SeeLevel Soul™

Data Link Module



PROTOTYPE

MODEL 708-RVC

USER MANUAL

Printed in Canada

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Data Link Module

MODEL 708-RVC

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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.

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CHAPTER 1 - OVERVIEW

The **SeeLeveL Soul™ Data Link Module** is a cost-effective solution for multiplex systems or third-party hardware on travel trailers, fifth-wheels, or motorhome coaches. The Soul Data Link Module is a concealed module that gathers data from up to seven holding tank SeeLeveL senders and a propane (LPG) tank and reports them on the RV-C bus.

The new Soul Hardware Rev. E prototype can now support up to seven water tanks compared with previous Soul Hardware Rev. B released on 2021.

SeeLeveL Soul™ will monitor the level up to seven tanks including FRESH, GREY and BLACK holding tanks as well as the battery voltage and the level of propane in the LPG tank with a third-party sensor. In addition, the system can check the operating characteristics of each of the tank sending units, giving it unsurpassed diagnostic capability.

SeeLeveL Soul™ is also able to communicate with a desktop or laptop computer. The computer USB port must be connected to the Data Link Module micro-USB port and a serial Terminal application program must be running in the host computer. This communication channel is used to set the configuration of the tanks and for troubleshooting and diagnostics information feedback.

The SeeLeveL Soul™ user interface is a command-line-based interface and consists of text command lines typed in the Terminal application program window that is running on the host computer. The Terminal application takes the typed command line and sends it as serial row of ASCII characters to the Data Link Module. The Data Link Module receives the row of ASCII characters, decodes the embedded command, verifies that it exists, and executes it returning acknowledge and response data back to the host computer as a serial row of ASCII characters.

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Sender Installation

This manual provides installation of the Data Module only. It is important to read carefully for specific instructions about your model. The installation guide for the senders is in a separate document. Manuals can be found at our online Resource Library from our website at:

http://garnetinstruments.com/holding-tanks-resource-library/

CHAPTER 2 - SYSTEM DESCRIPTION

The SeeLeveL Soul 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 Data Link Module, 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. Two different sender options are available; 710-AR and 710-ES2 and the ability to double stack the senders provide accurate level measurement for tank heights ranging from 3.5" to 26″.

> ⚠ **NOTE:** Previous sender models 710-ES, 710-JS, 710-SS can be combined with new sender models 710-AR and 710-ES2.

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The Data Link Module: The Data Link module receives the information from up to seven sender panels via a single two-conductor wire, and it computes and reports the level information data on the RV-C bus.

If a sender is operating properly and connected to the Data Link Module with good wiring, then the Data Link Module will show the level normally. If the wiring is disconnected, shorted, or cut, or if the sender panel is defective, then the Data Link Module will indicate an error code. The various error codes are shown in the troubleshooting chapter.

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 can also report in diagnostic mode the RV battery voltage by measuring the voltage which powers the Data Link Module. The voltage is reported with a resolution of 0.1 volt.

The Data Link Module can use one existing LPG electrical sensor to show the LPG tank level. It can be automatically calibrated to any sender, and reports level on the Data Link Module RV-C bus in percent of full, from 0% to 100%.

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CHAPTER 3 - OPERATING INSTRUCTIONS

The SeeLeveL Soul Data Link Module is designed to monitor and send the liquid level information read from up to seven tanks and an LPG tank continuously to the RV-C bus.

To visualize the data sent by the Data Link Module, there must be a display console in the motorhome or RV travel trailer capable of reading data from the RV-C can bus and show it to the user.

However, there is an alternative channel of communication with the Data Link Module. This channel is used for tanks configuration settings, feedback level readings and diagnostics, through a desktop or laptop computer connected to the micro-USB port. It is also necessary to have a Terminal application program running on the computer connected to the Data Link Module.

System configuration instructions are given to the Data Link Module by typing special commands in the terminal application program window. Configuration, diagnostic, and liquid levels information can also be read back in this Terminal application program window.

Operation of the Data Link Module through the terminal application program running in the computer connected to the Data Link Module can be achieved by typing special commands in the window of the terminal application program as follows.

> ⚠ **NOTE:** See Chapter 5 "User Interface" for more details on how to install and use a Terminal program application in your desktop or laptop computer.

PROTOTYPE

To read a water, sewer and LPG tank level:

Type **AT+TKLEVEL?** (in the Terminal application window) and then press the "Enter" key.

