no short circuit is shown, then the wiring is open. If the display does show a short circuit, then the senders must be bad.
3. If a single sender is showing an open, try shorting the wiring together right at that sender. If a short now shows, the sender is bad or not wired properly. If no short circuit shows on the display, the wiring to that sender is open.

To review the sender diagnostics:

1. The sender diagnostics can be reviewed periodically to check for any degradation of the tank senders. If a sender appears to be malfunctioning, reviewing the diagnostics should be the first step in the troubleshooting process.
2. There are two diagnostics for the senders: the signal power, and the sender height.

The signal power is an indication of how much signal is being transmitted through the tank wall and picked up by the receive part of the sender. If the signal power is too low, it can indicate a sender which is detached from the tank, excessive buildup on the inside of the tank, bad wiring to the sender, low battery voltage, or a defective sender. Typical signal power should be 50% to 60%. The minimum signal power for proper operation is 20%.

The sender height is the number of receive segments present in the sender. To determine the length of the sender, multiply the calibration by 2.0 (SS sender) or 1.5 (ES sender) or 1.0 (JS sender) to get the length in inches. The senders always auto calibrate to the length that they are cut, so this diagnostic allows the user to confirm the length and to make sure that the auto calibration is working properly.

3. To check the diagnostics, press and hold the button for the tank to be checked, the display will show the level for that tank.
4. While continuing to hold down the button for the tank, press the **BATT** button. When the display shows "d lR", release the buttons, the display will then change to showing the signal power diagnostic. This is indicated by a "P" showing on the left digit, for example "P25" indicates a 26% signal power.
5. The signal power will show for 5 seconds. The display will then change to showing the sender height. This is indicated by a small "h" showing on the left digit, for example "h 6" indicates that the sender has 6 receive segments, which is 6" high for a JS sender, 9" high for an ES sender, or 12" high for an SS sender.
6. After 5 seconds of showing the height, the display will shut off.

TROUBLESHOOTING AND INSTALLATION TIPS

What to do if the system freezes or is unresponsive:

If the display is unresponsive, it may be "hung" due to a static discharge or electrical noise. Try rebooting it by shutting off the 12V power to it for a few seconds, then turning it back on.

What to do if operation becomes erratic or stops completely:

Make sure all wiring connections are solid. Do not use spade connectors to join wiring as they will degrade over time. Use insulated crimp-on butt connectors or solder and insulate the wire connections.

What to do in dual console systems if the two displays do not read the same:

For dual display console applications, if the consoles disagree the most likely reason is a bad console ground. Both console grounds, and the sender grounds, must be connected together with ground wiring. Do not depend on metal chassis components. See item 2 in the following section for further details.

What to do if readings jump or are inaccurate

1. We have had a few instances where 120VAC interference has caused the readings to stall and create a gap; readings would skip from 50% to 70% and then begin to function again. The cause was wiring between consoles and senders being tied too close to entrance boxes for shore power or bundled with other high AC voltage lines or junction boxes.

2. Always ground the senders and the console to the same ground circuit. This is very important; RV's can have several ground circuits with resistance between them. We have had instances where two consoles are installed with a different ground for the service bay console and interior console. If you see different levels from each console on the same tank, then the ground circuit is not common. Connect both consoles to the same ground back to the breaker panel ground point.

What to do if the system indicates a residual or non-zero water level even though the tank is drained completely:

1. This can be due to a convex tank bottom or a sloped tank bottom. In the case of the convex bottom tank a ring of water may remain after draining. In the case of the sloped bottom (to the drain valve side) a very small amount of water left in the tank will result in a non-zero level indication. In both of these cases, temporary installation of the sender using duct tape or masking tape will allow the installer to check the tank level before committing to a final sender position. After cutting the sender to length and connecting the wires, be sure to tape down both sides of the sender to eliminate air gaps between the sender and tank surface which can cause low signal strength and unpredictable performance. The ends of the sender must be at least $\frac{1}{4}$ " to $\frac{1}{2}$ " away from the tank bottom and top to allow for wall thickness. The exterior bottom & top of the tank are not the same as the interior bottom & top; depending on the tank wall thickness the inside height is $\frac{1}{2}$ " to 1" shorter than the outside height. Knowing the wall thickness of your tank will allow you to find the optimal sender position; placing the sender where it can "see" the water will ensure proper level calculation and sender operation.
2. The signal strength should be in the 50% range for best performance. If the signal strength is in the 20% range it is indicative of a high resistance in a connector, a bad ground, or improper bonding of the sender to the tank (a possible air gap on one or both sides of the sender).
3. With the console installed you can check the level on each tank, if you get an indicated level of 10% to 20% and you know this is too high, reposition the sensor board as follows:

In the case of a convex tank bottom, usually found on large flat tanks, raising the sender is the best solution to accomplish a zero reading when the tank is empty. This may result in having to shorten the sender by an additional segment.

