Technical Reference

Second Revision
October 2021

Welcome to Silverleaf Electronics!

The information contained herein is intended to be a primer and is by no means exhaustive. Because of the scope of the industry – equipment, software revisions, wiring schemes, OEM options, and scores of other topics – the amount of knowledge relevant to a Silverleaf owner cannot possibly be contained in a single document. Because the industry is always changing, and because differences occur even among similar coach models, the information in this reference should not be assumed to be completely accurate for each coach. Studying the included data, however, is a means by which a technician or coach owner may quickly learn a large number of concepts that will be helpful for for diagnosis and use of Silverleaf and connected equipment.

This document does not qualify a person to service the systems described herein. Service should be conducted by a qualified technician. Silverleaf assumes no responsibility for damage to property or injury sustained during diagnosis or service.

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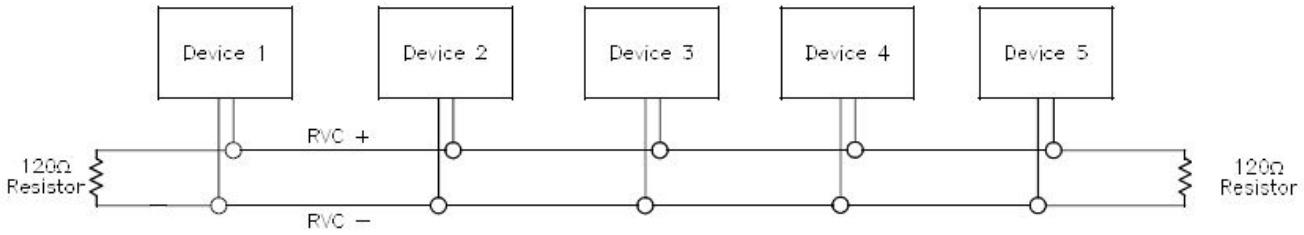
COACH SYSTEMS

1.1 The RV-C Network

Overview

Today's coaches have numerous active systems monitoring and controlling various functions and interacting with each other. Typically, there is no centralized control module, but a network of modules exchanging data, much like a computer network. This “RV-C” network is based on a protocol called “CAN,” or “Controller Area Network.” CAN networking is used in almost every automobile today.

An RV-C Network is a specialized CAN network comprised of a twisted pair of wires that are terminated at each end by 120 Ohm resistors. Only two terminating resistors are used for the whole network. Each device is then connected to the twisted pair at some point between the terminating resistors. Digital messages and commands are broadcast throughout the network, and devices on the network are programmed to listen for and respond to the commands, then perform a task.



Motor Vehicle Network Protocols

J1708

In the 1990's the SAE established a standard network format for heavy duty trucks. J1708 emerged as the standard for the physical layer (wiring) which eventually included the 6-pin Deutsch connector for diagnostic access, and J1587, the data format. J1708 is defined as an 18 gauge twisted pair up to 130 feet with a data transmission speed of 9600 bits/s. It is half-duplex RS485. In half-duplex systems, two devices on the network can both send and receive messages, but devices cannot receive and send at the same time, much like two-way radios. A full duplex network would function more like a cell phone; both devices can listen and transmit at the same time.

6-Pin Diagnostic Plug

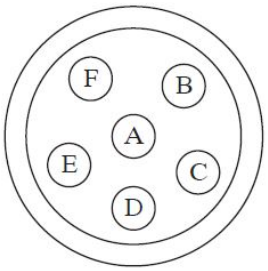
A	J1708 +	D	---
B	J1708 -	E	Ground
C	Power	F	---

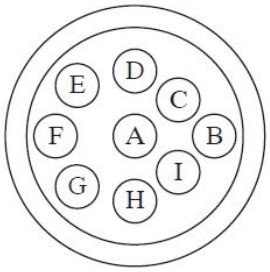
9-Pin Diagnostic Plug

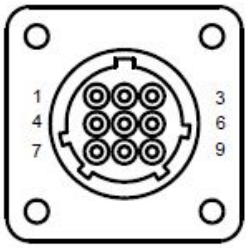
A	Ground	F	J1708 +
B	Power	G	J1708 -
C	J1939 +	H	Diagnostic Can +
D	J1939 -	I	Diagnostic Can -
E	---		

RV-C Diagnostic Plug
(Video connections are for SLE internal use)

1	Power	6	---
2	---	7	---
3	(Video Signal)	8	RV-C +
4	(Video Shield)	9	RV-C -
5	Ground		







Pin Side View (Front)

J1939

As the need grew for faster transmission speeds, J1708 was replaced with J1939, a CAN-based network with a standard baud rate of 250 Kbit/s. A new 9-pin Deutsch connector for diagnostic ports was also standardized. This new plug has pins for both J1939 and J1708. Unlike J1708, J1939 uses terminating resistors at each end of the network. J1939 also allows for much longer messages (1785 bytes vs 21 bytes in J1708).

Terminating Resistors.

Terminating resistors are added to certain network standards as a way to eliminate signal reflections, increasing transmission speeds. As stated in the RVIA standards, the RV-C network must have two 120 Ohm resistors, no less, no more. Each coach should be checked for compliance by the coach builder, but it is not uncommon for a coach to be built with one or even multiple extra resistors. This is often the result of peripheral equipment, such as an RV-C entertainment system or push-button ignition module having a built-in terminating resistor. The result is that messages are not reliably propagated from one end of the network to the other because the voltage differential (seen as 1's and 0's) deteriorates before it reaches the other end.

Additional information can be found in section 5.4.

TROUBLESHOOTING:

When troubleshooting a problem with the network, it is often necessary for the technician to measure the impedance across the network. This must be done with the entire RV-C network un-powered. Otherwise, data packets propagating through the network will make it impossible to get a clear measurement. It is not enough to use the house battery disconnect, since this only removes power from certain appliances. The coach must be unplugged from shore power, the generator turned off, and both battery banks disconnected. Even with these conditions met, there are sometimes additional wires delivering power from one of the battery banks, so it is best to verify that power has been removed by taking a measurement at both main terminals of the Charge Bridge / Boost Solenoid with a volt meter.

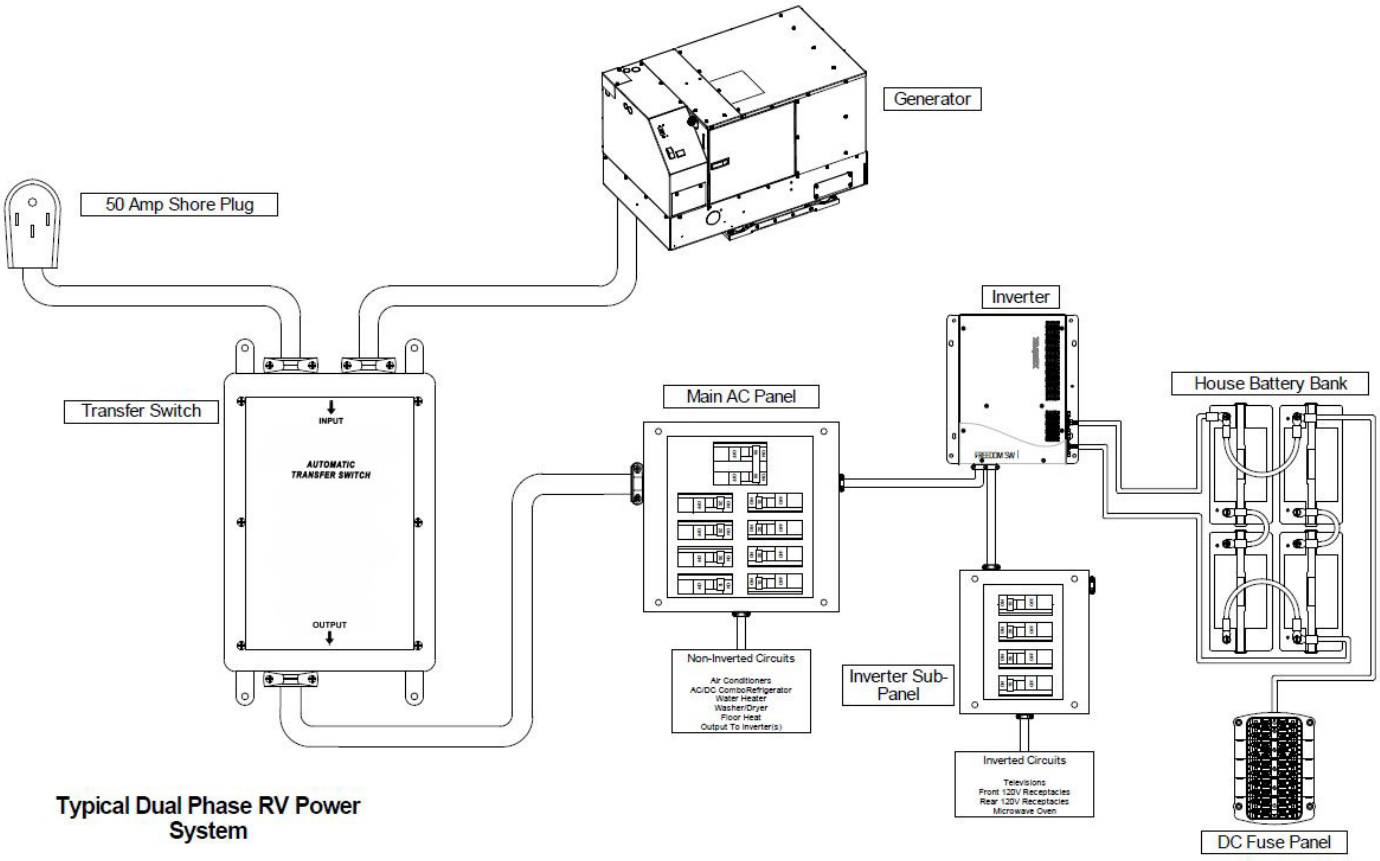
1.2 Power Systems

Overview

An RV has two main power sources feeding the batteries: shore power and the generator. When neither is available, power for both house side and chassis side appliances and devices comes from their respective battery banks. Since there are AC appliances, an inverter is required to convert DC battery power to usable AC power. Charging the batteries from AC sources again makes use of the inverter.

Residential AC voltage comes in from the shore cord or the generator to the transfer switch. When the power is first received, the transfer switch “qualifies” the power, checking for proper voltage and frequency before delivering it to the rest of the system. This usually takes a few seconds. Once the power is qualified, the transfer switch closes mechanical contacts, connecting the power source to the main AC panel. From here, power is split, some going to the breakers in the main panel, which will power various house appliances, and some going to the inverter.

From the inverter, power is again split, some going to a secondary breaker panel, which supplies voltage to appliances that must remain powered when generator or shore power is not available. This usually includes the refrigerator, though in less expensive coaches, the refrigerator may be an AC/DC refrigerator that primarily runs off of the main breaker panel and alternatively may be powered from a DC source (battery).



Typical Dual Phase RV Power System

When power is coming in from the generator or shore cord, the inverter converts AC to DC to charge the batteries and supply power to the DC systems. When no incoming AC is available, the inverter converts DC to AC to power any appliances connected to the secondary AC breaker panel.

Shore Cord

The shore cord is a four conductor AC cord that brings residential power into the coach from either a 30 amp or, preferably, 50 amp outlet. At the end of the cord opposite the outlet, the shore cord is connected to a power reel, which coils up the cord for storage. The cord is bolted to high current electrical contacts on the reel, which are then connected to a set of rings and wiper contacts, allowing power to pass through the power reel no matter where it stops in its rotation.