The liquid level in the currently configured tanks will be read and displayed in the computer monitor (inside the terminal application program window) as follows:

FRESH WATER TANK LEVEL IS AT 96 %

GREY WATER TANK LEVEL IS AT 25 %

BLACK WATER TANK LEVEL IS AT 11 %

LPG LEVEL IS AT 83 %

To read the Serial Number:

Type **AT+SN?** then press "**Enter**" key.
The Serial Number of this unit will be read from the flash memory and displayed on the computer monitor as follows:

DEVICE SERIAL NUMBER: 708-RVC-0003PP

To read the battery voltage:

Type **AT+BATT?** then press the "Enter" key.
The voltage read from the battery powering the data Link module will be displayed in the computer monitor with 0.1 volts precision as follows:

BATTERY VOLTAGE = 12.7

To read the current configuration of tanks:

Type **AT+TKCONFIG?** then press the "Enter" key.
The current tanks configuration of this unit will be read from the flash memory and displayed on the computer monitor as follows:

FRESH WATER TANK IS CONFIGURED TO ONE SENDER

GREY WATER TANK IS CONFIGURED TO ONE SENDER

BLACK WATER TANK IS CONFIGURED TO ONE SENDER

LPG IS CONFIGURED AND ENABLED BUT NOT CALIBRATED

PROTOTYPE

CHAPTER 4 - DATA LINK CALIBRATION

System configuration instructions are given to the Data Link Module by typing special commands in the Terminal application program window. Configuration, diagnostic, and liquid levels information can also be read back in this Terminal application program window.

To perform any calibration, diagnostic or configuration setting, the Data Link Module must be connected through its micro-USB port to a desktop or laptop computer and a Terminal application program must be running in the connected computer. Configuration, diagnostic, and liquid levels information can also be read back in this Terminal application program window.

> ⚠ **NOTE:** See Chapter 5 "User Interface" for more details on how to install and use a Terminal program application in your desktop or laptop computer.

To configure or program the number of senders for each tank:

Compared to the earlier hardware (Rev. E, Rev. H and beyond) prototype can now support up to seven water tanks compared with previous Soul Hardware (Rev. B) released in 2021. Here are updates in the User Interface Commands that allow setting up to seven water tanks, please see below the upgraded Command "**AT+TKCONFIG=f,g,b,f2,g2,b2,g3,l**" (compared with previous Soul Prototype Hardware Rev. B "AT+CONFIG=f,g,b,l").

The user can still use the old model senders' type 710s (ES, JS, etc.) combined with new sender models "710-AR" and "710-ES2".

> ⚠ **CAUTION:** To be able to connect more than 3 water tanks to Soul Prototype Hardware Rev. E, the User must use the new advanced sender types: "AR" or "ES2" which can be programmed for any type of tank from fresh, Grey, black, second fresh, second grey, second black and third grey.

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If combining sender's mode, then the Fresh, Grey and Black tanks must be connected with the senders model 710, whereas the "AR" and / or "ES2" models must be used to connect (or programmed to) to the higher id tanks, i.e. 2ND Fresh, 2ND Grey, 2ND Black and 3RD Grey.

1. To program the number of senders for each tank, the Data Link Module needs to enter the tank's configuration mode. This should only be done at the time of installation; there is no reason to change the number of senders afterward. Make sure that the number of senders programmed into the Data Link Module matches with the number of senders connected; otherwise, the Data Link Module will report an error in the RV-C bus.
2. To enter the tank's configuration mode, the Data Link Module must be connected to a desktop or laptop computer through the micro- USB port and a Terminal application program must be running in this computer.

3. To program the number of senders per tank, type command **AT+TKCONFIG=f,g,b,f2,g2,b2,g3,l** then press "**Enter**" key, where "**f**" represents the number of senders in the FRESH tank, "**g**" represents the number of senders connected to GREY tank, and "**b**" represents the number of senders connected to BLACK tank, "**f2**" represents the number of senders connected to the 2ND FRESH water tank, "**g2**" represents the number of senders connected to 2ND GREY water tank, "**b2**" represents the number of senders connected to 2ND BLACK water, and "**g3**" represents the number of senders connected to 3RD GREY water tank.
    - Typing number "**0**" means no tank for this liquid type, number "**1**"means one sender in this tank, and number "**2**" means two senders (stacked senders) in this tank.
    - Finally, "**l**" represents the number of active LPG tanks where "**0**" means no LPG tanks active in this system, "**1**" means only one LPG tank is active and this tank is LPG.
4. For example, command **AT+TKCONIG=2,1,1,1,2,1,0** means that two senders are programmed for the Fresh tank, one sender for the Grey tank, the Black tank, and the 2ND Fresh tank, then two senders on the 2ND Grey tank, one sender on the 2ND Black tank and that there is no (zero) 3RD Grey tank connected to this Soul device and that there is one LPG tank active in this system.

For example to setup SeeLeveL Soul for 4 water tanks and one LPG tank:

1. Fresh (with top and bottom senders) ,
2. Grey (only one sender),
3. Black (only one sender),
4. Grey2 (with top and bottom senders)

User must write following command in the serial Terminal (for example Tera-Term):

AT+TKCONFIG=2,1,1,0,2,0,0,1

When writing the command user must fill all 8 parameters that represent tank positions,

- if a tank is not configured then put "0" in its position
- if a tank is configured with one sender then put "1" in its corresponding position
- if a tank is configured with two senders then put "2" in its corresponding position

Please see below command format:

AT+TKCONFIG=f,g,b,f2,g2,b2,g3,l ---- set system tanks configuration
---- **f:**fresh, g:grey, **b:**black, **f2**:2nd fresh, **g2:** 2nd grey
---- **b2:**2nd black, **g3:**3rd grey, **l:**number of LPG tanks…..