On sloped tanks, which are used to promote complete draining, one alternative is to measure the end of the tank opposite from the drain valve. It may be necessary to extend the wire harness to be

able to measure on the optimal side. On the drain valve side, the best choice is to elevate the sender to avoid reading a puddle at the drain valve.

4. The close proximity of metal to the sender can be misinterpreted as water, since they have similar electrical characteristics. Any metal such as steel, aluminum, copper, or brass can affect the sender reading if it is closer than about 2" from the face of the sender. If there are metal frame pieces, brackets, straps, pipes, ducts, etc. close to the sender you may have to move the sender away from them. Again, trial positioning using tape is necessary until the problem disappears. Flexible pieces of metal can be held away from the sender with rubber wedged between the sender and the metal. If the metal is off to the side of the sender, or just butting to the edge then it is usually not a problem, particularly on the right hand side of the sender.
5. Make sure that metal doors or covers are far enough away from the sender as well, once everything is closed up the positioning may change. The symptoms of exposure to large metal components are usually a non-zero reading when the tank is empty, or the level appearing to jump suddenly as the tank is drained or filled.
6. On fresh tanks there is sometimes a potential to not be able to use all the water in the tank, we suggest you elevate the fresh sender 1" off the tank bottom and position the top of the sender to allow for vent position (if the vent is on the side of the tank). This way you should see '0' before the pump starts to suck air. Some tanks have a sump style draw system, in this case there is no concern with unusable water, just allow for the wall thickness when positioning the sender board (usually ½" to 1" margin from the outer shell). If the sender is positioned above the vent then the maximum reading may be less than 100%.
7. There may be a buildup on the inside walls of black and grey tanks. We get calls occasionally about older coaches that have not been in service for a few years in which the black tank will now indicate a level even though it is empty. The likely cause is that the tank has a significant build-up, probably exceeding ¼" to ½" thick! Redex is not an acceptable chemical to promote clean tank walls; it is far too slow to get the breakdown action started. Use an RV type of liquid chemical, we suggest Tissue Digester, Sensor Cleaner, or the latest we have used called Happy Campers Holding Tank Extreme Cleaner available at www.happycampersworld.com. The next time you take a trip, leave with a high concentration of the chemical in the tank and approximately 30% full of fresh water. Hopefully you can drive for 2-3 days allowing the tank levels to rise through normal use. We recommend that you exceed the level that you see the system report when the tank is empty. After the sloshing and

the soaking hopefully the build-up will be flushed away when the tank is drained and flushed. If you still have symptoms the treatment may required a few more times. The waste did not build up on the tank wall in one day, so it may not dissolve in one treatment! The build-up looks like water to the system since it holds a significant volume of water in the build-up area. It takes much more than a film or piece of tissue to cause the error.

What to do if the system reads a zero water level at all times, or does not reach 100%:

1. This may be due to excessive tank wall thickness. We have tested the sender on an actual tank with $\frac{3}{8}$ " wall thickness to ensure proper operation. If you encounter an excessively thick tank wall the symptom will be a zero reading regardless of the actual tank level. The cross check would be to test the sender on another tank by taping it in place temporarily, if it now works the tank wall thickness is well over $\frac{3}{8}$ ". You can also use a 1 gallon jug or a 5 gallon pail as a test tank to crosscheck operation of the sender.
2. A symptom we have seen is the sender will not indicate 100% when the tank is full. If the sender is positioned too high on the tank, then water cannot reach high enough on the sender for it to read 100%. The top of the sender must be at least $\frac{1}{4}$ " to $\frac{1}{2}$ " away from the top of the tank to allow for wall thickness.
3. Another possibility is a tank wall thickness issue that may occur at the corners or edges of the tank. This has not been a common issue, and the only correction you can make is to move the board slightly lower, away from the thick area.