The rings and wiper contacts – even the cord itself – can be a source of problems as they age. Often, when unknown or incongruous errors related to the transfer switch or inverter appear at the panel it is a result of a poor connection somewhere in the shore power assembly. A worn contact, broken wire, or loose connection can all cause similar faults. A tell-tale sign of this scenario is an illogical shift in current draw. Logically, when one of the two AC legs has a heavy load it will see a slight decrease in voltage. This is usually a few tenths of a volt. When the wiring is faulty, we might instead see the voltage on the loaded leg rise while the unloaded leg falls. This is because a poor connection is allowing one leg to rob current from the other leg.

Troubleshooting:

- When the technician measures the incoming voltages at the plug, are they the same voltages that the transfer switch is reporting? If not, there is a bad connection in the shore cord assembly.

- If the above situation exists, measuring the resistance on each conductor from the plug to the transfer switch, then working backwards can help identify the location of the fault. If there is no fault in the shore cord assembly, there may be a problem with the house wiring. A loose residential neutral wire has been observed to cause very similar symptoms.

Inverter

The inverter, often referred to as the inverter/charger, is responsible for converting incoming AC power to DC for charging batteries and powering DC systems, and for converting battery DC power to residential AC. The inverter also charges the house batteries using a three-stage charging scheme. These three stages are Bulk, Absorb, and Float.

Bulk: When charging begins, the inverter charges in Bulk mode, providing as much current to the batteries as possible. The amount of time spent in the Bulk stage depends on the voltage threshold set in the control panel.

Absorb: Once the batteries reach the set voltage threshold, the inverter switches to the Absorb stage. This usually occurs when the batteries are 80-90% full. During this stage, the batteries are held at a programmed charging voltage. As the batteries approach a full charge, the current draw decreases. This is usually a timed stage and the inverter will end Absorb charging at the end of the programmed time interval whether they are fully charged or not.

Float: Once the batteries reach 100% (or the Absorb time has expired) the inverter switches to the Float stage. This is a trickle charge.

Search Watts: As a way to conserve energy, inverters may enter a “Search Mode” state during which the inverter does not put out its full voltage. While in this state, the inverter will periodically send out test pulses to measure the presence of loads. A threshold is set which determines whether a load is large enough to necessitate full output from the inverter. This threshold is the inverter's “Search Watts.” Decreasing the search watts will make the inverter more sensitive to loads and the inverter will revert from Search Mode sooner. For instance, if the search watts are set to 10 watts, a 6 watt load will not bring the inverter out of Search Mode, but that same 6 watt load will accomplish this if the search watts are set to only 5 watts.

Although there are many brands of inverters, the two that Silverleaf owners will most often encounter are Xantrex and Magnum. The Xantrex Freedom SW 3012 has been Newmar's preferred inverter for several years and is a common choice for owners of older Country Coaches upgrading to RV-C. The Freedom SW naming convention gives us some details about the specific model. For instance, the 3012 is a 3000 Watt, 12

Volt inverter, while the 2024 is a 2000 Watt, 24 Volt inverter. Xantrex inverters broadcast messages on the RV-C network, but those messages are not in an RV-C format. This is because they use their own protocol called Xanbus. The TM102 listens for Xanbus messages, translates them into RV-C messages, and rebroadcasts them. Therefore, even though the Xantrex is directly connected to the RV-C network, if the TM102 is offline, the inverter will appear to be offline as well.

The Magnum inverter, though not RV-C compatible itself, has been used in many RV-C coaches with the help of the TM502 Magnum interface. A new model of Magnum inverter, MSH3012RV, is RV-C compatible and no longer needs a TM502, but is not yet widely used.

Inverters typically have external control panels that give access to configuration settings. This is true of Xantrex, Magnum and Outback, all of which are common in a Class-A RV. Xantrex and Outback inverters both have a removable control panel that only needs to be connected when changing configuration settings. At any other time, they will operate normally without the panel in place. The communication port that the TM102 uses to connect to an Outback inverter is built into the Outback control panel, so in an RV-C coach, the Outback control panel will always be connected. In the case of Magnum inverters, the control panel is the TM502, which must remain connected at all times. User serviceable settings like voltage thresholds and charging times can be accessed from the house control panel inside the RV, though in the case of an Outback inverter these settings are more limited. For this reason, Xantrex control panels are rarely used for anything beyond initial installation.

Troubleshooting:

DC Volts are no longer being displayed on the house panel:

- The TM102 may have lost communication with the inverter. Try rebooting the TM102. For Magnum inverters, try rebooting the TM502. If the coach has a Xantrex inverter, the TM102 must have Xanbus communication enabled. It is possible that this has been disabled. HMS-365 touch panels have a TM102 Configuration screen that will show whether it is enabled. The Xanbus option can only be configured through Omniscope.

- If the TM102 has been rebooted and it is still not reporting DC Volts, check the TM102 message count under System Diagnostics. If the message count is not climbing, something is causing the TM102 to hang up or the TM102 is damaged. This also applies to missing tank data.

Batteries are not charging:

- Chassis batteries: Is the charge bridge engaging?

- Are there any diagnostic messages at the mate panel (Outback) or touch panel?

- Does the panel show bulk or absorb charging but there is very little charging current? Many inverters are designed to throttle back charging current when the batteries are too hot. In such cases, there will be no notice of this change at the panel. Try unplugging the battery temperature sensor from the inverter. If this allows full charging current, replace the temperature sensor.

Lithium Batteries

Lithium batteries have been gaining popularity in recent years because of their longevity, weight savings, and capacity. However, they come with some additional challenges that must be addressed. In extreme

temperatures, lithium batteries do not perform well and can even be damaged including catastrophic failure. An example of this is charging the batteries in temperatures below 30°F. Because of this, heating and cooling measures must be added to the battery compartment. The temperature of each lithium cell is usually monitored by the battery management system (BMS).

When upgrading to lithium batteries, the owner must choose between simple drop-in replacements and managed batteries. The benefit of drop-in replacements is a far lower cost and easier installation. The owner can simply hook up the battery cables just as they were connected to the original batteries. This provides a quick and reasonably affordable path to many of the benefits of lithium. With this cost savings comes a compromise in functionality, however, and the better option is usually to spend the extra money on a managed battery system.

Unlike lead acid and AGM batteries, which have a predictable decrease in output voltage as the charge decreases, lithium batteries maintain a consistent voltage until they are drained, at which point the voltage drops steeply. This creates a significant challenge when integrating Lithium batteries into an RV-C network, since the TM102 is not able to make decisions for charging and other necessary functions. In order to properly integrate them, the batteries must include a BMS which reports state-of-charge (SOC) on the RV-C network.

Without an RV-C compatible BMS, drop-in lithium batteries do not report SOC. In such cases, the chassis batteries must be permanently connected to a trickle charger since the TM102 does not have the necessary information to determine when the charge bridge solenoid needs to be closed, the coach owner will not know that the batteries are dying until they are completely dead, and the inverter will not know when to convert shore power to DC to charge the house batteries. The inverter's three stage charging scheme – bulk, absorb, and float – relies on SOC messages, as does the AGS (automatic generator start). In short, the affordable drop-in lithium batteries present far more detriment than benefit.

Owners wishing to upgrade their coach to RV-C-ready lithium batteries must send in their TM102 for a software upgrade. Software version K adds support for certain brands. They will likely also need to update the software on their touch panels. The touch panel must be configured for lithium batteries and thresholds for warnings, charging, etc. will be expressed as a percentage rather than a voltage.

Generator

A typical Class-A RV generator is rated at between 8,000 and 12,000 watts. Since watts are volts x amps, at 12kW, the generator is providing 100 amps at 120v. A 50 amp shore post also provides 50A per leg, or 100A. These generators are diesel-powered and draw from the same fuel tank as the main engine. In order to prevent the generator from draining the tank and stranding the owner, the generator's fuel line is typically connected ¼ of the way up the fuel tank.

AGS: Generators can be started manually, either from the house control panel or at the generator, or they can be started automatically by AGS. In most cases, the TM102 provides the AGS. The AGS may turn on the generator when battery voltages drop below a programmed threshold, when the coach is not on shore power and current demand rises (e.g. the air conditioners are active), or at a scheduled time for the purpose of exercising the generator.

For safety purposes, locks are used to prevent the generator from automatically starting under certain conditions. If the operator has stopped the generator, the AGS is disabled until the lock is cleared. Logically, this makes sense because the coach may be stored in an enclosed space or other conditions may exist which are adverse to the generator running. There is also a generator slide switch on some coaches which prevents

the generator from automatically starting if the generator slide is out. This is typical on Country Coach. The slide switch is usually mounted along the lower frame rail under the generator and is a plunger-style switch with a single wire. The switch makes and breaks a connection to the chassis, thus grounding the “generator hood switch” pin on the TM102. In either case, the operator can still manually start the generator. When servicing the generator, be sure to disconnect the remote harness first as a safety precaution.

Quiet Time: If an owner wishes to prevent the generator from auto-starting at an inconvenient time, such as the middle of the night, a quiet time may be set during which AGS is prevented. Setting the quiet time Begin and End times to the same time disables quiet time.

Top Off Volts / Top Off Run Time: To make sure the batteries are still adequately charged in the morning (if quiet time has been set) a top-off charging period may be set so that quiet time starts with a full charge. The top-off run time is the period of time just prior to quiet time during which the batteries will be topped off. For instance, if quiet time begins at 10pm and the top-off run time is 45 minutes, the charging will begin at 9:15 and will charge at the specified top-off voltage.

TROUBLESHOOTING:

No generator data:

- Onan only. Pre-2007 Country Coach: Can the operator start and stop the generator? If the operator can still control the generator but is not receiving data from it, the Onan Node has likely failed. Whereas the start/stop passes directly through this board, other data must be translated. After 2006, Country Coach switched from PM002/TM101 to TM102. The TM102 communicates directly with the generator.

- The generator's internal inverter controller may have a communication problem. This can occur on late model coaches as well.

- Country Coach only: Is there a ground wire at the RS232 or RS485 serial common pin? Often, this wire was omitted. As a result, current surges from the generator during startup have no easy path to ground. The RS232 / RS485 chip sustains damage. The TM102 must be repaired and a ground wire must be added to the main connector pin 10.

- Check for a broken shield wire. The generator is often connected to the TM102 through a two-conductor wire with a shield that is used as the serial common. This shield is fragile and may have broken at the pin.

The generator does not start automatically:

- Can the generator be started manually? If not, there may be a problem with the TM102. If it can be started manually but not automatically, try clearing the AGS locks on the Genset screen. If this doesn't solve the problem, there may be a problem with the generator slide switch.

The generator runs but shuts off after only a few seconds:

- If this occurs when starting the generator at the generator, thus eliminating the TM102 as the source of the problem, It may be a problem with the internal transfer switch in the generator. If you hear a click just before the generator shuts off, it is likely that as soon as the generator's transfer switch tries to transfer the power out to the coach, some fault condition is occurring.

Charge Bridge

The charge bridge solenoid is Newmar's preferred method for keeping the chassis batteries topped off. When the coach is plugged into shore power, incoming power keeps the house batteries charged via the inverter. The chassis batteries, however, are not charged by the inverter. Therefore, over time, the chassis batteries will drain. In a Newmar coach, once the chassis battery voltage (measured directly by the TM102) drops below a threshold, the TM102 grounds the low side of a relay on the KIB Relay board, allowing current to flow through the coil of the Charge Bridge Solenoid. Contacts within the solenoid connect the two battery banks together and the chassis batteries are charged off of the house batteries for a predetermined amount of time (typically 60 minutes). This interval can be adjusted through the touch panel.

