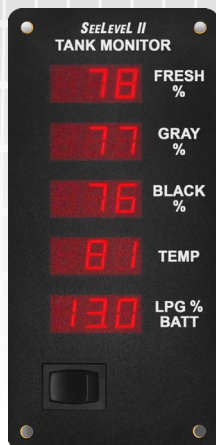


SEELEVEL II™

Tank Monitor



714



714-P

MANUAL

IMPORTANT OPERATOR INFORMATION

DATE INSTALLED: _____

	Signal Level	Sender Height
Black Water Tank		
Gray Water Tank		
Fresh Water Tank		

GARNET

SEELLEVEL II™

Tank Monitor

MODEL 714 / 714-P

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

The 714 will monitor the battery voltage, the water and sewer holding tanks, the temperature and the LP Gas tank. The 714-P model also includes a pump switch. The information is displayed on five LED displays. In addition, the system can display the operating characteristics of each of the tank sending units, giving it unsurpassed diagnostic capability.

The 714 can also be made RV-C network compatible with the optional CAN interface. With this option, the tank levels for the fresh, gray, black and LP tanks, and the temperature valves, would be available on the RV-C bus.

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

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. 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. For tanks less than 7 inches tall, 50% better accuracy is achieved by using the JS sender, which can be shortened for a minimum of 4 inches. For tanks from 7 inches to 13 inches tall, a single ES sender is used. For tanks from 13 inches to 25 inches tall, two ES senders can be stacked to allow measurement of levels up to 24 inches.

The Display: The display continuously shows the levels for the fresh, gray, and black tanks, inside and outside temperatures and battery voltage or LPG level. The display automatically obtains the level or temperature information every 10 seconds and updates the display accordingly.

The display receives the information from the three sender panels via a single two conductor wire. If the wiring is disconnected or cut, or if the sender panel is damaged, then the display will indicate an error code. The various error codes are shown in the troubleshooting chapter.

The temperatures are is measured with digital temperature sensors mounted on the inside or outside of the coach. The temperature can be programmed to read in degrees Celsius or Fahrenheit and is accurate to within 3 °F (1.5 °C).

With these diagnostic features and the digital nature of the tank level sensing technology, it is almost impossible for the system to indicate an incorrect water level, and in the very unlikely event it does occur, servicing is greatly aided with the diagnostic information.

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.

The display can use an existing LPG electrical sender to show the LPG level. It can be automatically calibrated to any sender, and shows level on the LED display in percent of full, from 0% to 100%.

If equipped with the optional CAN interface, the RV-C output provides a connection to the CAN bus on the coach.

In order to keep the tank level information on the display and RV-C bus current, the display regularly scans the senders every 10 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.

User operation of the display is described in the next chapter.

The display is the only system component that is accessed by the user. Operation of the display is as follows:

To read a tank level:

The levels in percent are continuously shown on the LED displays, and are updated every 10 seconds. If more frequent updates are required (~2 seconds) while loading or unloading a tank, the tank can be put into hold mode by pressing the button for that tank, located just to the right of the LEDs. A display in hold mode is shown by the decimal in the bottom right corner of the readout. Hold mode for a tank is only available on the primary display.

To read the temperatures:

The temperature in degrees is continuously shown on the LED display, and is updated every 10 seconds. If there are 2 temperature senders installed, then pressing the button to the right of the temperature display will toggle between the two temperatures. The second temperature will be indicated by a decimal point on the right. The sender with the cut jumper will be the first temperature with no decimal point. The sender with the uncut jumper will be the second temperature indicated by the decimal point. The temperature can be programmed to be in either degrees Celsius or Fahrenheit. Refer to the programming section to obtain instructions on how to set this.

To read the battery voltage or LPG:

The fifth display can be toggled between the battery voltage and the LPG tank level. Press the button to the right of the readout to change the display, each time the button is pressed the display will switch to the other value and will update the reading. There is no hold mode for the voltage or the LPG level. Battery voltage will be shown with a decimal point and LPG level will not.