What to do if sender delamination occurs:

1. We have had reports of the senders literally falling off the tanks or showing serious delamination. This is likely caused by a lack of tank surface preparation. Surface prep is very simple, wipe the area to be adhered to with products like Pro Bond, alcohol, or acetone. Do not use thinners because they leave residues which attack the adhesive. Ambient temperatures of less than 60°F or 15°C prevent the bonding agents in the adhesive from working properly; use a heat gun to warm the tank surface if necessary. Also be sure the surface is dry, again a heat gun is the best way to dry the bonding area. Finally, the surface of the tank must be smooth. The adhesive works much better on smooth surfaces, if necessary use an orbital sander with fine grit paper (220 grit) to quickly accomplish the desired smoothness.

2. Another possibility is the wiring harness pulling on the sender. Make sure the wiring to the tank sender is well supported so that it does not put a load on the sender. Be sure to support all connecting harnesses; do not let the board support the harness, this will in time cause delamination of the board. One simple way to do this is to use Gorilla tape across the top of the sender at a 90 degree angle to the sender orientation, with the wiring held in place by the tape. The wires from the sender must be routed straight up or to the right for reliable operation.

How to protect the sender from road spray and debris:


1. On installations where the holding tank is exposed to under chassis road spray and flying rocks etc. we recommend the use of an auto body undercoat, which is easily purchased in auto parts stores. This tar based material clings well to the senders and protects from water and debris.
2. One material in particular is 3M Professional Grade Rubberized Undercoating, product code 03584. Another product that works well is a Dominion Sure Seal rubberized undercoating such as Gravel Guard Rocker Guard Coating.
3. After the system is completed and tested apply the undercoat over the complete board using two coats. Do not use lacquer, enamel paint, or plastic paint for auto bumpers as these contain chemicals that will dissolve the conformal coating on the board and cause malfunctions.

How to avoid damaging the display when mounting:

1. If mounting the display in a metal panel or wall there is a risk of permanent damage due to a jagged opening or too small of an opening. The metal panel can short circuit the display rendering it inoperable and requiring the installer to replace it. Ensure that the edges of the cutout are smooth and that no material is bent outward where it can dig into the display. Make sure that the cutout is large enough so that the display can be easily inserted without having to angle it. There is a $\frac{1}{2}$ " border all around the display to cover the edge of the hole, so if the hole is a bit larger than the minimum requirement it will still be covered by the display.
2. When fastening the display to the panel, make sure that it is centered in the hole and not resting on one edge.
3. Non-conductive mounting spacers are available to help prevent damaging the display. Contact Garnet for further details.

How to avoid damaging the display or pump switch due to excessive current:

1. Please be aware that the water pump switch circuit has a limitation on current draw of 7.5 amps, some large pumps can draw over 10 amps. These high drain pumps must use a relay or the display console printed circuit will overheat and damage the display permanently.
2. If the 12V supply line from the electrical panel does not have a 7.5 amp fuse rating, please be sure to install the supplied fuse holder with a 7.5 amp automotive style fuse inline on the +12V red wire.

 **WARNING:** All power circuits must be fused. If a fuse is not provided with the system then it is the installer's responsibility to install a fuse with a maximum rating of 10 amps. A relay is required if more than 7.5 amps is needed for the pump.

CHAPTER 8 - SPECIFICATIONS

Resolution	JS sender: $\frac{1}{4}$ " (6 mm) ES sender: $\frac{3}{8}$ " (10 mm) SS sender: $\frac{1}{2}$ " (13 mm)
Accuracy:	+/- 8% or better, limited by resolution and tank height and shape.
Temperature range:	+32 °F to +140 °F (0 °C to + 60 °C)
Sender materials:	0.008" thick glass epoxy circuit board with conformal coating for circuit protection. Laminated on the back with 3M 300LSE Bonding Adhesive.
Sender length range:	JS sender: 4" to 6", which will measure tank heights from 4½" to 7". ES sender: 4 ½" to 12", which will measure tank heights from 5" to 13" (single sender) and up to 25" (dual senders). SS sender: 6" to 16", which will measure tank heights from 7" to 17" (single sender) and up to 34" (dual senders).
Display mounting panel:	Black panel, approximately 4" wide by 2.8" high by 1" thick (102mm wide X 71mm high X 25mm thick). Panel screws to wall.
System power requirements:	Display requires 12 volts from the RV battery, the system will function from 11 volts to 16 volts. Current drain is less than 200mA.
Wiring:	A single two wire conductor required from the display to the senders. All the senders are wired in parallel. 12 V power and ground required for display.
Pump switch: (if equipped)	The pump switch is rated for a maximum of 7.5 amps. The use of a relay is required if more than 7.5 amps is needed. A 7.5 amp (max) fuse must be installed in series with the 12V power circuit to the switch!
Common Alarm Output: (if equipped)	Maximum voltage: 16 volts DC Maximum current: 100 mA DC Polarity: The output makes a connection to ground when the alarm is on.