The TM102 uses a “DC Sense” wire on output pin 9 to sample the chassis battery voltage. This wire is attached to the chassis battery post on the charge bridge solenoid. If, during replacement of the solenoid, the DC Sense wire is installed on the house battery post of the solenoid, the TM102 will think that the house battery voltage is the chassis battery voltage. Therefore, on shore power, it will never close the solenoid and the chassis batteries will drain.

On coaches with an echo charger, this solenoid is still present and will be referred to as a “boost solenoid.” In such cases, it is used to bridge the battery banks together for the purpose of starting the engine when chassis batteries are weak.

The #4 relay (4th from the top) on the KIB relay board controls the solenoid. It may be activated manually by pressing the #4 switch (4th from the left) at the bottom of the relay board.

On Newmar coaches except for New Aire and late model King Aire, the charge bridge solenoid is on the back wall of the shore cord compartment in the upper right corner. There may be a carpeted panel covering the back wall, which is easily removed. In a late model King Aire, it is in the rear compartment opposite the chassis batteries (driver side) or in the house battery compartment on a frame rail. In a New Aire, it is in the mid-compartment breach off of bay 3 (driver side). It can be accessed through the slide-out bay across from the furnace by removing the carpeted panel at the back of that compartment.

TROUBLESHOOTING:

- Does the solenoid feel warm? If so, it is most likely powered. The charge bridge solenoid draws a lot of current and therefore produces a lot of heat.

- Does the house panel show the same voltage (within 1/10 of a volt) for both the house and chassis batteries? If not, the two battery banks are not connected together. Either the solenoid is not powered or the internal contacts are worn.

- Is the LED above the #4 switch lit? If so, the TM102 has activated the relay and the solenoid should be powered.

- Can you manually activate the solenoid by pressing the #4 switch? If not, check the fuse next to the #4 relay. If you need to test this and the TM102 is already activating the solenoid, pull the green wire with a white stripe off of the terminal next to the #4 relay.

- Is the green wire with a white stripe next to the #4 relay (or output pin 4 on the TM102) grounded? If so, the TM102 is sending the signal to activate the charge bridge solenoid.

- Is there a lightning bolt or “Bridged” on the touch panel by the battery voltages? If so, the TM102 has decided to activate the charge bridge solenoid.

House Battery Disconnect

Also called a “salesman switch,” the house battery disconnect is a way to preserve house battery levels when away from the coach long term. Though some coaches have a way to completely disconnect the house batteries, many coaches use a switch to remotely power a solenoid, which removes only certain appliances from the house circuit. Many RV-C appliances will remain powered. Therefore, if a coach is going to be stored, it should be connected to shore power, a trickle charger should be put on the house batteries, or the house battery main cables should be removed. The chassis batteries, however, often have a mechanical disconnect in the battery compartment that allows the owner to completely disconnect the chassis batteries.

Echo Charger

When an RV is plugged into shore power, the inverter is keeping the house batteries charged. The chassis batteries, however, are only directly charged by the alternator when the main engine is running, and may be indirectly charged via the inverter when the generator is running. Whereas Newmar uses the charge bridge solenoid to keep the chassis batteries charged, many other OEMs use an echo charger. An echo charger is similar to a trickle charger except that it draws power from the inverter. The benefit of drawing power from the inverter rather than a primary AC source is that there is no risk of overcharging or undercharging the chassis batteries.

Power Management

Breaker Panels

Most coaches will have two breaker panels – a larger primary panel for the usual 20A circuits, and a smaller secondary panel. From the primary panel, a breaker feeds the inverter, which sends inverted power back up to the smaller panel. AC circuits connected to this panel will still have power when shore or generator power is unavailable. The breaker panels are usually located in the bathroom or rear closet.

TM-250

The TM250 monitors loads and determines when a load needs to be shed. These are usually climate loads, specifically the heat pumps/air conditioners and floor heat. Because the house batteries do not provide enough current for sustained use of these devices, the TM250 will shed them when the coach is not on shore or generator power. It accomplishes this by sending out messages to these devices repeatedly. After a time-out interval, if no shed messages are received, the device will turn on again. Loads that are shed are reported on the touch panel.

When a TM250 fails, it may shed loads without reporting it or without reason. If a device is not responding to commands, but the load is not shown as shed, unplugging the TM250 may reveal a solution.

Transfer Switch

The transfer switch is a smart switch that connects either the generator or shore cord to the rest of the

electrical system. When power is first supplied from either of these sources, the transfer switch measures the voltage coming in and determines whether it is within a programmed voltage and frequency range. These ranges can be configured within the touch panel. Once the power has been qualified, contacts close and the power is transferred to the breaker panel.

TROUBLESHOOTING:

Comm Error:

- On older coaches, this often means that the TM102 has lost communication with the transfer switch and may be accompanied by a transfer switch unknown fault. Check whether the transfer switch is still communicating with the panel. Are the house voltages being displayed? Rebooting the panel will ensure that you are not seeing stale data. If you have an RV-C transfer switch, such as a Surge Guard 40350-RVC, it will connect directly to the RV-C network and the TM102 will not come into play.

- On the System Diagnostics screen, is the TM102 message count climbing? If not, the TM102 has stopped communicating. Restart the TM102. On most panels this can be done from the System Diagnostics screen. If this does not resolve the error, check for a blinking red light on the TM102. If it is not blinking, unplug the main connector and plug it back in. Sometimes the TM102 can get "stuck" and you will need to remove the internal backup battery with the power unplugged, count to ten and replace the battery and main connector.

1.3 Climate

Floor Heat

TM-229

The TM229 is responsible for turning the floor heat on and off. Some coach builders use a duty-cycle schedule to regulate the temperature. In other words, the heat is on for a certain amount of time, then off for a certain amount of time. The higher the floor heat level is set for that zone, the longer the "on" cycle and shorter the "off" cycle. Other coaches use temp sensors and the floor heat levels are displayed on the panel in terms of temperature rather than a level of 1-10.

TROUBLESHOOTING:

No floor heat:

- Is the TM229 communicating on the network? Check the census. On HMS360 and 365 control panels, this can be accessed through FEATURES > COMPONENT VERSIONS. On HMS707 panels, select CONFIG > SYSTEM COMPONENT LIST. If you see a TM220 or TM225 but no TM229, the TM229 has failed.

- Is the problem solved by unplugging the TM250? When a TM250 fails, it can shed loads unnecessarily and without reporting it.

- Is the panel reporting a missing temp sensor? The TM229 may have failed and thinks it is a TM220.

- Is a breaker or GFCI tripped? There are often two breakers for floor heat (main panel). One tile will be on a 15 amp breaker and the other two will be on a single 20A breaker. If there is no power getting to the tile heat relays, this may be the cause.

Furnace

Diesel RV's have a type of furnace called hydronic heat. This type of furnace uses burners, which can often alternate between diesel fuel and electricity, to heat antifreeze and circulate it throughout the coach. A heat register and blower is located at each of the heating zones. An additional heating loop is sent to the hot water distribution module to provide hot water for the faucets and shower.

OA-600

The OA600 was designed by Silverleaf for Oasis. Though Silverleaf initially handled the manufacturing, the intellectual property was eventually sold to ITR (Oasis) who now manufactures the OA600 themselves. As such, even though the circuit board says Silverleaf, it is not our product. It is typically found in Newmar coaches and is responsible for transferring data to and from the Oasis.

TM-225

The TM225 controls up to 4 heating zones for the Aqua-Hot furnace, each with its own four-pin plug.

TM-299

The TM299 is common in Newell coaches and is used as an Aqua-Hot monitor.

TROUBLESHOOTING:

No heat in one zone:

- Are any of the red LEDs lit on the Oasis panel? This panel has an LED for each zone that indicates faults.
- Does the blower work for that zone? If not, check fuses.
- The output pins on the Oasis RV-C Node (OA600) send a control voltage to activate a relay for each zone. A technician can test inactive zones by connecting a jumper wire between an active zone contact at the Oases and the contact for the inactive zone.
- Is the OA600 sending a control voltage on the corresponding pin? If not, there may be a problem with the OA600 or with thermostat configuration.

Input zone fault 157, 11:

- This is an Oasis error code that essentially means that it has power and is able to heat the water, but unable to heat a zone. This usually occurs as a result of a failed circulating pump or low water level.

Air Conditioner / Heat Pump

The rooftop air conditioners, like residential heat pumps, can also provide heat. They are less efficient in colder weather, so when the heat source is set to “automatic” and the outside temperature drops below about

40 degrees, the system will select the furnace (hydronic heat).

The air conditioners are 120v appliances and are connected to the main AC panel. They can only run when generator or shore power is available. The exception to this is when a coach has a second inverter. In such cases, two of the three rooftop units are usually connected to the main panel and a third one is connected to the secondary (inverter) panel so that it is available at all times.

These rooftop units have a mechanical valve to control the flow of coolant. This valve determines whether the rooftop unit is heating or cooling. As they age, the valve becomes harder to turn and will eventually lock completely. A sign that an A/C unit is on its way out is when one cooling zone takes longer to turn on than the others. This usually means that the valve is starting to fail.

The compressor is another component that will eventually fail. Every compressor has a high initial current draw – about 17 Amps – and then a lower current draw once it is running. When the compressor begins to fail, the initial current draw is very high – 35 Amps or more. It is often high enough to trip a breaker or cause the TM250 to shed the load. A failed starter capacitor or valve can also cause these symptoms.

TM-200

The TM200 is used to control up to three rooftop units. Each unit has its own plug on the TM200, so swapping plugs can be a useful step in troubleshooting.

TM-2000

In addition to the features already available in the TM200, the TM2000 and its variants provide furnace control and load management.

TM-510

Unlike the TM200, the TM510 has only one output that is daisy-chained to up to four Dometic rooftop units. These are used by Newmar.

TROUBLESHOOTING:

No A/C / No Heat:

- Are all the ambient temperatures showing up? Do they look reasonably correct? Is any temperature specifically at 70 degrees? In some systems, a missing or failed temp sensor will default to 70 degrees.
- Are loads being shed? Is the coach plugged into shore power? Try unplugging the TM250. It may be shedding one or all zones.
- Are the heat and cool instances set correctly for the coach?
- If the coach has a TM200, try switching the plugs around. Does the problem follow the plug or stay with the zone?
- If no A/C, can it heat? If no heat, can it cool? If the rooftop unit can do one but not the other, it has a

bad reversing valve.

- Check circuit breakers.

1.4 Control Systems and Monitoring

Water / Tanks

An RV usually has three water and waste tanks. These are Fresh, Black, and Grey. Some RV's have a two tank system with Fresh and a single waste tank. The fresh tank holds clean water, the grey tank holds runoff from showers and sinks, and the black tank holds the toilet waste. Each tank has its own sensor to convey tank levels to the HMS. These sensors may be pressure sensors that come in direct contact with the contents of the tank or are mounted at the end of an air trap to minimize direct contact with the tank contents. Other sensors attach to the outside of the tank and “feel” the water levels through the tank wall.

Auto Fill

When a coach is connected to city water, the operator may want to keep the fresh tank topped off. Thresholds for both minimum and maximum tank levels can be set at the HMS. For our purposes, the TM102 is almost always the device controlling this feature, and directly monitors tank levels on most coaches. When the fresh tank level drops below the threshold, or when the manual fill switch is active, the TM102 grounds output pin 2, allowing current to flow through the fill-valve relay.

Pump

The water pump pressurizes the water so that plumbing fixtures may be used. When the coach is tied into city water, the pump is not necessary, though it typically produces more water pressure than city water. If the operator chooses to use city water pressure rather than the pump, the fill is bypassed. In such cases, the fresh tank does not need to remain filled, and whatever water is in the tank will become stale over time. The TM102 activates the pump the same way it activates the fill valve, using output pin three to turn on the relay.