RV-C Bus Communication:

RV-C is a communications protocol based on CAN that is used for control, coordination, and diagnostics.

NOTE: Anyone that intends on connecting to the RV-C bus should have a knowledge of the RV-C specification. For more information on RV-C protocol go to: <http://www.rv-c.com>

The sensors use a default source address of 72 and SPN-ISB instances are 0 for fresh, 1 for black, 2 for grey and 18 for galley (depending how the display is equipped). The LPG sensor uses a default source address of 73 and a SPN-ISB instance of 3.

There is a button located to the right of each of the LED displays, underneath the tank label. Use these buttons for all of the following procedures.

To display the code revision number and to display the primary/secondary status.

To set display options.

The display can be programmed to display LPG or not, depending on whether the coach is equipped with LPG. Similarly, either zero, one, or two temperatures can be displayed.

1. Press and hold the bottom button and then the top button.
2. The display will show "COd rEL 3.12 Pri/SEC Scn". This shows the code release as 3.12 and whether the display is set as primary or secondary.
3. If the buttons are released within 5 seconds, the display resumes normal operation.
4. If the buttons are held down for longer than about 5 seconds, the display shows "SEt dIS PLY OPT ion", release both buttons.
5. The display will show "tE1 tE2 LPG bAt dun". This represents the options temperature 1, temperature 2, LPG, battery voltage and done. If an option is not currently turned on it will not show.
6. Press the button next to each option to toggle it on and off. When the option is off it disappears.
7. Temperature 1 must be on for temperature 2 to be on, if only one temperature is used it must be temperature 1. The battery voltage is always on, it cannot be turned off.
8. When the correct configuration is displayed press the bottom button next to "dun" to store and exit. The displays will show "Sto" while the button is pressed to show that the settings have been stored.

To calibrate the temperature readouts to degrees F or degrees C:

Note: At least one temperature must be turned on for this menu to be accessible.

1. Press and hold the bottom button and then the third button from the top.
2. The display will show either "Set TEP F-C t-C dun" or "Set TEP F-C t-F dun" depending on whether degrees F or C is currently shown. When this occurs release the buttons.
3. To alternate between Fahrenheit and Celsius, press any of the top four buttons, each time a button is pressed the display will switch to the other temperature.
4. When the display shows the correct temperature mode, press the bottom button next to "dun" to store and exit. "Sto" will be displayed to indicate that the temperature unit has been stored.

To calibrate the display as primary or secondary:

1. This should only need to be done at the time of installation. If there are two displays connected to the senders, one must be set as primary and the other as secondary. If there is only one display, it must be set as primary.
2. Press and hold the bottom button and then the third button from the top. Continue to hold both buttons for about 5 seconds until the display shows "SEt Pri or SEC Scn". When this occurs release both buttons. The display will now show either "Pri Scn dun" or "SEC Scn dun".
3. Press the top button next to "Pri" or "SEC" to toggle between primary and secondary scanning mode. The bottom button next to "dun" will store and exit the menu, all the displays will show "Sto" until the button is released. Normal operation will then resume.
4. The LPG must be wired to the primary display only.
5. If the primary display malfunctions the secondary display will automatically take over the functions of the primary display except for the LPG level. The scan rate will be reduced as the secondary display regularly checks to see if the primary display is again operational.

To calibrate the number of senders for each tank:

1. This should only need to be done at the time of installation, there is no reason to change this afterward. Hold down the button under the applicable tank label (FRESH, GRAY, or BLACK). The display will show "HLd, then "dIA", then "AnA, and then "FrS/GrS/bLS" for Fresh/Gray/Black number of senders. This will take about 15 seconds. When this occurs release the button.

2. The display will now show "1SE/2SE" (one/two senders). These are the only two options, the display will not work with more than two senders per tank. The bottom display will show "dun".
3. To change the number of senders, press the same button, each time the button is pressed the display will store the value.
4. When the display shows the correct number of senders, press the bottom button next to "dun", this exits the menu and normal operation resumes. Each tank will need to be calibrated individually using this procedure.