PROTOTYPE

To calibrate an LPG sender:

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 the LPG tank number one, type command **AT+LPGCAL=1** then press Enter key. The Data Link Module will respond with an acknowledge message displayed in the Terminal application program window. If successful then the following message will be displayed in the Terminal application window:

   LPG CALIBRATION SUCCESSFUL

To enable/disable the LPG senders and/or water tank senders:

The LPG tanks or the water tanks cannot currently be independently disabled once the Data Link Module has been configured without affecting the configuration of the other tanks.

> ⚠ **NOTE:** This is a temporary nuisance. A new command AT+TKENABLE will be added to next firmware revision. This command will allow independently enable/disable of any tank without losing LPG calibration.

The LPG or water tank senders can only be disabled by re-issuing the tank's configuration command with the appropriated combination of parameters. This action will effectively re-configure all tanks again and then a re-calibration of the standing LPG tank must be performed.

To check the software revision:

1. Software updates may be periodically released to add features. To check the software version of the Data Link Module, use the following procedure.
2. Type command **AT+DIAG?** then press "**Enter**" key. The diagnostics information for this Data Link Module is displayed in the window of the Terminal application program showing in the second line (typically all diagnostics information is contained in 8 lines) the software revision number as follows:

   FIRMWARE REVISION NUMBER: rev 4.3.4

3. For more details on command **AT+DIAG?** please refer to section **"The diagnostics can be used to check the wiring and the senders"** in Chapter 7.

PROTOTYPE

CHAPTER 5 - USER INTERFACE

The SeeLevel Soul User Interface is a command-line-based user interface that consists of text-based command lines typed in a Terminal application program window that is running in a host desktop or laptop computer connected to the micro-USB port of the Data Link Module. The User Interface commands start with the letter sequence "**AT**" followed by a plus sign (+) and the name of the command that will be executed and ending by pressing the "**Enter**" key.

The Terminal application takes the typed command line and sends it as a serial row of ASCII characters to the Data Link Module. The Data Link Module receives the row of ASCII characters, decodes the embedded command, verifies that it exists, and executes it, and returning acknowledge and response data back to the host computer as a serial row of ASCII characters.

User Interface requirements

1. A desktop or laptop computer with a Serial Terminal Console application program installed on it, we recommend "Tera Term" which is a widely known and free Serial Terminal Application program for desktop and laptop computers.
2. Connect the host computer USB port to the micro-USB port in the Data Link Module.
3. The Terminal Console Application must be configured for serial communication with following settings: transmission speed of "115,200" bauds, size of the data characters to "8" bits, the number of stop bits to "1" and parity type to "N".
4. The Console Application in the PC should be configured as a Terminal with feedback of the typed characters in the screen window to make it easier for the user to work with it.
5. If a serial Terminal application program is not available on the host computer, then we recommend "Tera Term" which is a free Serial Terminal Application program for desktop and laptop computers.
6. For details on how to proceed with the "Tera Term" Terminal application installation and configuration settings see section **"To download and install "Tera Term" Terminal application"**.