TM-102 / TM-101

The TM102 (TM101 in older coaches) is responsible for monitoring tank levels and reporting those levels to the house monitor. Calibration information, tank configuration, and auto fill settings are stored within the TM102. The internal jumpers must be set properly for it to read the tank sensors. It is also the TM102 that controls the relays for the pump and fill.

TM-250

Although the TM250 is a load manager, in some coaches it is also used to prevent the toilet from flushing when the black tank is full. In such cases, the toilet uses two flush valves: one opens to flow fresh water into the bowl and one opens the bottom of the toilet to dump into the black tank. The valve controller is wired to one of the TM250 output pins allowing the TM250 to prevent the valves from opening.

Kavlico Sensors

The Kavlico 3 PSI sensor uses an internal element to vary the resistance across the device. A 3 wire pigtail connects the sensor to the TM102 forming a voltage divider with the device's internal resistance. This voltage appears on the touch panel as a “Raw Count,” which is used to determine tank levels. A new sensor should have an empty raw count of about 97. As the sensor ages and corrodes, it will need to be re-calibrated through the touch panel's “dry calibrate” feature. Black tank sensors fail most frequently, followed by grey tank sensors.

MSC Sensors

MSC tank sensors are an external stick-on type of sensor. They are usually connected as a string of 4 to 10 sensors per tank. Raw counts for an empty tank are just under 1000 and go down as the tank fills. Because they do not come in contact with the contents of the tank, they are more reliable than Kavlico sensors.

See-Level

The Garnet See-Level II monitor reads tank sensors and displays the levels on a seven-segment LED array. In our Aladdin Conversion kits, we use a 709RVC, which reports these tank levels on the RV-C network as well. Certain models also have Bluetooth support.

TROUBLESHOOTING:

Inaccurate or missing tank levels:

- When switching the sensor for the faulty tank level with the sensor for a good tank level, does the fault follow the sensor to the new tank? If so, the problem is with the sensor or tank.
- Is the raw count high but the tank shows empty (opposite for MSC)? Dry calibrate the tank.
- Is the tank level erratic or unresponsive to calibration? The sensor may have failed.
- Does the tank level indicator move slowly and then suddenly change? There may be a kink or obstruction in the vent tube.

The toilet won't flush even though the black tank isn't full:

- Try unplugging the TM250. If the problem goes away, the TM250 is faulty and needs to be repaired.

The fill won't turn on:

- The fill valve uses a relay, which is normally preceded by a fuse. If either of these fails, the fill will not work.
- Is the tank data current? If the HMS is showing stale data, the TM102 has lost communication and can't turn on the fill.
- Is the fresh tank level missing? The TM102 will not turn on the fill if it doesn't know the tank level.

Video Monitoring and Switching

VMS-350

The VMS-350 performs several functions within a coach. Principally, the VMS-350 acts as a camera switcher, displaying center and turn-signal cameras, and as a chassis monitor. It receives J1708 and J1939 chassis data, which includes engine and transmission as well as tire data, and overlays that data on top of the composite video display. Video inputs are NTSC (analog composite) and are switched based on turn-signal and reverse input pins at the secondary connector. A 14-pin ribbon cable connects a keypad and encoder to the VMS-350, allowing access to menus and settings.

TM-350

The TM-350 shares the same hardware as the VMS-350 but is configured as a dedicated video switcher and does not have the ability to overlay chassis data on the video monitor. Instead, the TM-350 makes full use of its 7 video inputs and 5 outputs either as a standalone video switcher or working in conjunction with HD video switchers.

VMS-333

The VMS-333 shares many of the same features as the VMS-350, but has only a single video input and output. It does not have video switching capability.

Tire Pressure Monitoring

We currently offer support for only two tire pressure monitoring systems: TST and Pressure Pro. The Pressure Pro receiver is no longer in production and is nearly impossible to find. For customers who already have a working Pressure Pro system, we offer replacement pressure sensors. Support for the TST system was recently added to our VMS software. Both systems will require a VMS333, VMS350, VMSpc, or SilverLeaf Glass Dash plus the proper receiver.

House Monitoring

Silverleaf has made a number of different house monitoring panels over the years. As such, it would be unfeasible to address the various menus and layouts individually here. What can be said for all house monitoring panels, however, is that they do not directly monitor any house systems. Instead, the data is reported to the panel by other products connected to the RV-C network. The panels can also request changes, which are carried out by the connected module which monitors and controls its respective systems. The following is a partial list of house functions and the product that monitors or controls them and reports the data.

AC Power – Transfer switch
AC Loads – TM250
DC Power – TM102 (Chassis DC) Inverter (House DC)
Tanks, Pump, Fill – TM102 (TM101 in earlier coaches)
Primary Heat – TM510 for Dometic units, TM200
Secondary Heat – OA600 for Oasis, TM220
Floor heat – TM102 (typical in Newell) or TM229

System Clock – TM102, unless provided by dash GPS

Remote Monitoring and Control

Rozie (TM-555)

Rozie is a cloud-based monitoring and control system that uses a TM555 to relay RV-C data between a web interface and the RV-C network. The TM555 connects via either WiFi or Ethernet and, on a timed schedule, uploads data to the host server and downloads commands. This time interval can be adjusted at the user panel and is limited to no less than 15 seconds between updates.

The user panel is accessible through a web browser by logging in at myrozie.com and entering a coach ID and password. At the panel, the user has access to various coach data and controls. The user can also set email alerts for a number of different events and can retrieve still shots from the coach's cameras.

RVCair (TM-550)

Similar to Rozie, RVCair allows owners to monitor and control their coach remotely. RVCair, however, does not use a separate web server, but instead uses a TM550 to communicate through a TCP port. The TM550 has its own built-in WiFi bridge. Because RVCair does not rely on a shared server, the operator must be within the coach's WiFi range, and commands are sent and acknowledgment received immediately.

System Control (LR-125)

The LR-125 combines WiFi with a built-in Linux web server, allowing multiple users to connect and eliminating the need for an external web server. Using the System Control app, operators have access to the same data and controls as with Rozie, but with a shorter response time, and unlike RVCair, do not have to be within WiFi range.

AFTERMARKET

Aladdin Conversions

The Aladdin system was a total coach control system very similar to a typical Silverleaf system with monitoring of tanks, temperatures, cameras and chassis data. As coaches age and components fail, many owners are forced to replace their Aladdin systems. Silverleaf offers an affordable and complete replacement package that can be installed by the owner.

An Aladdin Junior kit includes only a VMS350 and adapter harness, since the Aladdin Junior system had limited capability. The original equipment would have used the video monitor to perform its own video switching. After the conversion to Silverleaf, the VMS350 handles video switching.

In addition to the VMS350, the full Aladdin conversion includes a TM240 for AC/DC monitoring, a TM102SG for communicating with the Surge Guard transfer switch, if equipped, and See Level II tank monitor, plus all sensors and cabling required.

Glass Dash

“Glass Dash” is a generic term for any of several Silverleaf products. Various models were original equipment in Newmar coaches in 2017 and 2018, in Newell coaches from 2006 to 2014, and Foretravel coaches from 2006 to 2019.

Silverleaf currently offers two models: the VMS755 (9”x7”) and VMS765 (11”x7”). In addition to displaying gauges, these units offer diagnostic message centers, camera display, TPMS compatability, customizable gauge layouts, trip information and other features.

VMSpc

VMSpc is a hardware J1939/J1708 interface plus software bundle that may be used to replace factory gauges. A principal advantage over the Glass Dash is the lower cost. It also provides a very flexible interface, allowing customers to customize the layout and type of gauges. A TM501 connects to the chassis diagnostic port, converts the data, and relays it through a USB cable to a Windows-based laptop or tablet. There are currently two software versions, with a third in testing. Coaches made in 2006 or earlier will need v3. Later models will need v4.

SILVERLEAF PRODUCTS

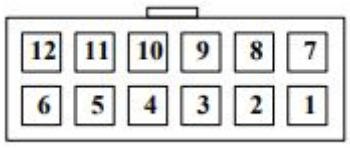
3.1 DB-100 / DB-200

The DB-100 is a DC-switching unit which manages up to 10 DC loads of 1 to 13 Amps. This may be (lighting) Dimmers, Locks, Water Pump or other loads on a design-by design basis within the house systems of a coach or towable.

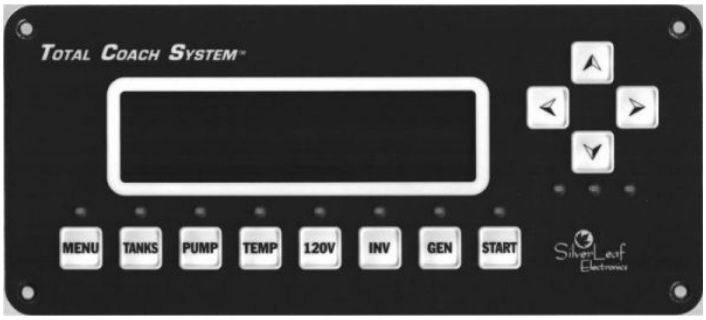
The DB-200 is similar to the DB-100. This unit, however, uses H-Bridges to drive up to six DC motor loads directly. Nominal max is 4 Amp per motor, 15Amp trip. These, like the DB100, are controlled via 'digital circuit breakers'. The DB-200 may be used to control lighting and locks as well.

Pinout

	Main Connector		
1	Ground	7	Power (12V DC)
2	LIN Bus (19200 baud)	8	Serial TX (RS-232)
3	---	9	Serial RX (RS-232)
4	---	10	Serial Ground
5	RV-C Data +	11	---
6	RV-C Data -	12	---



3.2 HMS-060 / HMS-062

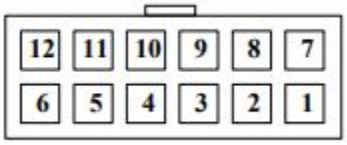


The HMS-060 (left) is a monitor panel for the house system of the coach. It specifically monitors the water tanks, water pump, water fill, 120V system, inverter, and generator. The screen uses a vacuum fluorescent array that weakens and dims with age. A burn-in process may help this.

The button layout for the HMS-062 is different but it performs the same functions and also has a vacuum fluorescent screen. Both of these were originally designed to work with a PM001/PM002 and TM101. Later sotware versions integrated RV-C and worked with the TM102.

Pinout

	Main Connector		
1	Ground	7	Power (12V DC)
2	---	8	---
3	House Data + (J1708)	9	---
4	House Data - (J1708)	10	---
5	RV-C Data +	11	---
6	RV-C Data -	12	---



3.3 HMS-360 / HMS-365 / HMS-707

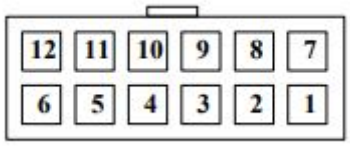
The HMS-360 was the first touch panel from Silverleaf. It monitors and controls climate systems, tanks, AC and DC power and other systems. The HMS365 replaced the HMS360 with a more sensitive touch screen, improved resolution, more memory, and a better processor. The HMS365 also has additional optional functions available such as shades, awnings and lighting.

The HMS365 can process video via a single composite input. That processed video can then be output serially, and if wired to a TM555 or LR125, and port those ½ frames of VGA onto the RVC bus, usable by the Rozie telematics system.

The HMS700 series panel replaces the HMS360/365 with a wider touch screen, more memory and a faster processor. The HMS700 became the standard house monitoring panel beginning in 2020.