To program the LED brightness:

1. If the display is to be used inside the coach, the LED brightness should be low. If it is to be used in the service bay area where sunlight can reach it, the LED brightness should be high.
2. Press and hold the bottom button and then the second button from the top, release the buttons when the display shows "Set bri UP dn dun".
3. The third button next to "UP" increases the brightness and the fourth button next to "dn" decreases the brightness.
4. The current brightness level ("b-1", "b-2", "b-3", or "b-4") will be shown while the "UP" or "dn" buttons are held, where "b-1" is the minimum brightness and "b-4" is the maximum brightness.
5. When the display shows the correct brightness, press the bottom button next to the "dun" to save the brightness level and exit the menu. When the bottom button is pressed all the displays show "Sto" to indicate the brightness level has been stored. Normal operation will then resume.

To set the CAN Temperature DSA and Instance values:

If the 714 is equipped with the optional RV-C CAN interface, the values for the 714's temperature DSA (Default Source Address) and both temperatures' Instance numbers will need to be set. It is up to the installer to determine what these numbers should be; the following instructions describe how to program those numbers into the 714.

1. Press and hold the bottom button and then the second button from the top, the display will show "Set bri UP dn dun". Continue to hold the buttons for about 5 seconds until the display shows "SEt CAN dSA InS tAn".

2. Release both buttons, the display will now show "DSA 90 UP dn dun". This is the DSA setting menu, the "90" is an example of a possible value.
3. Press the button next to "UP" to increase the DSA number, and the button next to "dn" to decrease the number. The DSA number will not go below 90 or above 93.
4. Press the button next to "dun" to store and exit, the bottom display shows "Sto" for a second, and then the Instance menu for temperature 1 appears. It shows "In1 200 UP dn dun", the "200" is an example of the Instance number for temperature 1.
5. Press the button next to "UP" to increase the instance number for temperature 1, and the button next to "dn" to decrease the number. Hold the UP/dn button to go fast. The instance number will not go below 1 or above 250.
6. Press the button next to "dun" to store and exit, the bottom display shows "Sto" for a second, and then the Instance menu for temperature 2 appears. It shows "In2 200 UP dn dun", use the same procedure as in step 5 to set the instance for temperature 2.
7. Press the button next to "dun" to store and exit, all the displays show "Sto" for a second, and then normal operation resumes.

To calibrate the LPG sender:

Note: The LPG display option must be turned on to access this menu.

1. The LPG tank must be full when the sender is calibrated, otherwise the calibration will be invalid. Fill the LPG tank by using an alternate measurement method, such as weight, a spit valve, or a mechanical gauge on the tank.
2. To calibrate, press and hold down the bottom button and then the fourth button from the top, the display will show "CAL LPG HLd 5 SEC." The seconds will count down if the buttons are held down.
3. When the countdown expires, the display shows "LEt Go to CAL LPG".
4. When this occurs release both buttons to calibrate the display to 100%. The bottom display will show "100" and the other displays will show "Sto". Calibration is now complete and normal operation resumes.

5. If either button is released before the countdown is complete, then "Abort LPG CAL" is shown. The new calibration is aborted and the existing calibration is retained. Normal operation resumes.
6. The LPG can be recalibrated as many times as desired, although recalibration should not be needed unless the LPG tank sender or the display has been replaced.

To program the 710ES 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, gray, 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 gray 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 gray tank sender, then cut out the recessed gray-black correction tab that says "**GBC**" next to it. This reverses the effect of the gray 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 dual stacked senders are used, the top sender must have additional programming, as described below.
10. Refer to the 710ES sender programming diagram.

To program the 710ES 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.