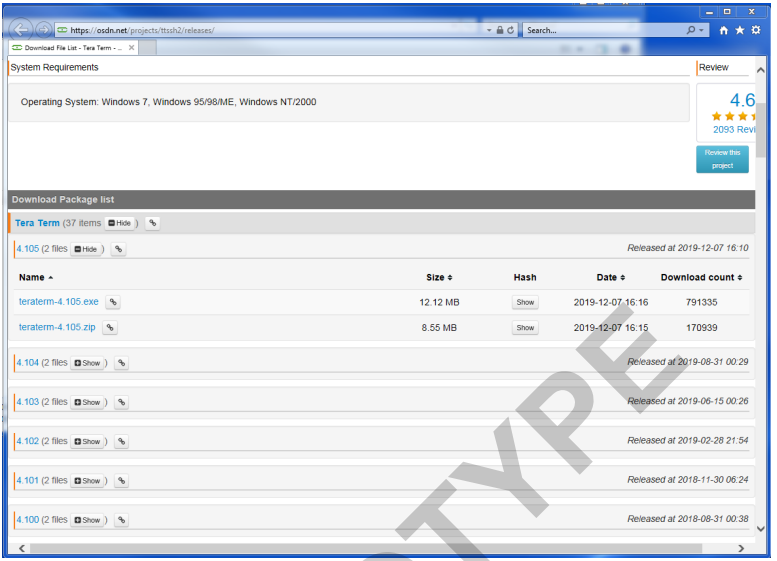
PROTOTYPE

Commands	Description
AT+TKCONFIG?	Display the tank's configuration.
AT+TKCONFIG=f,g, b,f2,g2,b2,g3,l	Set tanks configuration: '**f**' is **Fresh** water tank, '**f2**' is 2nd Fresh '**g**' is **Grey** water tank, '**g2**' is 2nd Grey '**b**' is **Black** water tank, '**b2**' is 2nd black '**g3**' is 3rd Grey '**l**' is **LPG** tank Valid values for **f,g,b, f2, g2, b2,g3** are: **0** = no tank **1** = One Sender **2** = Two Senders Valid values for '**l**' are: **0** = No LPG **1** = One LPG
AT+LPGCAL?	Display calibration status of **LPG** tanks.
AT+LPGCAL=lpg	Set calibration for LPG tank. Valid values for '**lpg**': **1** = LPG will be calibrated
AT+TKLEVEL?	Display the liquid level read from all configured tanks, including the LPG tanks.
AT+BATT?	Display the system input voltage value.
AT+DIAG?	Displays diagnostics information: **Serial Number**, **Firmware Revision**, **Input Voltage**, **Height** and **Signal Power** per Sender If no Error was detected otherwise the **Error Code** detected on that Sender.
AT+SN?	Display this Unit Serial Number.
AT+CLEAR?	Clears the screen.
AT+HELP?	Displays summary of all available AT commands and what they do.

PROTOTYPE

To download and install "Tera Term" Terminal application

1. Go to website "https://osdn.net/projects/ttssh2/releases/".



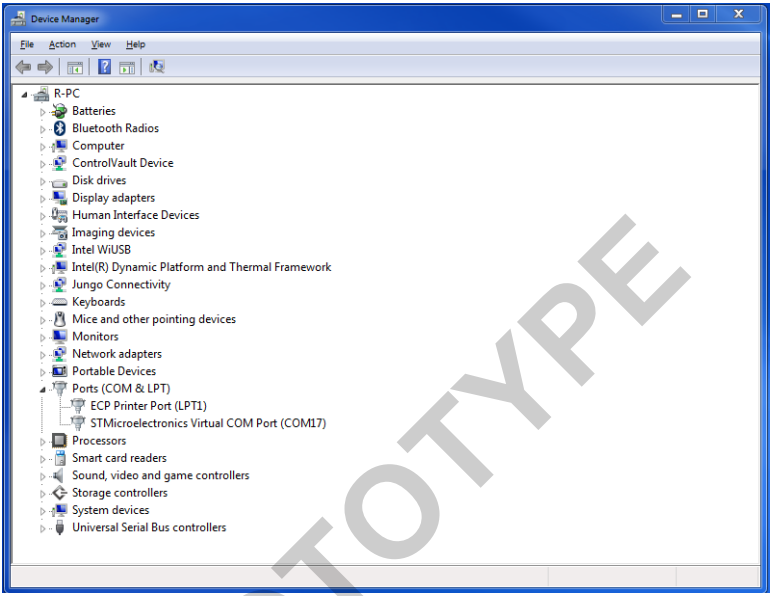
2. Click on .exe file "**teraterm-4.105.exe**", the download of this file will automatically start.
3. Once the download is completed, "double click" on the downloaded file and the automatic installation of Tera Term in the host computer will be executed.
4. Once the installation has completed an icon in the host computer desktop with a shortcut to "Tera Term" Terminal application program.

To connect Data Link Module to Terminal application:

1. The Data Link Module uses a USB to micro-USB serial cable to connect to your computer. Once the driver is successfully installed and the serial port cable is connected, a new serial port displays among the other ports in the windows "device manager" list (note that "device manager" is an application that is part of the operating system of the host computer, and it should be launched to check the serial ports connected to the host computer).
2. After the cable is connected to your Data Link Module to either a desktop or laptop computer's USB ports and the device is powered on, the serial port will open and Windows will automatically install the virtual serial port driver if necessary.

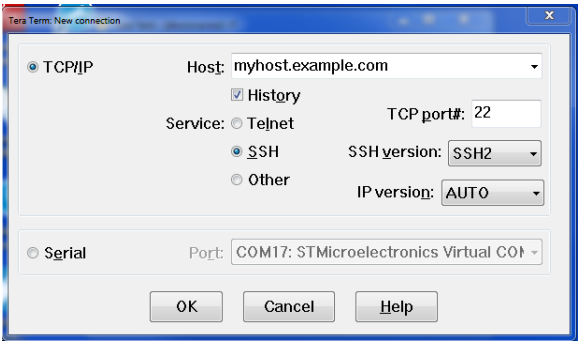
PROTOTYPE

3. To ensure the presence of the virtual serial port and the exact serial port number created by Windows, you need to check the computer “device manager”. Inside “device manager” window then click on the icon called “Ports (COM & LPT)” to expand it and look for the newest “Virtual COM Port” that showed up just after connecting the USB cable to Data Link Module, see in Figure below:

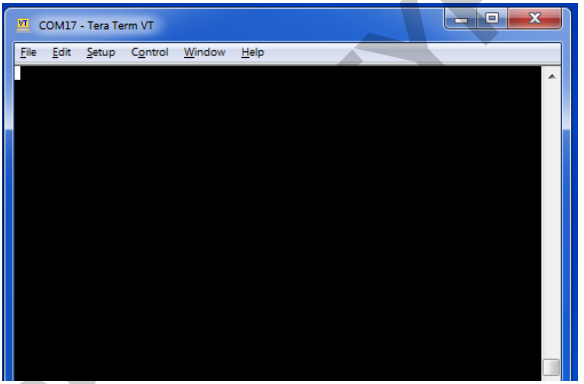


PROTOTYPE

4. In the example picture above the newest serial port’s full name is “STMicroelectronics Virtual COM Port (COM17)” but the name of this port could be different depending on the operating system in the computer being used. The most important is to remember the number of the port in between parenthesis, i.e. in this example port number is “COM17”. This is the serial port number that needs to be set as the communication port in configuration parameters of the Terminal application program “Tera Term” (see step 6).
5. To open “Tera Term” Terminal application, double click on the “Tera Term” shortcut showing in the host computer desktop. “Tera Term” window opens indicating that Terminal is now active but the serial communication port needs to be configured to match the communications parameters expected by the Data Link Module. See picture below:



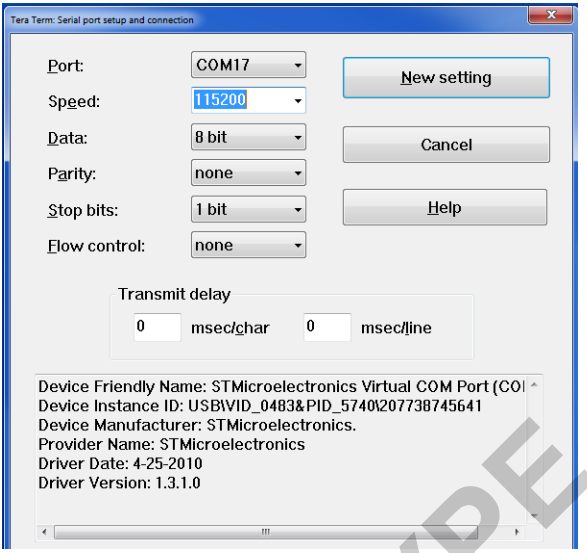
6. Click the ‘Serial” choice button, and expand the dropdown menu box beside it, called “Port:”, in the expanded list look for the COM port number selected in the “device manager” (see step 4 above) and select it, then click OK button and this window will close and the “Tera Term” main window will open automatically. See picture below:



To configure “Tera Term” communication parameters:

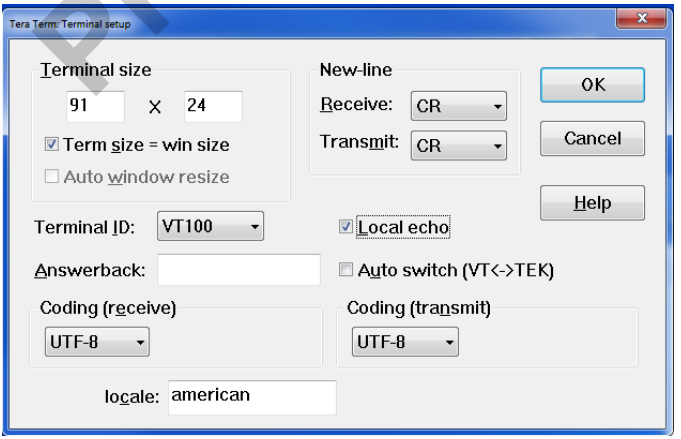
1. To open the serial port configuration window, click in the menu item called “Setup” on the top menu bar in the Tera Term main window (see above picture of Tera Term main window in step 6 of section “**To connect Data Link Module to Terminal application**”). In the dropdown items list that opens, select item “Serial port…” and the “serial port setup and connection” window will open.
2. Once the “serial port setup and connection” window is opened (see below picture) then select 115200 in the “Speed:” dropdown list box. Make sure that the “Data:” dropdown list box says “8 bit”, the “Parity:” dropdown list box says “none”, the “Stop bits:” dropdown list box says “1 bit”, and the “Flow control:” dropdown list box says “none”. Finally, click “New setting” button to confirm selections. The windows then will close and the main Tera Term window will show up again.