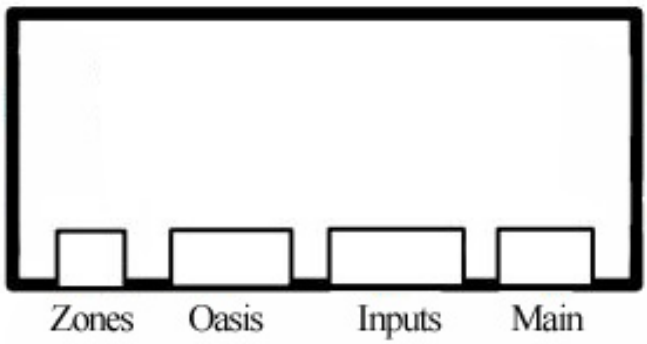
Pinout

	Main Connector		
1	Ground	7	Power (12V DC)
2	Input 1 (low)	8	Serial TX (RS-232)
3	Input 2 (low)	9	Serial RX (RS-232)
4	Input 3 (low)	10	Serial Common
5	RV-C Data +	11	Output 1 (low)
6	RV-C Data -	12	Output 2 (low)



3.4 OA600

The OA600 was designed and initially manufactured by Silverleaf but is not a Silverleaf product. Programming and configuration are done by ITR Oasis. The OA600 contains all of the logic for the Oasis hydronic furnace and is its only means of communication and control in an RV-C system. Activating zone heat within the Oasis is accomplished by supplying a control voltage on one of the OA600 output pins to turn on a relay within the Oasis. These outputs can supply up to 115 mA. All connectors on the OA600 are Amp style, which are identical in size to the Molex Mini Fit connectors used in Silverleaf equipment but are incompatible.



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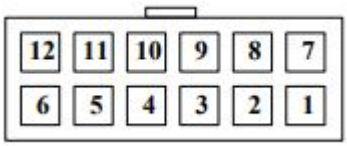
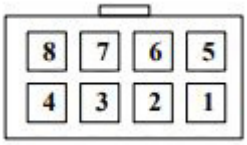
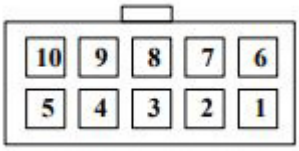
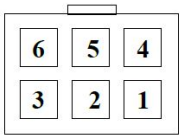








	Main Connector
1	Power
2	Serial RX (232)
3	Serial TX (232)
4	Ground
5	RV-C Data +
6	RV-C Data -
7	Ground
8	Power

	Intputs	
1	Ground	
2	Burner Switch	High / Low
3	Engine Switch	High / Low
4	AC1 Switch	High / Low
5	AC2 Switch	High / Low
6	Ground	
7	Sensor 1	Analog
8	Sensor 2	Analog

	Oasis Connection	
1	---	
2	Heater Fault Status	In (High)
3	AC1 Control	Out (High)
4	---	
5	---	
6	Burner Control	Out (Low)
7	AC Status	In (High)
8	AC2 Control	Out (High)
9	Engine Heat Control	Out (Low)
10	Zone Fault Status	In (High)

9	Sensor 3	Analog
10	Sensor 4	Analog
11	Sensor 5	Analog
12	Sensor 6	Analog

	Zones	
1	Zone 4 Control	High
2	Zone 5 Control	High
3	Ground	
4	Zone 1 Control	High
5	Zone 2 Control	High
6	Zone 3 Control	High

3.5 Omniscope

The Omniscope is a service tool used to monitor and diagnose devices on the RV-C network. The tool connects to a 9-pin or 6-pin (depending on the age of the vehicle) circular diagnostic connector and to the USB port of a PC. The computer can then be used to troubleshoot problems on the network, and control and configure different devices on the network.

Integrated modules for specific devices and device functions provide additional diagnostic information and control within Omniscope for their respective devices, thereby providing access to settings and data not available through the touch panel. An extensive collection of scripts allow a technician to load pre-configured instructions onto supported devices, allowing a device to be quickly configured for a specific coach or other application.

3.6 PM-001 / PM-002

The PM-002 (also known as the Total Power System Controller) allowed the Silverleaf VMS and HMS products to interface to the electrical systems of the coach. The electrical systems may include the generator, inverter/charger and transfer switch depending on the PM-002 variation. The PM-002 also includes AGS control.

These modules were J1708 only and were discontinued once RV-C was implemented. The PM001/PM002 and TM101 were replaced with the TM102.

Interfacing components connect to the PM-002 through RJ11 connectors on the side of the box. A blinking LED under each RJ11 port indicates communication at that port.

Common Locations

Country Coach – Under transmission shifter panel to the left of driver's seat.
Beaver – Behind dash.

Safari – Front wall of storage bay.

3.7 TM-101

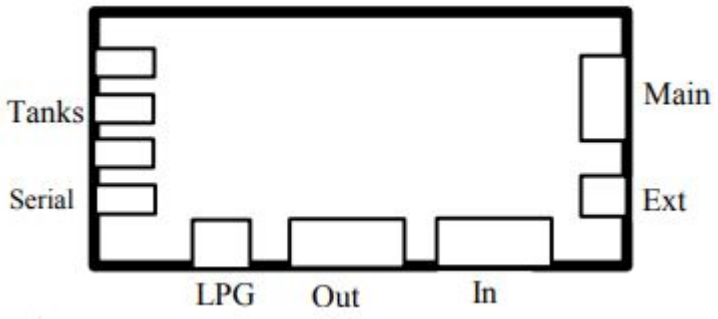
The TM101 is a data collector interface which can be used for several systems in the coach. Most commonly, it is an interface with the tank systems. In this configuration it can monitor the fresh, black, grey and LPG tanks and control the water fill and pump. It is also used to provide chassis information to the digital dash. In such cases it monitors the air brakes, fuel tank, and the various dash indicators like blinkers and high beams. The TM101 may have a 4-pin or 12-pin power plug. It is J1708 only and is most commonly found in older Country Coaches. On RV-C Country coaches, it was replaced by the TM102.

Common Locations

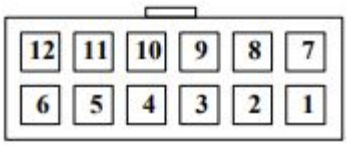
Country Coach: Behind dash or driver's side bay forward of tank bay under cover.

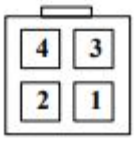
3.8 TM-102

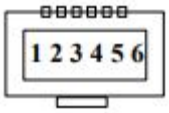
Replacing both the PM001 and TM101, the TM102 monitors and controls a number of systems in the coach and may be controlled with a VMS, HMS, or Omniscope diagnostic tool through the RV-C network. The TM102 may monitor the tanks systems (fresh, gray, black, lpg), electrical systems (inverter, generator, transfer switch), and many other systems in the coach (tile heat, temperatures, awning, etc.) depending on its configuration. It also is the logic and rules behind the auto-genstart system (AGS).



Pinout







Specified Pin Connections per Application Document

	Main Connector
1	Ground
2	J1939 Common
3	J1939 Data +

	Inputs	
1	Park Brake	Low
2	Gen Switch	Low
3	Fill Switch	Low

4	J1939 Data -
5	RV-C Data +
6	RV-C Data -
7	Power (12V House)
8	Gen Com 232 TX / 485+
9	Gen Com 232 RX / 485-
10	Gen Common (232)
11	---
12	---

4	Pump Switch	Low
5	Bypass Detect	Low
6	Gen Demand 1 (Thermostat out or Gen Lock)	Low
7	Pump Switch or AC Current Detect	High
8	Gen Running	High
9	Water Heater or Battery Disconnect Sense	High
10	Water Pressure or Load Shed	High
11	Engine Run or Charge Bridge Sense	High
12	Gen Demand 2 (2nd Therm input or gen Lock)	High

	Outputs	
1	Main Door Lock or Therm Control or Block Heater	Low
2	Fill Valve	Low
3	Pump Control	Low
4	Therm Control or Battery Solenoid	Low
5	Gen Start	Low
6	Gen Stop	Low
7	Pri. Floor Ctrl or Awning Extend or Disconnect_close	High
8	2nd Floor Ctrl or Awning Retract or Disconnect_open	High
9	DC Sense	Analog
10	Tile Temp	Analog
11	Ground	
12	Relay Protect	

Typical Application as used by Newmar

	Main Connector	
1	Ground	Black
2	---	
3	---	
4	---	
5	RV-C Data +	White
6	RV-C Data -	Green
7	Power (12V House)	Red
8	---	
9	---	
10	---	
11	---	
12	---	

	Inputs		
1	---		
2	Gen Start / Stop	Low	Violet
3	Fresh Fill Switch	Low	Yellow
4	Pump Switch	Low	Green
5	Pump Bypass Detect	Low	White
6	Gen Slide Switch	Low	Blue
7	---		
8	Gen Run Signal	High	Orange
9	---		
10	Water Pressure Detect	High	Brown
11	---		
12	---		

	Outputs
1	---

2	Fresh Fill Valve	Low	Orange
3	Water Pump	Low	Violet
4	Charge Bridge Solenoid Control	Low	Lt Blue
5	Generator Start	Low	Red
6	Generator Stop	Low	Green
7	---		
8	---		
9	Chassis DC Sense		Yellow
10	---		
11	---		
12	---		

Common Uses

Generator Control and Auto Gen Start: The TM102 determines when to automatically start the generator based on a number of factors such as battery voltages, exerciser scheduling, current demands, and in older coaches, temperatures. This last factor was used as a way to predict when current demand was about to increase due to air conditioner demand. Later programming makes this unnecessary because air conditioner use is broadcast on the RV-C network.

Typically, chassis voltage is measured directly at the TM102 on output pin 9 and house battery voltage is reported by the inverter. The inverter may report this voltage directly to the TM102 through the serial port (Non-RVC) or on the RV-C network with or without the help of a translator node such as a TM502. If either the house or chassis batteries fall below a threshold (usually set at the control panel), the TM102 will request power from the generator.

A generator run signal is transmitted from output pin 5 of the TM102. A generator stop signal is transmitted from output pin 6. A run signal from the generator is connected to input pin 8 which tells the TM102 if the generator is running. Crank settings for the generator can be configured through the TM102 configuration tool in Omniscope. In older, non-RV-C coaches, these settings can be changed from the control panel.

Charge Bridge: On Newmar coaches, chassis battery voltages are maintained by a charge bridge solenoid. When the coach is plugged into shore power, the TM102 uses the house batteries to keep the chassis batteries topped off by connecting the two banks together. It accomplishes this by energizing the coil on the charge bridge solenoid (active low output pin 4) and closing the contacts.

System Clock: The TM102 provides the system clock for most coaches. A CR2032 coin cell is used to maintain power to the system clock when the TM102 is not powered through its main connector.

Pump: When water pressure is demanded and the coach is not connected to city water, the TM102 energizes the pump relay through active low output pin 3. The pump may be activated through an RV-C message or a mechanical switch at the water bay. In the latter case, the mechanical switch pulls input pin 4 low.

Fill: When the fresh tank is low and the coach is connected to city water, the TM102 energizes the fill valve relay through active low output pin 2. The fill valve may be activated through an RV-C message or a mechanical switch at the water bay. In the latter case, the mechanical switch pulls input pin 3 low. The threshold for the auto-fill can be set at the touch panel.

Tank Levels: The TM102 is often used for monitoring fresh, grey, black, and sometimes LP or a single waste tank. Tank level sensors are connected to one of the four RJ11 ports.

Common Locations

Newmar (long buses): Shore cord compartment back wall.

Newmar New Aire: Bay 4 electrical behind diagonal brace.

Country Coach Allure: In dash.

Fleetwood: In dash.