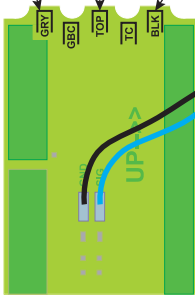
2. The senders default to single or bottom operation if the programming is not altered. Consequently, if the sender is for single or bottom operation, nothing further needs to be done to it (beyond programming it for the correct tank).
3. For a top sender, remove the tab that says "**TOP**" next to it.
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:

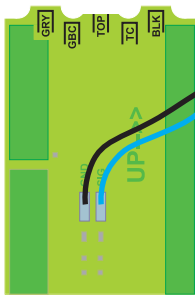
1. Since the senders are all connected in parallel to save wiring and to simplify installation, the senders must be programmed so they know which tank they are on. The senders can be programmed for either the fresh, gray, or black tank. This is done with the two tabs on the top corners of the sender. 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 gray 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

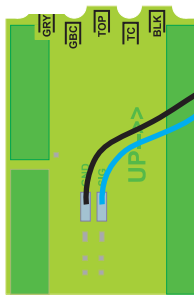
Cut for TOP sender
Cut for GRAY tank



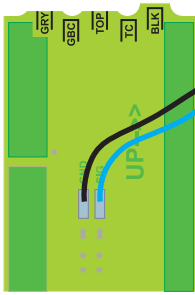
Tab cut for FRESH TOP sender programming



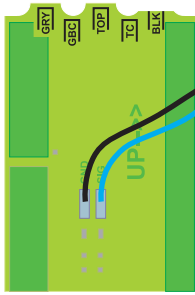
Tab cut for GRAY SINGLE or BOTTOM sender programming



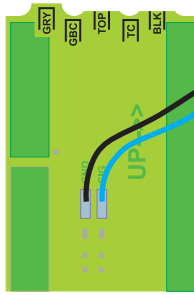
Tab cuts for GRAY TOP sender programming



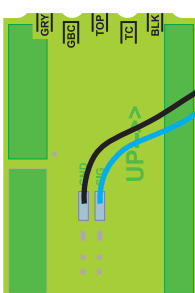
Tab cut for BLACK SINGLE or BOTTOM sender programming



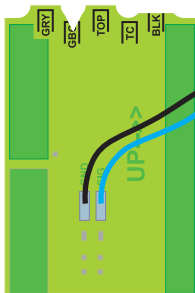
Tab cuts for BLACK TOP sender programming



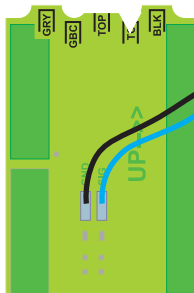
Example of corrected FRESH TOP sender programming (GRY or BLK tab cut by mistake)



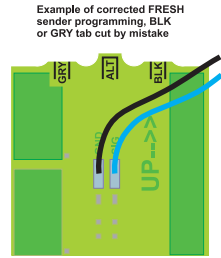
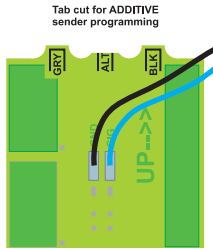
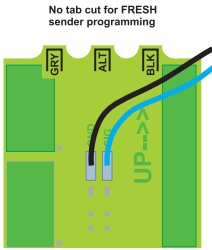
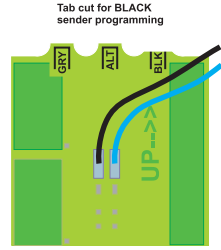
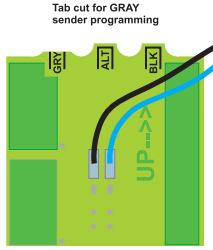
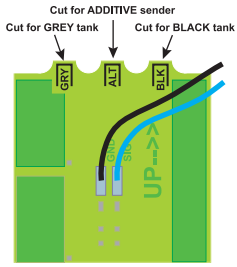
Example of corrected GRAY SINGLE or BOTTOM sender programming (BLK tab cut by mistake)