PROTOTYPE

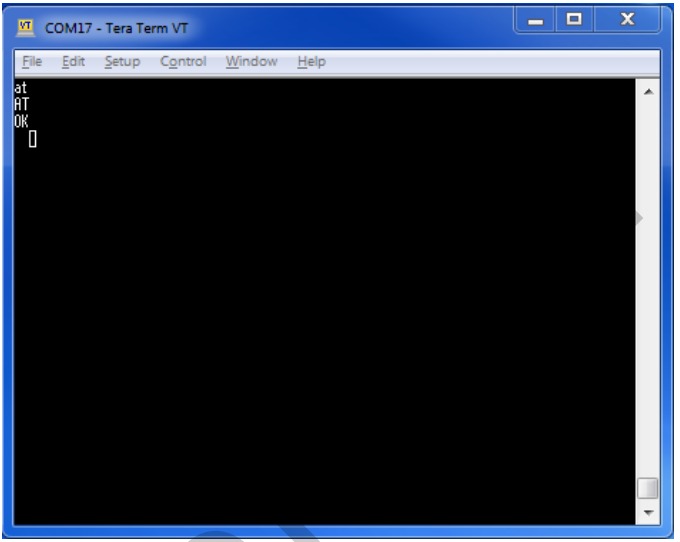


3. To select feedback (echoing) of any characters typed, click again in the menu item called “Setup” on the top menu bar in the Tera Term main window (see above picture of Tera Term main window in step 6 of section “**To connect Data Link Module to Terminal application**”). In the dropdown items list that opens, select item “Terminal…” and the “Terminal setup” window will open.
4. Once the “Terminal setup” window is opened (see below picture) then click on choice selection box called “Local echo” and then click OK button to confirm the setting. The windows then will close and the main Tera Term window will show up again.

PROTOTYPE



5. The Tera Term main window is shown again meaning that Tera Term is ready to accept command lines and send them to Data Link Module as soon as the "**Enter**" is pressed.
6. To check that Data Link Module is listening, simply type "at" and then press "**Enter**" key. The response from the Data Link Module is two consecutive lines: "AT" and "OK" shown in the Tera Term window see below picture.



7. Once Tera Term has been configured, then your host computer is ready to setup the tanks configuration and/or diagnostics feedback information can be gathered from Data Link Module through the User Interface commands described in section "**User Interface commands**" in Chapter 5.

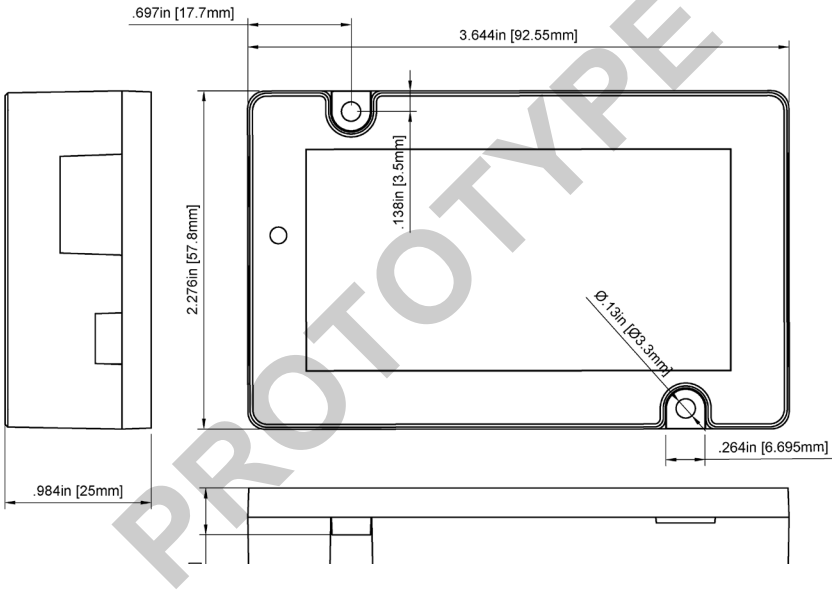
PROTOTYPE

CHAPTER 6 - INSTALLATION GUIDE

The installation consists of mounting the module inside the wall in 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.

Mounting the Module

The drawing below gives dimension data of the device box and can be used for locating the holes for mounting screws on the wall.



PROTOTYPE

Connect the wiring according to the following table. It is easier to connect the wiring to the Data Link Module connector first, and then plug the connector into the Data Link Module panel. The senders need to be grounded to a single ground wire from the Data Link Module. Make sure that the system ground is connected to the breaker panel ground.

> ⚠ **CAUTION:** Please refer to the "Troubleshooting and Installation Tips" section in Chapter 7 for details on avoiding installation issues.

Connectors:

It is easier to connect the wiring to the display connector first, and then plug the connector into the display panel. The device has two basic connectors, STR9 and micro-USB, and an optional RV-C CAN connector. Make sure that the system ground is connected to the breaker panel ground.