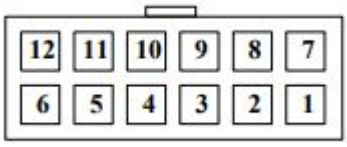
3.9 TM-200 / TM-250 / TM-299

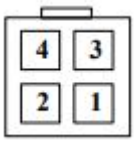
The TM-200 controls up to 3 roof top air conditioners. Multiple units can be used for more A/Cs. DIP switches on the unit determine the network address and which zones are controlled. The TM200 also monitors the transfer switch amperage so that the air conditioners don't overload the circuits. The TM200 may also control the roof airs as a heat pump.

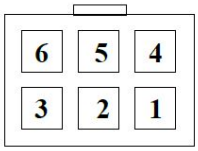
The TM-299 is a special data collector for Newell Coach and is based on the TM-220 electronics. As such it only really varies in software configuration. It monitors the Aqua-Hot water heater temperature. It can also monitor the slide air compressor. When the slide air compressor runs excessively it generates an error on the RV-C network.

The TM-250 monitors AC power as-reported from the transfer switch directly (RV-C) or via the TM102. It then sheds AC loads to maintain a maximum on each leg. Loads are also shed briefly when switching between power sources, IE when starting the generator while plugged into shore power. Devices are controlled through external relays. Loads are shed in a configurable order, and restored in the opposite sequence. The TM250 does not require a direct connection to RV-C devices. Instead, it sends out shed commands periodically. The recipient of the shed command will disable its specified function until a configured time period has passed without any new shed messages. The TM250 also supports up to three temperature sensors.

Pinout







	Main Connector
1	Ground
2	---
3	---

	Outputs (OUT1, OUT2, OUT3)	
1	Ground	
2	Load Control	Low
3	Load Control	Low

4	---
5	RV-C Data +
6	RV-C Data -
7	Power (12V House)
8	Serial TX (232)
9	Serial RX (232)
10	Serial Ground (232)
11	---
12	---

4	Load Control	Low
5	Load Control	Low
6	Load Control	Low

	Temperature Sensors (TEMP1,TEMP2, TEMP3)	
1	---	
2	---	
3	Ground	
4	Ambient Temp	Analog

Common Uses

The TM250 is commonly used to shed A/C and floor heat zones when a coach is not connected to shore or generator power. In addition, the toilet flush controller is treated as a load and is shed when the black tank is full.

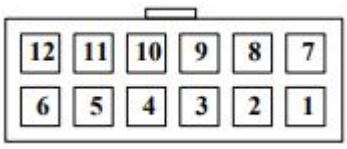
Common Locations

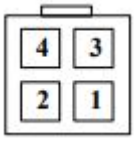
Fleetwood – Between chassis frame rails behind driver side bay 3 and passenger side bay 2
Newmar – Door side bay 4
Newell – Electrical bay across from Aqua-Hot

3.10 TM-220 / TM-225 / TM-229

As a TM-220, this unit can interface to a Dometic or Aqua-Hot heating system or control up to 4 floor heat mats. Its capable of controlling up to 4 zones of heating. The TM-225 and TM-229 are the same hardware as the TM-220. The difference is in configuration.
TM-220 = Dometic (4 Outputs + 4 sensors)
TM-225 = Engine preheat and heat source of the Aqua-Hot. (4 Outputs + 4 sensors)
TM-229 = Tile Heat (4 Outputs, timed -or- using AS112 sensors)

Pinout





Specified Pin Connections per Application Document

	Main Connector
1	Ground
2	---
3	---
4	---

	Aqua-Hot	
1	Zone1+	Attach to Therm1+
2	Zone1-	Attach to Therm1-
3	Zone2+	Attach to Therm2+
4	Zone2-	Attach to Therm2-

5	RV-C Data +		5	Zone3+	Attach to Therm3+
6	RV-C Data -		6	Zone3-	Attach to Therm3-
7	Power (12V House)		7	Zone4+	Attach to Therm4+
8	Serial Transmit (232)		8	Zone4-	Attach to Therm4-
9	Serial Receive (232)		9	Heater1_Control	Low
10	Serial Ground (232)		10	Heater2_Control	Low
11	---		11	Heater3_Control	Low
12	---		12	Heater4_Control	Low

	Tile Heat (TM220, TM229)	
1	Ground	
2	Floor Control	High
3	Ground	
4	Tile Temp	Analog

	Diesel (TM225, TM226)	
1	Ground	
2	Diesel	High
3	Ground	
4	Ambient Temp1 (225) Burner Status (226)	Analog / Discrete

	Electric	
1	Ground	
2	Electric	High
3	Ground	
4	Ambient Temp 2	Analog

	Electric High/Low	
1	Ground	
2	Electric High	High
3	Ground	
4	Ambient Temp 3	Analog

	Preheat	
1	Ground	
2	Preheat	High
3	Ground	
4	Ambient Temp 4	Analog

Common Uses

By far, the most common configuration for this unit is a TM229 tile heat controller. The TM229 can be configured to operate on a duty cycle, or regulated by a temperature sensor. When it operates on a duty cycle, it is on for a certain amount of time and off for a certain amount of time. The higher the floor heat setting for that zone, the longer it stays in the “on” portion of the cycle. A chart of specific times for each heat setting can be found in the application document. These are also commonly used as a TM225 Aqua-Hot controller in Country Coach and Foretravel.

Common Locations

TM225 – Typically right by the Aqua-Hot. In Country Coach, they may be inside the Aqua-Hot or in the bathroom cabinet above the toilet.

TM229
Newmar (except New Aire) – Passenger side bay 4. It may be behind an ABS cover, up on the ceiling, on the

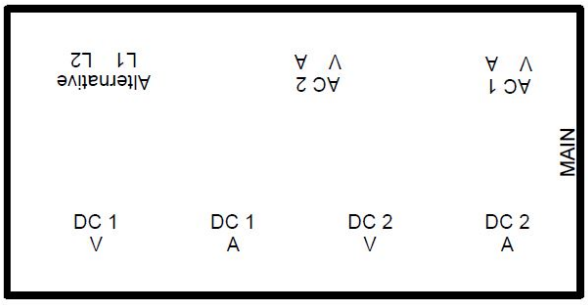
back wall, or behind the frame rail.
Newmar New Aire – Central overhead, dash, or passenger side bay 4.

Foretravel – Plumbing bay passenger side

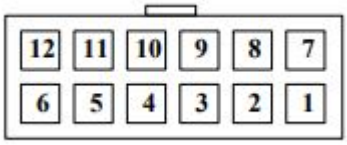
3.11 TM-240

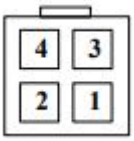
The TM-240 is a specialized data collector that measures and logs AC and DC power. In newer coaches, it is not commonly used because of the ability of newer transfer switches and inverters to report the same data. It is, however, an integral part of Aladdin conversions.

Using external sensors, the TM-240 is able to measure two legs of DC current and two legs of AC current. It can also read DC voltage up to 18V and AC volts up to 150V. AC voltage must be stepped down through a 7.5:1 transformer.



Pinout



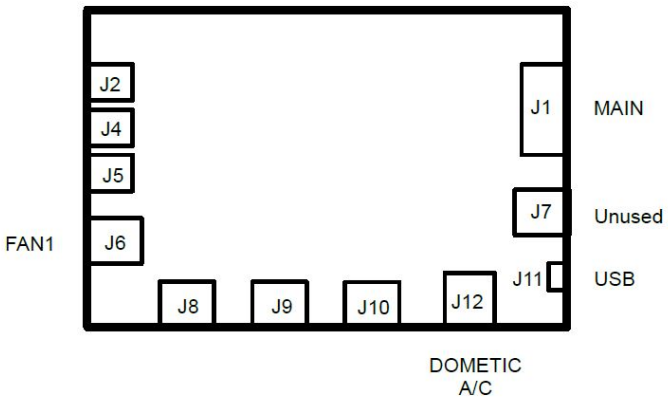


	Main Connector
1	Ground
2	---
3	---
4	---
5	RV-C Data +
6	RV-C Data -
7	Power (12V House)
8	Serial TX (232)
9	Serial RX (232)
10	Serial Ground (232)
11	AC Detect 1 (Low)
12	AC Detect 2 (Low)

	AC/DC Amperage Input
1	Ground
2	Sensor Out
3	---
4	5V

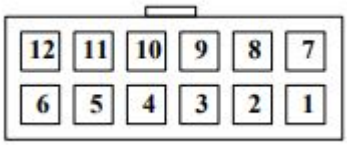
	AC/DC Voltage Input
1	AC - / DC -
2	AC + / DC +

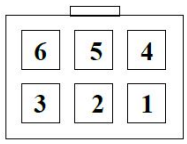
3.12 TM-2000 / TM-2020

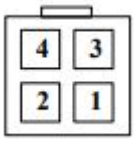


The TM2000 is a continuation of the TM200, but has additional load shedding capability, essentially combining the best features of the TM200 and TM250 into a single module. As many as three TM-2000 units may be installed in an RV.
TM-2000 can be configured for supporting different applications/projects depending on build and on-board dip-switch.

Pinout







	Main Connector		
1	Ground	7	Power (12V DC)
2	VBUS	8	Serial TX (RS-232)
3	---	9	Serial RX (RS-232)
4	---	10	Serial Ground
5	RV-C Data +	11	---
6	RV-C Data -	12	---

	Temperature (Temp1 – J2, Temp2 – J4, Temp3 - J5)	
1	---	
2	---	
3	Ground	
4	Ambient Temp	Analog

	Chassis Battery (Batt – J4) TM2021 only
1	---
2	---
3	Ground
4	Battery +

	Aquastat (Aquastat - J5)

	Pump Switch (Pump – J5) TM2021 only

1	---	
2	---	High
3	Ground	
4	Ambient Temp 2	Analog

1	---	
2	---	
3	Ground	
4	Pump SW	Low

	Dometic 5300 Fan Vent (Fan1 - J6)	
1	---	
2	---	
3	Ground	
4	RS485 +	Analog
5	RS485 -	
6	---	

	A/C1, A/C2, A/C3 (J8, J9, J10)	
1	Ground	
2	Fan Low	High
3	Fan High	High
4	AC Compressor	High
5	Heat Element	High
6	Fan High 2	High

	Espar Airtronic (J9)	
1	Ground	
2	Run	High
3	---	
4	Enable	High
5	---	
6	---	

	Secondary Vent Fan model 4100 (Fan2 - J8)	
1	Ground	
2	---	
3	---	
4	Fan Lid Open	High
5	Fan Lid Close	High
6	Fan Motor	High

	Rixen Furnace (J9)	
1	Ground	
2	Furnace Start	Low
3	Pump Out	Low
4	Fan 1 Out	Low
5	Furnace Power	Low
6	Fan 2 Out	Low

	Water Heater, Furnace (J10)	
1	Furnace +12V In	
2	Furnace Load	High
3	Water Heater (Elec)	High
4	Water Heater (Gas) or Furnace	High
5	---	
6	Water Heater Fault	High

	Electric, Tank Heat, Misc Fans (J10)	
1	Ground	
2	Electric Heat	Low
3	Tank Heat	Low
4	Fan 3 Out	Low
5	Fan 4 Out	Low
6	Aux Fan Out	Low

	A/C1(J8) – TM2000 Application mode, ProAir v1.39+	
1	Ground	
2	Fan PWM	High
3	Fan Relay	Low
4	Compressor	Low
5	Heat	High
6	Fan High/Medium	Low

	Dometic A/C (Dometic A/C - J12)	
1	---	
2	---	
3	---	
4	Ground	
5	Dometic – TTL	TTL
6	---	

Common Uses

Ambient Temperature and Thermostat: The TM-2000 monitors up to three temperature sensors and broadcasts the temperature readings.