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



710ES SENDER PROGRAMING



710JS SENDER PROGRAMING

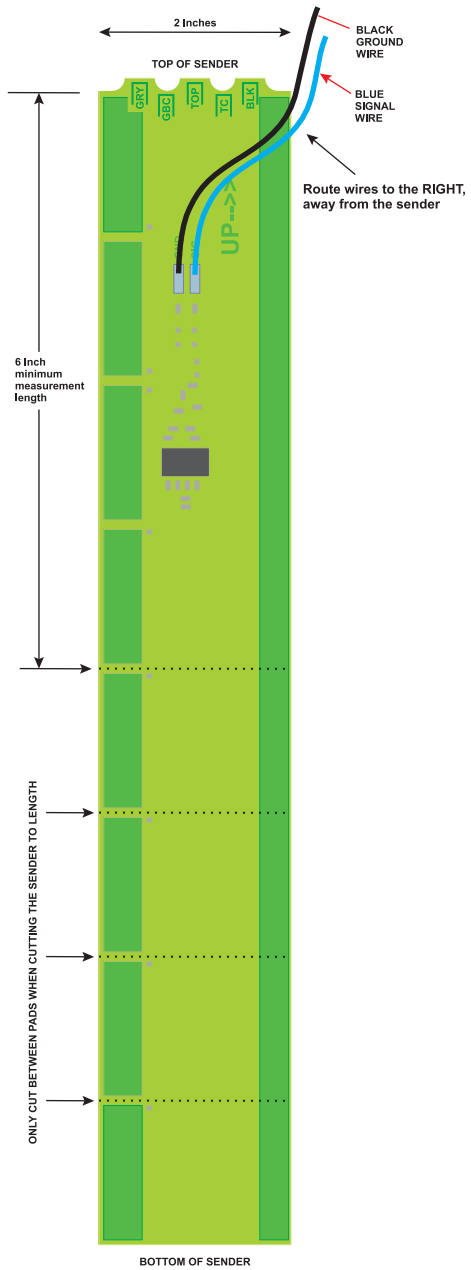
1. Please refer to the "Troubleshooting and Installation Tips" section in Chapter 7 for details on avoiding installation issues.
2. The installation consists of mounting the display inside the RV, cutting and fastening the senders to the sides of the holding tanks, connecting wiring, and programming 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 2 1/4" wide by 4 3/4" 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 sender needs 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 Color	Function
Green 22 gauge	LPG sensor
Blue 22 gauge	Tank Senders
Black 18 gauge	Ground
Red 18 gauge	+12V power input to monitor

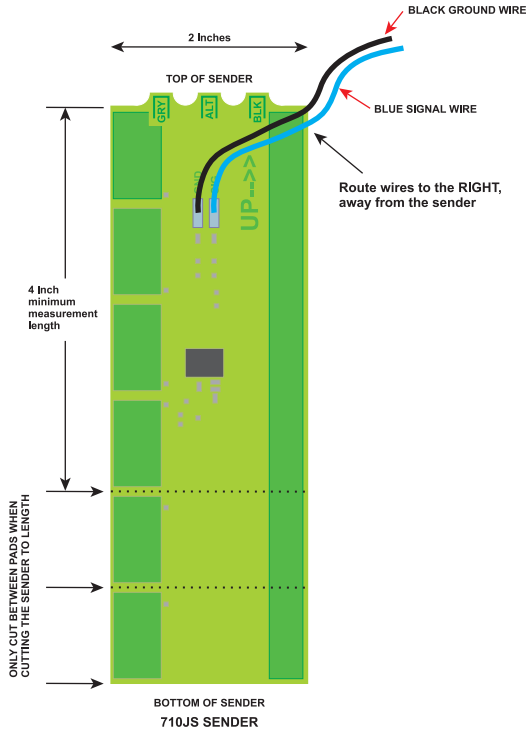
5. Determine where to mount the senders on the tanks. They will need to have a flat area on the side of the tank large enough so the whole width of the sender is in contact with the side of the tank, all the way from the top to the bottom of the tank. Make sure that any metal is at least an inch away from 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 how long the senders should be. For tanks less than 13" tall, follow step 6. For tanks greater than 13" tall, follow step 7.
7. For tanks less than 13" tall, a single sender is used. For tanks less than 7" tall a 710JS sender should be used. The sender ends should be 1/4" to 3/4" 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 ES sender is cut to the nearest even 1.5 inch in length, for example, a system with a tank height of 11.75 inches, cut the sender to be 10.5 inches long, this allows 5/8" at each end when the sender is centered vertically on the tank. The JS sender is cut to the nearest 1.0 inch in length. IMPORTANT: Do not cut the 710ES sender shorter than 4-1/2 inches! The sender will not work if it is cut less than 4-1/2 inches. Do not cut the 710JS sender shorter than 4 inches! The sender will not work if it is cut less than 4 inches.