STR9 Connector: is providing Power, Ground, Sender, LPG, and CAN Bus connections. A pigtail cable assembly with 12" AWG18 wires is included. The micro-USB connector is being used to connect the device to a computer for programming and configuration purposes. A standard micro-USB cable can be used.



PROTOTYPE

Wire Colours on STR9 Connector

Wire Color	Function
Red 18 gauge	+12V DC Main Power
Blue 18 gauge	Senders
Green 18 gauge	LPG
Purple 18 gauge	CAN-Hi
Yellow 18 gauge	CAN-Lo
Black 18 gauge	Ground

Micro USB: For programming and configuration using Tera Term application.

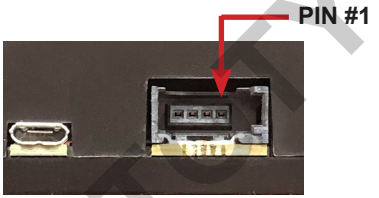


RV-C CAN Connector: provides an extra CAN BUS connection. This connector will be added if ordered.

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

The sensors use a default source address of 72 and SPN-ISB instances are 0 for fresh, 1 for black, 2 for grey. If more than one tank of any instance is configured in the system, then SPN-ISB instance for the second item will be reported with a shift of 16 from the previous. For example: for the first fresh tank SPN-ISB instance will be 0 but for the second fresh tank it will be 16 and for the third tank 32 and so on. The same procedure applies to the sewer types grey and black. The LPG sensor use the default source address of 73 and SPN-ISB instances 3 and 19.

1. By disabling the LPG or changing the FRESH/GREY/BLACK to zero senders, you are disabling that sender's updates over the RV-C bus as well.
2. The RV-C has a 4-pin connector as shown below.



PROTOTYPE

RV-C CAN Connector

Pin Number	Signal Description
1	CAN-Hi
2	CAN-Lo

Sender Installation

This manual provides installation of the Data Module only. It is important to read carefully for specific instructions about your model. The installation guide for the senders is in a separate document. Manuals can be found at our online Resource Library from our website.

CHAPTER 7 - TROUBLESHOOTING GUIDE

If a sender or its wiring is not operating properly, the following codes will be shown in the Terminal window app in response to command **AT+DIAG?** (See below):

CODE	POSSIBLE CAUSE	SOLUTION
Opn: Open Circuit	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.
Sht: Short Circuit	A sender is shorted or there is a short in the wiring.	See "Wiring Diagnostics" section.
Err: Sending Bad Data	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.
StA: Double-Stacked Sender	The Data Link Module has been programmed for a single sender where double-stacked senders have been connected. The Data Link Module has not be set to look for two senders	Change the senders or reprogram the Data Link Module as required.
ntP: No Top Sender **nbo: No Bottom Sender**	1. The Data Link Module has been programmed for a single sender and double-stacked senders have been connected. 2. The Data Link Module has been programmed for double-stacked senders and one of these error codes are showing: • ntP - only the bottom sender is reporting. • nbo - only the top sender is reporting.	Correct the programming on the sender.
For LPG only **OPn: Open Circuit**	The only LPG diagnostic code is the open circuit. If the wiring to the LPG sender is shorted then the LPG will always show "O".	

PROTOTYPE

Wiring Diagnositcs

1. To perform diagnostic, the Data Link Module must be connected through its Micro-USB port to a desktop or laptop computer and a Terminal application program must be running in the connected computer. Configuration, diagnostic, and liquid levels information can also be read back in this Terminal application program window.
2. To issue the diagnostic command, type **AT+DIAG?** then press "**Enter**" key. The Data Link Module will display diagnostic information in the Terminal application program window as follows:

   DEVICE SERIAL NUMBER: 708-RVC-0001PP

   FIRMWARE REVISION NUMBER: rev4.3.4

   BATTERY VOLTAGE = 12.8

   FRESH SENDER IS 7 PADS HIGH, SIGNAL POWER IS AT 57 PERCENT

   GREY SENDER IS IN ERROR STATE, StA: Double-Stacked Sender
   BLACK SENDER IS 7 PADS HIGH, SIGNAL POWER IS AT 100 PERCENT

   LPG IS IN ERROR STATE, CAL: Out of Calibration

   OK

3. 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 Data Link Module, the short indication should go away. If it doesn't, the Data Link Module is bad.
4. If an open circuit for all the senders is showing, it is most likely a wiring open circuit or Data Link Module failure, since it is unlikely that all three senders are bad. Try shorting the wiring together at the Data Link Module, the Data Link Module should indicate a short circuit on the RV-C bus. If it doesn't, the Data Link Module 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 Data Link Module does show a short circuit, then the senders must be bad.
5. 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 Data Link Module, the wiring to that sender is open.