CHAPTER 9 - SERVICE AND WARRANTY INFORMATION

The warranty will only apply only if the warranty card that is shipped with the equipment has been returned to Garnet Instruments Ltd.

DISCLAIMER OF WARRANTY ON HARDWARE

Garnet Instruments Ltd. warrants equipment manufactured by Garnet to be free from defects in material and workmanship under normal use and service for a period of one year from the date of sale from Garnet or an Authorized Dealer. The warranty period will start from the date of purchase or installation as indicated on the warranty card. Under these warranties, Garnet shall be responsible only for actual loss or damage suffered and then only to the extent of Garnet's invoiced price of the product. Garnet shall not be liable in any case for labor charges for indirect, special, or consequential damages. Garnet shall not be liable in any case for the removal and/or reinstallation of defective Garnet equipment. These warranties shall not apply to any defects or other damages to any Garnet equipment that has been altered or tampered with by anyone other than Garnet factory representatives. In all cases, Garnet will warrant only Garnet products which are being used for applications acceptable to Garnet and within the technical specifications of the particular product. In addition, Garnet will warrant only those products which have been installed and maintained according to Garnet factory specifications.

LIMITATION ON WARRANTIES

These warranties are the only warranties, expressed or implied, upon which products are sold by Garnet and Garnet makes no warranty of merchantability or fitness for any particular purpose in respect to the products sold. Garnet products or parts thereof assumed to be defective by the purchaser within the stipulated warranty period should be returned to the seller, local distributor, or directly to Garnet for evaluation and service. Whenever direct factory evaluation, service or replacement is necessary, the customer must first, by either letter or phone, obtain a Returned Material Authorization (RMA) from Garnet Instruments directly. No material may be returned to Garnet without an RMA number assigned to it or without proper factory authorization. Any returns must be returned freight prepaid to: Garnet Instruments Ltd, 286 Kaska Road, Sherwood Park, Alberta, T8A 4G7. Returned warranted items will be repaired or replaced at the discretion of Garnet Instruments. Any Garnet items under the Garnet Warranty Policy that are deemed irreparable by Garnet Instruments will be replaced at no charge or a credit will be issued for that item subject to the customer's request.

If you do have a warranty claim or if the equipment needs to be serviced, contact the installation dealer. If you do need to contact Garnet, we can be reached as follows:

CANADA

Garnet Instruments Ltd.
286 Kaska Road
Sherwood Park, AB T8A 4G7
CANADA
email: info@garnetinstruments.com

UNITED STATES

Garnet US Inc.
5360 Granbury Road
Granbury, TX 76049
USA
email: infous@garnetinstruments.com

TO MAXIMIZE YOUR WARRANTY PLEASE REGISTER ONLINE AT www.garnetinstruments.com OR MAIL THIS FORM IN TO GARNET.

GARNET

LIMITED WARRANTY REGISTRATION

MODEL NO. _____ SERIAL NO. _____

SENDER BAR SERIAL NO. _____ (if applicable)

DATE PURCHASED _____ DATE INSTALLED _____
YR/MO/DAY YR/MO/DAY

IMPORTANT: WITHOUT THE SERIAL NUMBER OF EACH UNIT IT IS
DIFFICULT TO DETERMINE WARRANTY VALIDITY

COMPANY NAME _____

DEALERS NAME _____

PRINCIPAL CONTACT _____

WARRANTY CONTACT _____

ADDRESS _____

ADDRESS _____

TELEPHONE _____ FAX _____

TELEPHONE _____ FAX _____

IN CANADA RETURN TO:

Garnet Instruments Ltd.
286 Kaska Road
Sherwood Park, AB T8A 4G7
CANADA

IN UNITED STATES RETURN TO:

Garnet US Inc.
5360 Old Granbury Road
Granbury, TX 76049
USA

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