8. For tanks greater than 13" tall, two stacked 710ES senders are used. The sender ends should be 1/4" to 3/4" 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 1/16" to 1/8" to between the two senders. Therefore total length of both senders will be: tank height -1/4"-1/4"-1/8", then rounded down to the nearest 1.5 inches. The top and bottom senders should be approximately the same length for best results. For example, if the tank height is 22", then $22" - 1/4" - 1/4" - 1/8" = 21 \frac{3}{8}"$, so the total length of both senders will be 21 inches. Make both senders 10.5" long.
9. 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). DO NOT cut the sides, and DO NOT cut the 710ES sender shorter than 4-1/2 inches or the 710JS sender shorter than 4 inches. 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.
10. 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**" and the section "To program the 710ES or 710JS sender for the correct tank" for details.
11. For two stacked sender systems, the senders need to be programmed so they know that they are being used as top or bottom senders. See the chapter entitled "**SENDER PROGRAMMING**" and the section "To program the 710ES sender as top or bottom" for details.



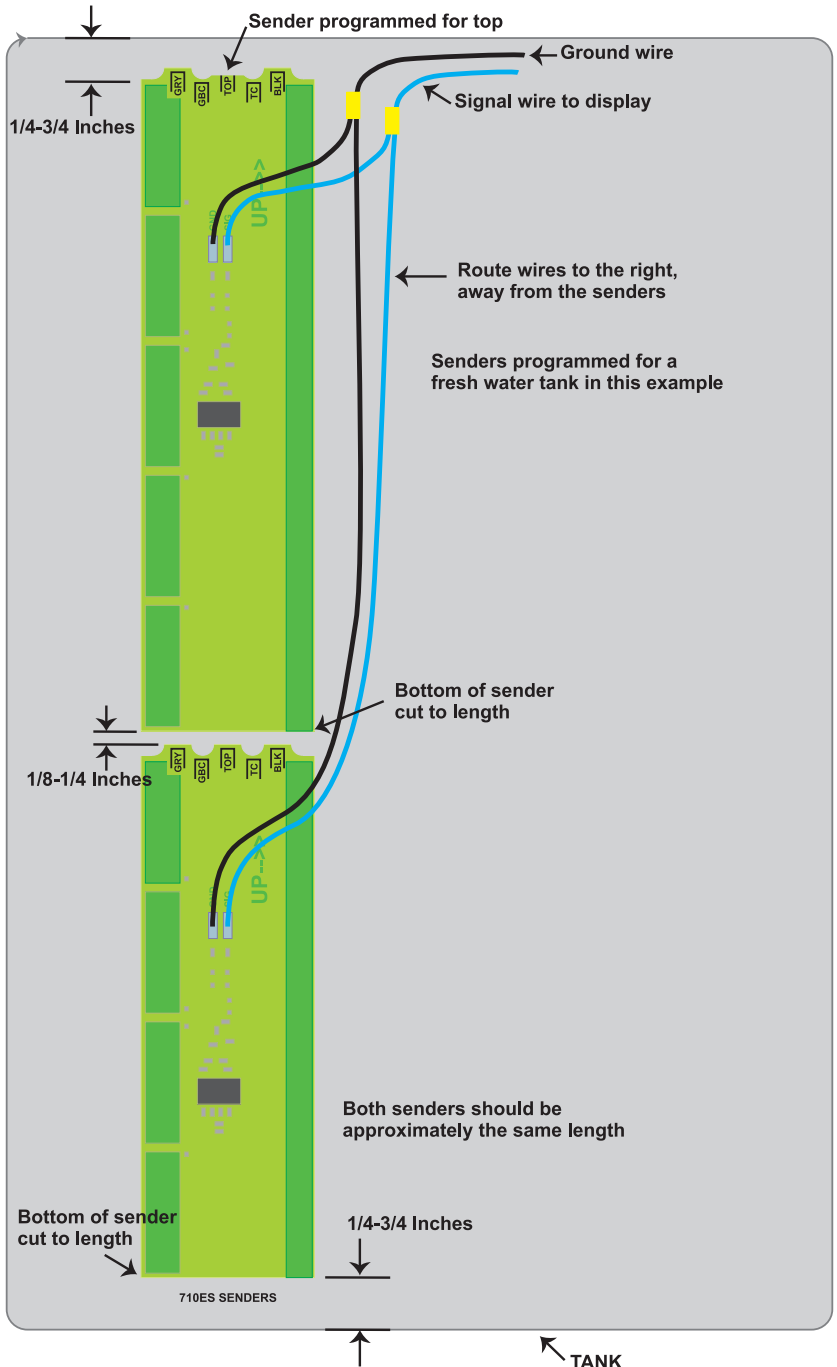
710ES SENDER



710JS SENDER

12. 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. **MAKE SURE THAT THE END WITH WIRES IS POINTING UP!!** Position the bottom of the sender at least 1/4" above the bottom of the tank, and more 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.
13. Do steps 4 to 12 for the other two holding tanks.
14. 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. 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. 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.
15. Connect the green wire from the display to the LPG tank sender. Make sure that the sender ground connection is connected back to the display ground or the breaker panel ground.
16. Mount the temperature sensors in the desired locations, making sure that they are well secured and not subject to road spray or rain. Connect the blue and black wires to the same wiring bus as the tank senders. Snip the wire loop on one of the temperature senders, this will allow the system to tell them apart, otherwise an error will result. The sensor with the cut wire will be temperature #1, and will be the one displayed without the decimal point next to it. If only one temperature sensor is used, be sure to cut the wire to make it temperature #1.

17. If equipped, connect the pump switch as required.
WARNING: 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. We recommend using a 7.5 amp fuse inline with the switch.
18. 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 one or two sender system for each tank. See the chapter entitled "**DISPLAY CALIBRATION**" and the section "**To calibrate the number of senders for each tank**" for details. Make sure you do it for each tank.