PROTOTYPE

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. To review the sender diagnostics, the Data Link Module must be connected, through its Micro-USB port, to a desktop or laptop computer USB port, a Terminal application program must be running in the computer and command **AT+DIAG?** must be typed in the Terminal application window, for more details on this command see above section "**The diagnostics can be used to check the wiring and the senders"**.
3. 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.
4. To check the diagnostics, type command "**AT+DIAG?**" in Terminal application window that is running in a PC previously connected to the micro-USB port of the Data Link Module (See Chapter 5 for more details on User Interface activation and available commands).
5. The signal power and the sender height of each configured tank will be displayed in the Terminal application window, one line per tank up to a maximum of three consecutive lines (Fresh, Black and Grey). For example, for the case of two configured tanks only with no errors detected, the screen will display:

   FRESH SENDER IS 7 PADS HIGH, SIGNAL POWER IS AT 56 PERCENT

   GREY SENDER IS 8 PADS HIGH, SIGNAL POWER IS AT 95 PERCENT

PROTOTYPE

6. If there was a configured tank with a sender in an error condition, then the corresponding display line will show the name of the tank and the detected error condition. For example, for the case of three configured tanks but an open circuit error condition in Grey tank sender, the screen will display:

   FRESH SENDER IS 7 PADS HIGH, SIGNAL POWER IS AT 56 PERCENT

   GREY SENDER IS IN ERROR STATE, OPn: Open Circuit

   BLACK SENDER IS 7 PADS HIGH, SIGNAL POWER IS AT 87 PERCENT

PROTOTYPE

RV-C Diagnostics:

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

FMI (Failure Mode Identifier) Table

Error ID	RV-C Protocol Error Description	Soul internal Error Description	Possible cause	Suggested Solution
0	Datum value above normal range	**Nbo**. No Bottom Sender	No bottom sender. Soul has been programmed for double-stacked senders and one of these error codes are showing: but only the top sender is working, and the bottom sender is not.	Correct the programming on the sender.
1	Datum value below normal range	**ntP**. No Top Sender	No Top Sender. No bottom sender. Soul has been programmed for double-stacked senders and one of these error codes are showing: but only the bottom sender is working, and the top sender is not.	Correct the programming on the sender.
2	Datum value erratic or invalid	**Err**. Sender sending bad data.	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.
5	Open circuit, or output current below normal	**Opn**. Sender is not sending data	1. A sender is unresponsive. 2. There is an open circuit in the wiring, so the sender is not connected.	Check sender wiring or replace unresponsive sender
6	Grounded circuit, or output current above normal	**Sht**.	A sender is shorted or there is a short in the wiring.	Check sender wiring or replace shorted sender.
13	Calibration required (only for LPG tanks)	**CAL**.	LPG tank level sensor needs to be calibrated by Soul input circuit	Calibrate LPG tank
15	Datum valid but above normal operational range (least severe)	**StA**. stacked error	Soul has been programmed for a single sender where double-stacked senders have been connected. Soul has not been set to look for two senders.	Correct Soul configuration programming or disconnect top sender

PROTOTYPE

TROUBLESHOOTING AND INSTALLATION TIPS

What to do if the system freezes or is unresponsive:

1. If the Data Link Module 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:

1. 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 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 ¼” to ½” 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 ½” 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).

PROTOTYPE

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

PROTOTYPE

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 be 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 ⅜“ 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 crosscheck 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 ⅜“. 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 that 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 from the tank. 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.

PROTOTYPE

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 Data Link Module when mounting:

1. If mounting the Data Link Module 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 Data Link Module 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 Data Link Module. Make sure that the cutout is large enough so that the Data Link Module can be easily inserted without having to angle it. There is a ½" border all around the Data Link Module 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 Data Link Module.
2. When fastening the Data Link Module 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 Data Link Module. Contact Garnet for further details.

PROTOTYPE

CHAPTER 8 - SPECIFICATIONS

Resolution:	710-AR sender: ¼" (6 mm) 710-ES2 sender: ⅜"(10 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:	710-AR sender: 3" to 9", which will measure tank heights from 3.5" to 10.5" (single sender) and up to 19.5" (dual senders) 710-ES2 sender: 4" to 12", which will measure tank heights from 5.5" to 14" (single sender) and up to 26" (dual senders).
Data Link Module:	Size: 3.65" wide x 2.28" high x 0.98" deep (92.7 mm wide x 57.8 mm high x 25 mm deep) Enclosure mounts to the wall with screws.
System power requirements:	Data Module 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 Data Link Module to the senders. All the senders are wired in parallel. 12 V power and ground required for Data Link Module. A separate two-wire conductor required from the Data Link Module to the LPG sender.
LPG:	Data Link Module will work with an LPG sender with a maximum resistance of 50 ohms to 250 ohms. Display Data Link Module shows increasing level as resistance increases. System must be calibrated with the LPG tank full.

PROTOTYPE

CHAPTER 9 - SERVICE AND WARRANTY INFORMATION

DISCLAIMER OF WARRANTY ON HARDWARE

Garnet Instruments 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, 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
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

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