Air Conditioning Control: Controls fan and heat settings for up to four Dometic rooftop units. A configurable dead band prevents excessive cycling. The Heat can be configured to be used only when either 50A Shore or Generator power is available, eliminating the need for an additional load manager.

Thermostat: The unit serves as the thermostat for all air conditioning units. The thermostat features are controlled through any RV-C control panel or device.

AC Power Management: One unit in the network may be designated a Master unit. This unit will monitor the status of the AC power, and suppress the number of AC units that will run at one time according to a configurable table. The decision of which zone has priority is based on the difference between the current set point and the actual temperature.

AC Settling: The unit monitors the transfer switch, and upon detecting a change in transfer status automatically turns off the A/C compressors for any units currently operating. It then restores the compressor power to each A/C individually, to prevent a large initial load from overwhelming the power source.

Secondary Heat Management: Allows the automatic management of a secondary heat source. Echoes the Thermostat heat settings to a second set of Thermostats, and sets the Operating Mode according to circumstances. Can be set to use one or the other heat sources, both, or automatically switch according to the outside air temperature. The echo process only echoes the Thermostat Commands. The scheduling is disabled on the secondary heat.

Roof Vent Fan Control: The unit can control/monitor a roof vent fan unit (from Dometic) through RS-485 interface. It converts and translates RV-C commands between RV-C bus and fan unit, and allows users to control and monitor the fan status (fan speed, dome lid position, rain sensor status, vent direction,...).

Secondary Roof Vent Fan Control: The unit also supports vent fans from Dometic that have only fan motor and lid open/close wiring. In this case, it simply controls fan on/off and lid open/close operations.

Water Heater Control: The unit has control outputs (on J10) to control Water Heater (gas and electrical).

Variations

TM2000 – Original hardware for 3 A/Cs - Direct replacement for the TM200.

TM2020 – Two A/Cs and Furnace/Water Heater control.

TM2021 – Same as TM2020 except replaces 2 temp inputs with chassis battery and water pump inputs - Modified for Triple-E RV.

TM2022 – Same as TM2020 but adds VBus. Uses Chassis Battery input and Water pump switch input.

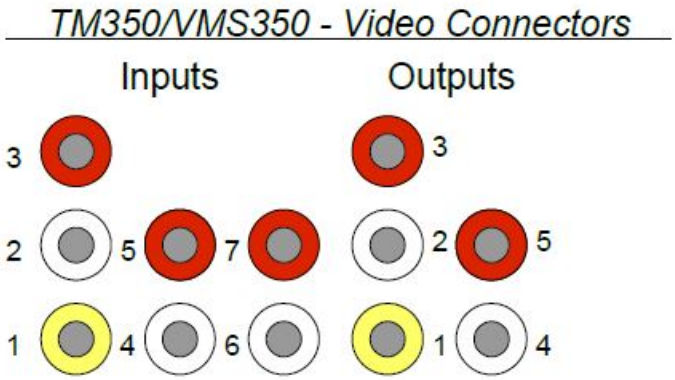
3.13 TM-350 / VMS-350 / VMS-333

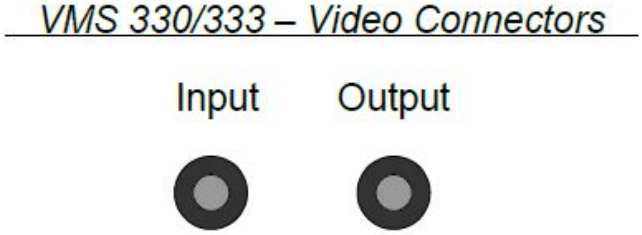
The TM350 is a composite video switcher. It replaces the VDX404 by supplying 7 inputs and 5 composite output channels. All control and functions are managed via RV-C or Omniscope diagnostic tool through the RV-C data network. The TM350 is a common feature (behind the scenes) in highline OEM coaches. As a remote-switcher, it does not use a keyboard and lacks internal hardware for other functions such as Video Overlay, J1708 or Analog inputs. Its construction is otherwise rooted in the VMS350's success in functionality and robust longevity.

The VMS333 and VMS350 use the same software and share many of the same hardware components. The

only real difference is the video switching configuration. The VMS350 is easily distinguishable from the TM350 by the inclusion of a ribbon cable connector on the side of the box. The TM350 case has a hole for this ribbon cable but no connector is mounted to the circuit board.

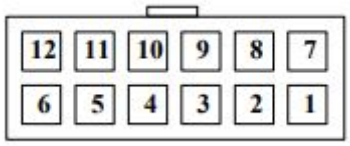
Pinout





These modules have an extra CAN transceiver and are designed to communicate on J1939 and RV-C. For added flexibility, RV-C communication can be configured for pins 5/6 or pins 11/12. This configuration can be accomplished through Omniscope or the keypad, if equipped. Once the setting is changed, if it does not have a keypad, it will no longer be able to communicate on the same pins and will have to be re-pinned before any further configuration is possible. Using the keypad, setting the RV-C port selection to 0 indicates pins 5/6 and setting it to 1 indicates pins 11/12.

	Main Connector		
1	Ground	7	Power (12V DC)
2	Output (High)	8	Serial TX (RS-232)
3	J1708 Data +	9	Serial RX (RS-232)
4	J1708 Data -	10	Serial Common
5	J1939 Data +	11	RV-C Data +
6	J1939 Data -	12	RV-C Data -



	Secondary Connector		
1	Ground	7	Reverse Input (High)
2	---	8	Left Blinker Input (High)
3	---	9	Right Blinker Input (High)
4	Input 1 (Low)	10	Input 3 (High)
5	Input 2 (Low)	11	Input 4 (High)
6	Output 1 (Low)	12	Output 2 (High)

Common Locations

Because the VMS333 / VMS350 / TM350 is used for both collecting chassis data and providing a video source for the front monitor, these units are most often found behind the dash.

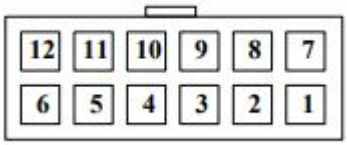
3.14 TM-501

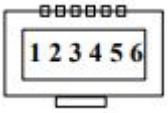
The TM501 is a USB to J1708 / J1939 bridge and is the hardware component of VMSpc. A connection to the chassis network is made through the diagnostic port, usually located below the dash. For coaches made in the 1990s, this is generally a DDEC 12-pin connector, while later coaches use 6-pin (J1708) until 2006, which marks a change to the 9-pin connector (J1939). Some coaches implemented 9-pin earlier than others, and some even used both J1939 and J1708 for a while.

3.15 TM-502

The TM502 interfaces with the Magnum MS or ME series of inverters over its serial RS485 port. In coaches with dual Magnum inverters, each inverter will have its own TM502. For stacking, the two TM502s will have different software – an A version and a B version for primary and secondary.

Pinout





	Main Connector	
1	Ground	
2	Input	High
3	RS485 Data +	RS485
4	RS485 Data -	RS485
5	RV-C Data +	CAN
6	RV-C Data -	CAN
7	Power (12V House)	
8	RS232 TX	
9	RS232 RX	
10	RS232 GND	
11	Out 1	Low
12	Out 2	Low

	RJ-11 “Inv”
1	---
2	RS485 Data -
3	Power (12V from inverter)
4	Ground
5	RS485 Data +
6	---
7	

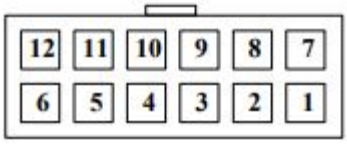
Common Locations

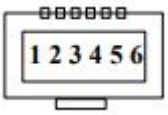
The TM502 will always be located near the inverter.

3.16 TM-510

The TM510 controls up to 4 rooftop Dometic air conditioning units. This also includes heat pump and heat strip control. It uses the same hardware as the TM502 and only differs in software and jumper configuration.

Pinout





	Main Connector				
1	Ground		7	Power (12V House)	
2	Dometic Data	TTL	8	Serial TX	RS232
3	---	RS485	9	Serial RX	RS232
4	---	RS485	10	Serial GND	RS232
5	RV-C Data +	CAN	11	---	
6	RV-C Data -	CAN	12	---	

Common Locations

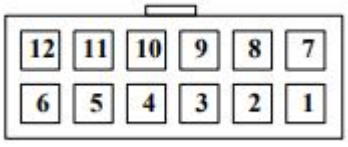
Newmar – Front overhead behind touch panel.

3.17 TM-550

The TM550 is the WiFi -to- RV-C interface module for RVCair (pronounced RVC air, not RV care). Using a local WiFi network, the TM550 takes user commands and outputs messages on the RV-C network, or collects RV-C messages and translates them into meaningful data. Thus, users can both receive data and control certain coach functions over their WiFi network.

Pinout

	Main Connector				
1	Ground		7	Power (12V DC)	
2	Input	High	8	Serial TX	RS232
3	Temp	Analog	9	Serial RX (RS-232)	RS232
4	Fuel / 12V	Analog	10	Serial Ground	RS232
5	CAN +	RV-C or J1939	11	Out	Low
6	CAN -	RV-C or J1939	12	Out	Low

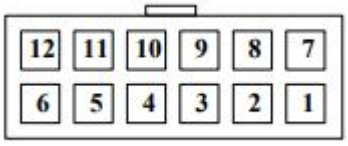


3.18 TM-555

The TM555 is a multi-I/O interface for use with the telematics system. It acts as a gateway from coach to secure, external services, for coach monitoring and management.
As an RVC bridge, it will output the coach environment as related by the outputing sensors on the RV-C network. This includes Tank Levels, Voltages AC & DC, Charger/ Inverter status, Heat & Cooling (zones) status and locks (when equipped.)
Within the context of telematics, it can also capture camera images and relay them to a secured server. This can work on a schedule as well as on upon unique commands or as the result of event. It can broadcast alerts under these same conditions on an ongoing basis.

Pinout

	Main Connector				
1	Ground		7	Power (12V DC)	
2	Input	High	8	Serial TX	RS232
3	J1708 +	J1708	9	Serial RX (RS-232)	RS232
4	J1708 -	J1708	10	Serial Ground	RS232
5	CAN +	RV-C or J1939	11	Out	Low
6	CAN -	RV-C or J1939	12	Out	Low

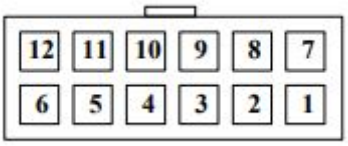


3.19 VMS-200EL

The VMS200EL is an engine/transmission monitor found in the dash of a coach. It provides information to the driver such as speed, tach, coolant temperature, and mpg. It also logs trips and engine diagnostic codes. It gets this information from the J1708/J1587 data bus. The VMS200 displays information using a monochrome electroluminescent (EL) display.

Pinout

	Main Connector		
1	Ground	7	Power (12V DC)
2	---	8	Headlight Switch
3	Engine Data + (J1708)	9	---
4	Engine Data - (J1708)	10	---
5	---	11	---
6	---	12	---



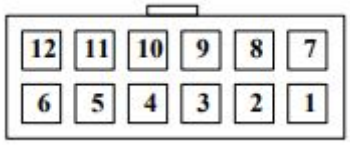
3.20 VMS-240CL

The VMS240CL is a engine/transmission monitor found in the dash of a coach. It provides information to the driver such as speed, tach, coolant temperature, and mpg. It also logs trips and engine diagnostic codes. It

gets this information from the J1708/J1587 data bus. The VMS240 replaces its predecessor the VMS200EL. It is the same size as a VMS200 but has a color display and larger buttons. This unit is out of production--having had a great run from about 2006 through 2013.

Pinout

	Main Connector		
1	Ground	7	Power (12V DC)
2	---	8	Headlight Switch
3	Engine Data + (J1708)	9	Acc Data + (J1708)
4	Engine Data - (J1708)	10	Acc Data - (J1708)
5	J1939 or RV-C Data +	11	---
6	J1939 or RV-C Data -	12	---



3.21 VMS-330

The VMS330 uses a video monitor in the dash to display engine and house systems data. It includes a keyboard to manipulate the display. Text from the VMS330 can be overlaid over an existing video image like a backup camera image.

Pinout

	Main Connector		
1	Ground	7	Power (12V DC)
2	Tire Lamp / Output 1 (High)	8	Serial TX (232)
3	Engine Data + (J1708)	9	Serial RX (232)
4	Engine Data - (J1708)	10	Serial Ground
5	J1939 Data +	11	RV-C Data +
6	J1939 Data -	12	RV-C Data -

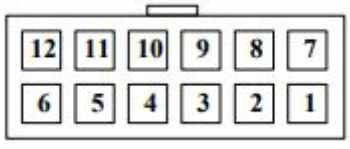
	Secondary Connector
1	Ground
2	Fuel Sense (Analog)
3	Temp Sense (Analog)
4	Reverse (High)
5	Blinker 1 (High)
6	Blinker 2 (High)

3.22 VMS-400CL

The VMS400CL is a engine/transmission monitor found in the dash of a coach. It provides information to the driver such as speed, tach, coolant temperature, and mpg. It also logs trips and engine diagnostic codes. It gets this information from the J1708/J1587 data bus. The VMS400 displays information using a color LCD display.
The VMS400 also has video capability. Many coaches use the VMS400 to show the backup camera image.

Pinout

	Main Connector		
1	Ground	7	Power (12V DC)
2	---	8	Headlight Switch
3	House Data + (J1708)	9	---



4	House Data - (J1708)	10	---
5	J1939 or RV-C Data +	11	---
6	J1939 or RV-C Data -	12	---

3.23 VMS-440CL

The VMS440CL is a engine/transmission monitor found in the dash of a coach. It provides information to the driver such as speed, tach, coolant temperature, and mpg. It also logs trips and engine diagnostic codes. It gets this information from the J1708/J1587 data bus. The VMS440 displays information using a color LCD display.
The VMS440 also has video capability. Many coaches use the VMS440 to show the backup and side-camera image(s).

3.24 VMS-616 / 640 / 645 / 647 / 650 / 747 / 755 / 757

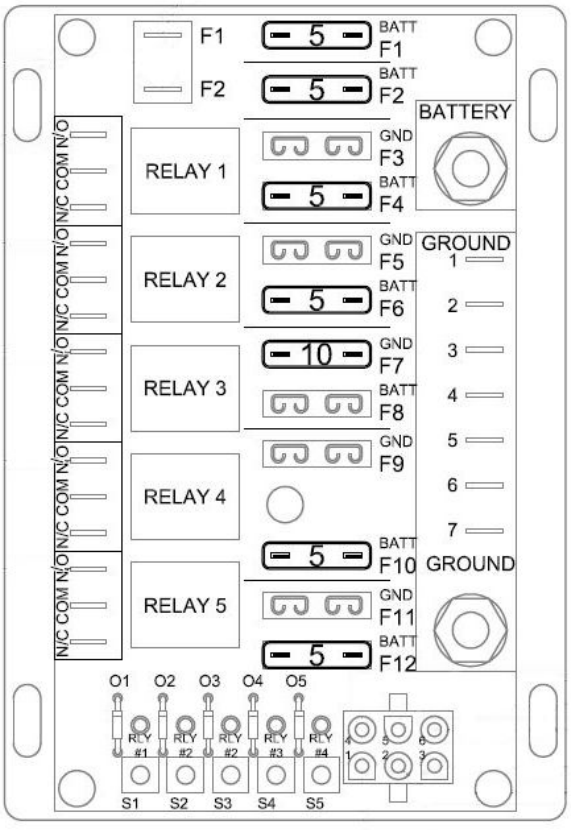
The VMS616, 640, 647, 650, 747, 755, and 757 are in a series of products commonly referred to as a "Digital Dash" or "Glass Dash." While a few of these were installed in Newmar, Newell, and Foretravel coaches, these are now used as aftermarket products and require some engineering and fabrication to install. There is rarely a need to diagnose problems with these due to the low number of installations. However, pinouts and additional technical data can be found on the shared drive.

OTHER PRODUCTS

4.1 KIB Relay Board

Several features on Newmar coaches are controlled by the KIB relay board. Understanding the layout of this board can be very useful when troubleshooting connected systems. In most cases, this relay board is located on the back wall of the shore cord compartment. In some cases, it is behind a removable carpeted panel. The panel is attached with Velcro and is easily removed. In New Aire coaches, the KIB relay board is located in one of the basement bays behind a diagonal brace and is only partially visible at the top of the wall.

Each of the relays along the left side of the board has a corresponding push-button (S1 through S5) that activates the relay. Additionally, a corresponding LED next to each push-button indicates whether an external controller is activating the relay. Normally, the relay would be activated by an active low output on an external controller, such as a TM102. Testing the relay manually with the push-button is an easy



116113 12V Relay Interface Board

way to determine whether a problem exists on the board or elsewhere.

Each fuse for the relays is either high-side (12V supply) or low-side (ground), as indicated next to the fuse. The top two fuses, F1 and F2, supply power to the LVDFET boards, and by extension, the RV-C network. Removing and replacing these fuses provides a convenient method for power cycling some equipment.

Relay 1: KIB Low Voltage Drop-Out board for TM102

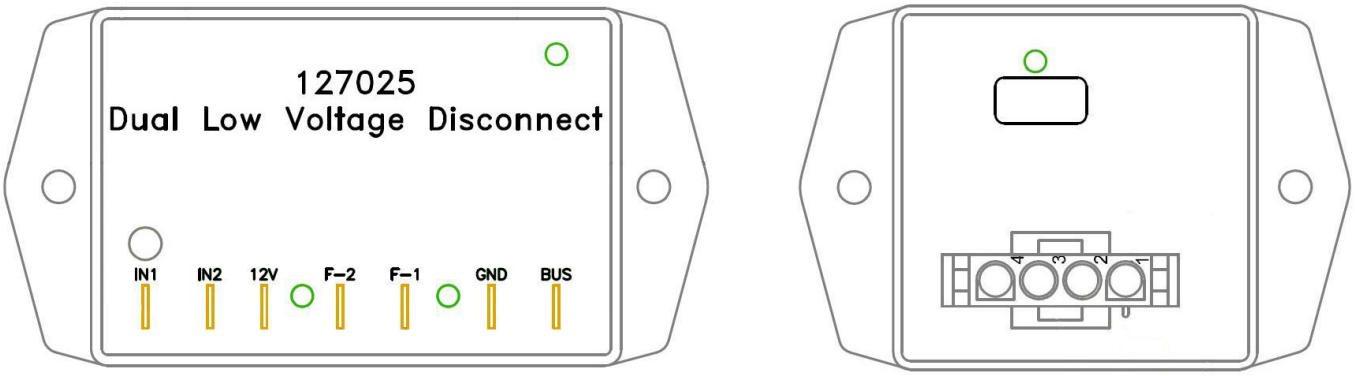
Relay 2: Auto Fill Valve

Relay 3: Water Pump

Relay 4: Charge Bridge Solenoid

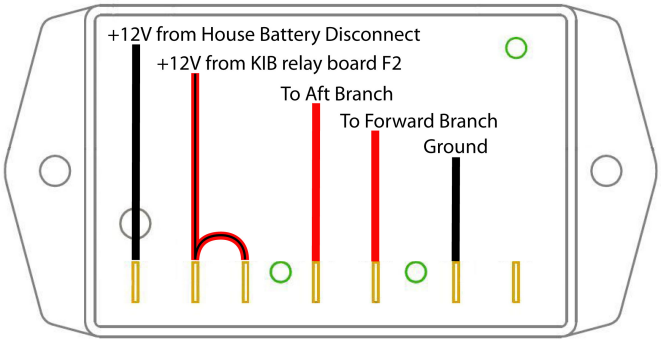
Relay 5: House Battery Disconnect

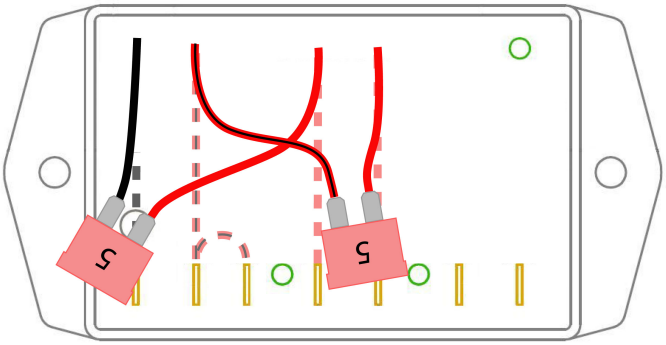
4.2 KIB LVDFET



On Newmar coaches there are two Low Voltage Drop-out boards made by KIB. The purpose of these boards is to prevent complete depletion of the house batteries in the event that charging cannot or does not occur. It accomplishes this by pulling a high-current FET into cutoff when the supply voltage drops to 10 volts, preventing any current from flowing. This ensures that once charging is possible again, the TM102 and inverter will have a high enough supply voltage to initiate the charging cycle.

These LVDFET boards fail from time to time, leaving owners with no control over certain house functions. Often, when a network census appears to show a break in communication, it is because the LVDFET is no longer supplying power to the modules in question. Fortunately, it is possible to temporarily bypass these KIB modules and restore power to the RV-C network until they can be replaced. Since the smaller board is only supplying power to the TM102, the owner or technician can easily bypass it by moving the TM102 supply wire from the terminal next to relay 5 to the F1 terminal that normally powers the LVDFET board, or move the TM102 supply wire from the NO contact to the NC contact. Bypassing the larger Dual LVDFET board is also very easy and involves bridging input and output wires with 5 amp fuses. A diagram is shown below.





4.3 KIB Bridge

KIB systems use simple “bit banging” binary messages to communicate, so they can't communicate directly with RV-C devices. The KIB Bridge is a translator between KIB equipment and the RV-C network that allows us to operate KIB devices from the touch panel. The Bridge takes commands from KIB push button panels throughout the coach so that lights, water pump and fill, and other functions may be controlled. When an operator turns on the water pump at the water bay, a message is sent from the water bay control panel to the Bridge, which is then translated to RV-C code and received by the TM102, which then activates the pump relay.

4.4 Tri-Mark Locks

Newmar coaches use Tri-Mark modules to control door locks and cargo bay locks. In 2016 and later coaches, these are the RV-C version, even in the Dutch Star, which is a non-RV-C coach. In these Dutch Stars, the Tri-Mark components utilize a Silverleaf RV-C bus tap for convenience. There are two components: the Tri-Mark handle with built-in keypad, and the controller. They send RV-C messages back and forth to request a lock state change and to confirm the lock state. Non-RV-C Tri-Marks can be converted to RV-C so that they are controllable from the touch panel, but it is expensive.

4.5 E-Plex

Prior to the adoption of the Silverleaf system in 2012, Newmar used the E-Plex system, which used only two wires for the network. These devices used a “Data Over DC” scheme, so that the data wires were also the 12VDC supply wires. A Silverleaf retrofit utilizes the existing pair of wires for RV-C data, which means that each module must have its own local power source, which can be difficult.