19. For the initial test, have the tank at least 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 50-60% 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 1/4 full the system will be properly "taught" and should read correctly after that.
20. Calibrate the LPG by filling the tank and following the instructions in Chapter 4 entitled "**DISPLAY CALIBRATION**" and the section "**To calibrate the LPG sender**".
21. 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.



Typical Dual Stacked 710ES Sender Installation

Display trouble codes:

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

1. If a sender is unresponsive or there is an open circuit in the wiring so that the sender is not connected, the display will indicate an open circuit by showing "OPn" on the LED display.
2. If a sender is shorted or there is a short in the wiring, the display will indicate a short circuit by showing "Sht" on the LED display.
3. If a sender is sending bad data, there is damaged wiring, or if there is electrical interference, the display will indicate a data error by showing "Err" on the LED display. Also, if the senders have not been programmed correctly, they can interfere with one another and result in "Err" on the LED display. Check all the senders to make sure they are programmed correctly. If they are, replace the sender that is creating the error.
4. If the display has been programmed for a single sender, and dual stacked senders have been connected, the display will show "StA". In this case, change the senders or reprogram the display as required. If only a top sender has been connected, the display will show "nbo", indicating that no bottom sender has been received. If the tank should only have 1 sender, correct the programming on the sender, it should not be a top sender.
5. If the display has been programmed for dual stacked senders for tall tanks, and only the bottom sender is working and the top one is not, then the display will show "ntP" indicating that no top sender is being received. If the top is working but no bottom sender is being received, then the display will show "nbo". If neither sender is working, then the display will show "OPn". Check the wiring and the programming of the senders. If all is OK with that, replace the bad sender.
6. The display contains a permanent memory which is used to store the programming for battery voltage calibration value and the tank sender signal levels. These signal levels are used to help the system adapt to the tanks, which increases sender accuracy at low tank levels. If this memory should fail, "CAL" will be flashed on the LED display, indicating a calibration failure. It will be necessary to replace the display if this occurs.

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. Note that there are no diagnostics for the battery voltage.
2. There are two diagnostics for the senders: the signal power, and the sender height.
 - a. 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% - 60%. The minimum signal power for proper operation is 20%.
 - b. The sender height is the number of receive segments present in the sender. To determine the length of the sender, multiply the calibration by 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 "HLd" initially. Continue to hold down the button, when the display shows "dIA", release the button, the display will then change to showing the signal power diagnostic. This is indicated by a "P" showing on the left digit, for example "P26" indicates a 26% signal power.
4. If the button is not pressed again, the signal power will show for about 4 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 9 inches high for an ES sender.
5. After about 4 seconds of showing the height, the display will resume normal operation.

RV-C Diagnostics:

Here is a list of the messages broadcast over the RV-C bus:

FMI (Failure Mode Identifier) Table

1	Datum value below normal range	DIS or OFF
2	Datum value erratic or invalid	Err, bot, top, ntP, nbp, or sin
5	Open circuit, or output current below normal	Opn
6	Grounded circuit, or output current above normal	Sht

TROUBLESHOOTING AND INSTALLATION TIPS

What to do if the system freezes or is unresponsive:

1. 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:

2. 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 two 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 8 in the following section for further details.

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 $\frac{3}{4}$ " 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 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:
 - a. 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.

- b. 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 inches 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 inch 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 $\frac{1}{2}$ - $\frac{3}{4}$ inch margin from the outer shell). If the sender is positioned above the vent then the maximum reading may be less than 100%.
7. 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. Be sure to support all connecting harnesses; do not let the board support the harness, this will in time cause delamination of the board from the tank.

8. 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 2 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.
9. There may be a buildup on the inside walls of black and gray tanks. We get calls occasionally about older coaches that have 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 $\frac{1}{4}$ to $\frac{1}{2}$ inch 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 $\frac{3}{8}$ inch 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 $\frac{3}{8}$ inch. 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 ¼" to ½" 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 15°C or 60°F 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. 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 2 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 ½" 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.

CHAPTER 8 - SERVICE AND WARRANTY INFORMATION

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

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 Technologies Inc.
201 M&M Ranch Road
Granbury, TX 76049
USA
email: info@garnettechnologiesinc.com

CHAPTER 9 - SPECIFICATIONS

Resolution:	ES sender: 3/8 inch (10 mm) JS sender: 1/4 inch (6 mm)
Accuracy:	+/- 8% or better, limited by resolution and tank height and shape
Temperature range:	+32 to +140°F (0 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:	ES sender: 4-1/2 to 12 inches, which will measure tank heights from 5" to 14" (single sender) and up to 26" (dual senders). JS sender: 4 to 6 inches, which will measure tank heights from 4 1/2" to 7".
Display mounting panel:	Black flush mount panel, approximately 2 3/4" wide by 5 3/4" high by 1" thick (70mm wide X 146mm high X 25mm deep). Panel screws to wall. Required cutout size is 2 1/4" wide by 4 3/4" high.
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.
Pump switch:	The pump switch is rated for a maximum of 10 amps. The use of a relay is required if more than 10 amps is needed. We recommend using a 10 amp fuse inline with the switch.
Wiring:	A single two wire conductor required from the display to the tank and temperature senders. All the senders are wired in parallel. 12 V power and ground required for display. Single wire required for LPG sender if sender grounded at tank.
LPG sender:	Display will work with an LPG sender resistance of 0-50 ohms to 0-500 ohms. Display shows increasing level as resistance increases. System must be calibrated with the LP tank full.
Temperature sensors:	Semiconductor sensor with integral A/D converter. Accuracy +/- 3 degrees Fahrenheit (+/- 1.5 degrees Celsius).

NOTES:

