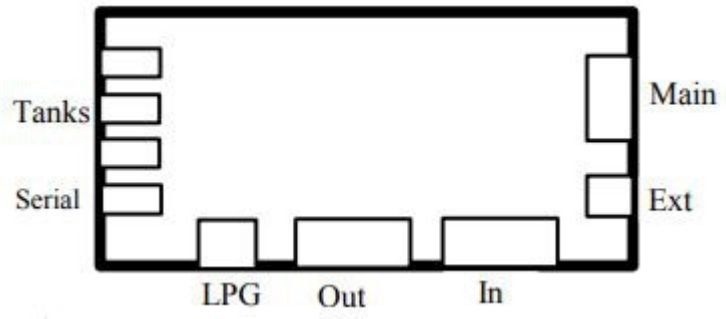
Silverleaf – Winnebago
Systems Overview

Feb 2023

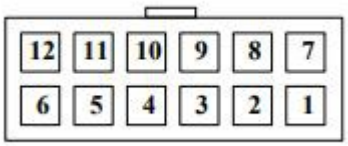
Silverleaf Device Summary:

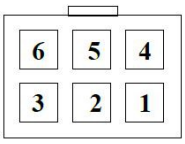
HMS407:
The specific model of control panel may vary between models and over time, but its basic function is constant. The HMS is the main user interface for all RV-C connected systems. The HMS does not control any devices, but sends messages to the modules which control them.

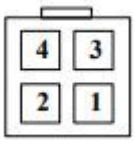
TM1010 Coach Management Module:
The TM1010 (TM1000 in the earliest models) performs a broad range of functions including the following:
AGS and generator control
System clock
AC/DC current monitoring
Chassis data bridge
LP tank monitoring
Auto-leveling control
Load shedding logic
Load shedding relay control
Park brake monitoring
Ignition switch monitoring
Chassis and house battery measurement



Pinout







All connectors shown from wire side.

	Main Connector
1	Ground
2	---
3	---
4	---
5	RV-C Data +
6	RV-C Data -

	Inputs	
1	Park Brake	Low
2	---	
3	---	
4	---	
5	---	
6	---	

7	Power (12V House)	
8	RS485+	
9	RS485-	
10	---	
11	---	
12	---	

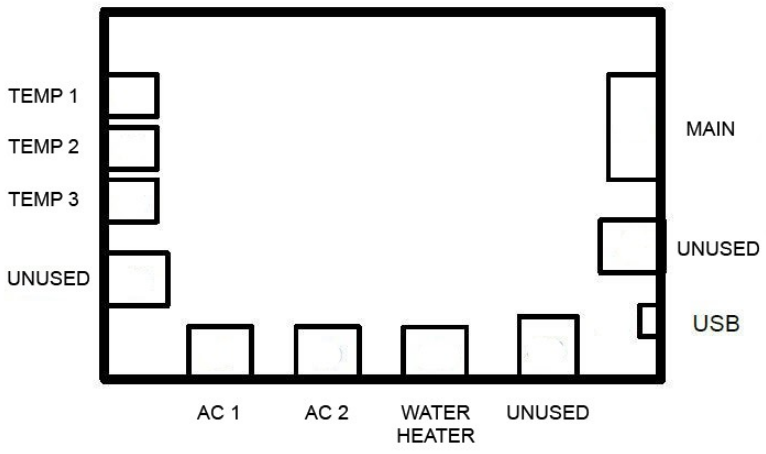
7	---	
8	Gen Running	High
9	Leveling Status Signal	High
10	Ignition Status Signal	High
11	---	
12	---	High

	Outputs	
1	Auto-Leveling Output	Low
2	Leveling-Retract Output	Low
3	Dryer Shed	Low
4	Park Brake Output	Low
5	Gen Start	Low
6	Gen Stop	Low
7	Fireplace Shed	High
8	Washer/Dryer Shed	High
9	Chassis Battery Sense	Analog
10	House Battery Sense	Analog
11	---	
12	---	

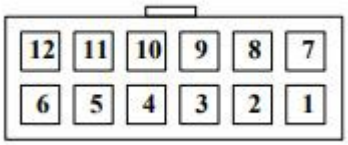
	Sense Inputs (shown as tanks)
1	5V DC Output
2	Ground
3	AC Leg 1 current (Sense 1)
	AC Leg 2 Current (Sense 2)
	House Battery Current (Sense 3)
4	---

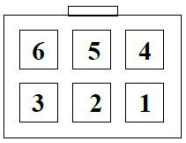
	ENG (To MS600)
1	5V DC Output
2	Ground
3	TTL Transmit
4	TTL Receive

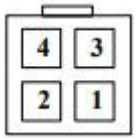
TM2022 HVAC Controller:
The TM2022 controls air conditioner and furnace functions as well as water heater and load shedding relays. It also acts as the RV-C to V-Bus bridge to grant control over KIB devices.



Pinout







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

	Temp1, Temp2	
1	---	
2	---	
3	Ground	
4	Temp Sense	Analog

	A/C1, A/C2	
1	Fan Low	High
2	Fan High	High
3	Compressor	High
4	Heat Strip	High

	Water Heater		
1	Furnace 12V Input	Input	High
2	Furnace Load	Output	High
3	Water Heater Elec	Output	High
4	Water Heater Gas	Output	High
5	---		
6	Water Heater Fault	Input	High

MS600 OBDII Interface:
The MS600 is a TM1010 sub-module that translates OBD chassis data and relays it to the TM1010 via a 2-wire TTL data link. It is powered directly by the TM1010 and must not be connected to a 12V source.

TM-630 Truma Interface:
The TM-630 is an RV-C interface for Truma water heaters. It translates data and commands from Truma's proprietary data format to RV-C.

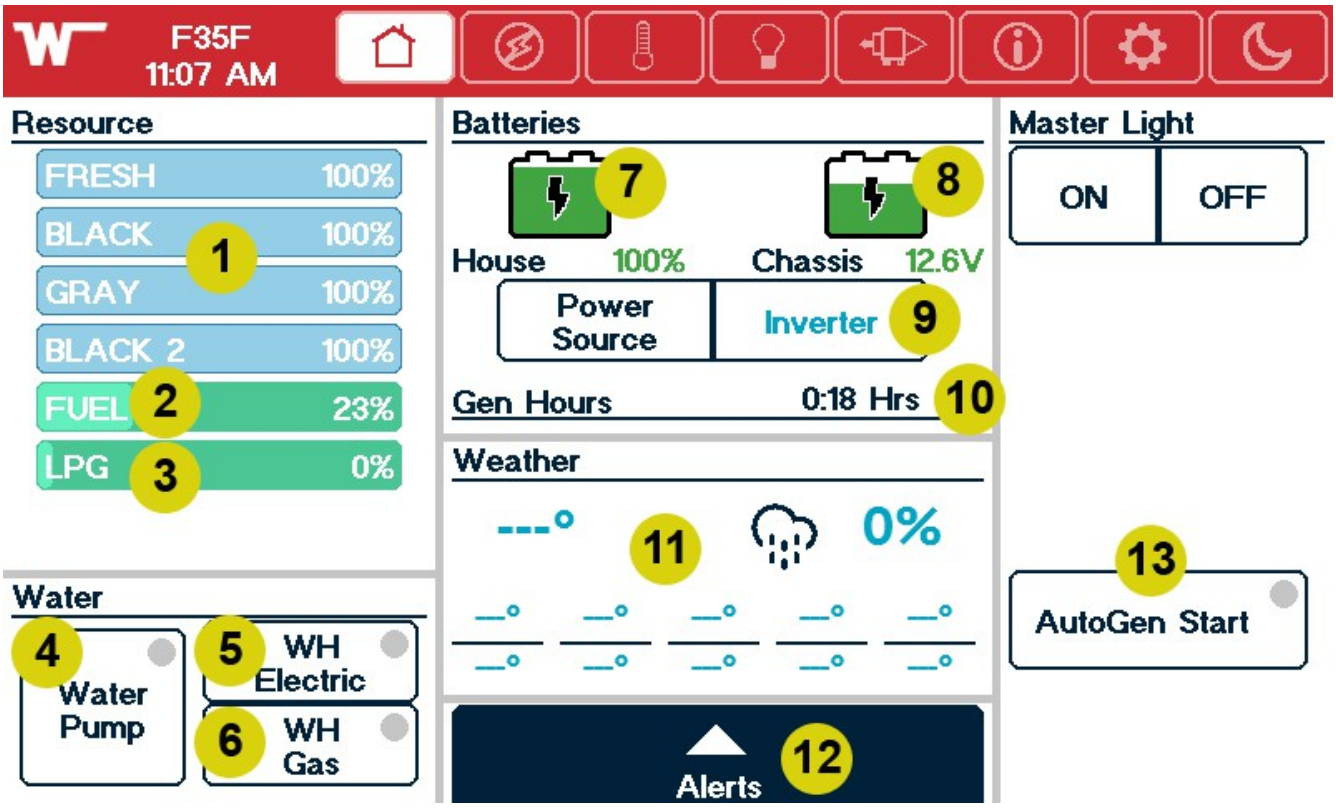
LR-125:
The LR-125 is a Wi-Fi connected web server which converts RV-C data to HTML data that can be displayed in a web browser or app. In terms of its function, it can be thought of as a second HMS. It sends and receives the same RV-C messages as the HMS does. In order for a user to interact with it,

however, it must be connected to a WiFi router.

The LR-125 can operate in two modes: near-field and far-field. Near-field operation is accomplished when a Wi-Fi-connected device is on the same Wi-Fi network as the LR-125. In this case, the Wi-Fi router is the only intermediary between the mobile app (or web browser) and the LR-125. As such, the device running the app must be in range of the RV's router.

The second mode, far-field, has additional requirements. Both the RV's router and the device running the app must have an active internet connection. The user must also be logged into a cloud account which has been registered to that specific LR-125. Additional information on this topic is covered in supplemental documentation.

HMS Function Guide:



1 Fresh, Black, Gray tank levels

KIB tank sensors are attached to the outside of the tank and wired into a KIB module. The pin location to which the tank sensor is connected determines the tank level with which the sensor will be associated. For instance, if a half-full fresh tank sensor is wired to the black tank pin, the black tank will read half-full.
The tank level is broadcast on the KIB V-Bus, which is intercepted and translated by the TM2022 and

rebroadcast on the RV-C network.

Each tank sensor must be calibrated to set both full and empty limits. This is done in the Tank Settings screen. Each tank must be given an instance and a name in the Monitor Settings menu in order for the HMS to pair a KIB tank level with its proper tank name on the HMS. The HMS firmware supports up to 6 tanks, excluding Fuel and LPG.

Displayed data source: KIB tank sensors > V-Bus > Translated to RV-C by TM2022

2 Fuel level

Fuel level is taken from the OBDII diagnostic port by the MS600 and relayed to the TM1010 at the ENG input. Pins must be configured for TTL. The TM1010 broadcasts the fuel level on the RV-C network.

Data taken from the OBDII port is only available when the ignition key is on Accessory or Run. If the TM1010 is not receiving an updated fuel level, it will broadcast the last known value.

Displayed data source: OBDII > MS600 > TM1010

3 LP Tank level

LP tank level is measured directly by the TM1010 on the LPG input. A simple resistive reading is converted to LP level through a corresponding table in the TM1010.

Displayed data source: TM1010 LPG input

4 Water pump status

The water pump is controlled by KIB and can be activated by a switch input on the main KIB board or by an RV-C message, which the TM2022 translates and rebroadcasts on V-Bus. An on-board KIB relay sends power to the water pump relay, activating it. The status of this relay is broadcast on V-Bus, which is then translated to RV-C and rebroadcast by the TM2022.

Since the KIB relay is sending power to the coil of a second larger relay, troubleshooting the water pump should start with checking for power at the larger relay.

The dot in the corner of the status buttons can be either gray (off), green (on) or red (fault).

Displayed data source: V-Bus > Translated to RV-C by TM2022

5 Water heater (electric) status, 6 Water heater (gas) status

The water heater can be controlled one of two ways. In some models, a TM630 is used to communicate to a Truma control panel. In such cases, RV-C commands are translated by the TM630 and relayed to the Truma panel. In other models, the TM2022 directly controls the water heater by activating relays using Water Heater pin 3 (electric) or Water Heater pin 4 (gas). A fault status from the water heater is monitored at Water Heater pin 6. In models with both electric and gas water heating elements, both can be active at the same time.

Displayed data source: TM2022 activates relay on water heater plug, pin 3 (electric) or pin 4 (gas);

TM2022 reports status. Fault status input from water heater on pin 6 or Truma control panel > TM630.

7 House battery

The house battery level is measured by the inverter and reported, either by its own CAN port (2000W inverters) or through an external RV-C interface (1000W inverters), on the RV-C network. In models with lithium house batteries, this value is reported as a percentage (State-of-Charge or SOC). In models with conventional house batteries, this value is expressed as a simple voltage and is translated by the TM1000 or TM1010 as an estimated state-of-charge based on the expected maximum voltage of the battery. For diagnostic purposes, the raw battery voltage can still be seen in the power screen settings menu.

While early models utilized the TM1000, that module was eventually replaced by the TM1010, which has the added ability to directly measure the house battery voltage through output plug pin 10. The additional wire at this pin is connected directly to the house battery positive terminal or to a house battery DC bus. A TM1010 can be used as a direct replacement for a TM1000, but a TM1000 cannot replace a TM1010. The voltage on the added wire will cause damage to the TM1000. If a TM1000 must be used, the added wire must be removed or disconnected from the voltage source.

The TM1010 checks for 'DC Source Status 1' messages from the inverter. If it does not see this message after a few seconds, it uses its own house battery measurement.

Displayed data source: Inverter > RV-C > TM1010 converts to estimated SOC. When the inverter is not broadcasting voltage, TM1010 uses its own measurement on output pin 10 (early units with TM1000 will not have this feature).

8 Chassis battery

Unlike the house battery voltage, the chassis battery voltage is always expressed as a raw voltage, not State of Charge. The TM1010 measures the chassis battery directly on output pin 9.

Displayed data source: TM1010 output pin 9

9 Power source

The inverter reports the presence of power from the shore cord, but since Winnebago does not use a smart transfer switch in Silverleaf-equipped models, the TM1010 looks at the status of the generator, which it directly monitors at input pin 8, and assumes that power is coming from the generator when it is running. Shore power is reported by the inverter. If the inverter or the external RV-C comm box for the inverter loses communication, “No Power” will be reported when the generator is not running.

Displayed data source: Inverter, TM1010

10 Generator hours

The TM1010 uses input pin 8 to monitor the generator run status. A positive voltage on this pin triggers the generator hour meter within the TM1010. In the event that the TM1010 or the generator must be replaced, generator hours may be edited through Omniscope.

Displayed data source: TM1010

11 Weather

The Winegard router obtains weather data from a weather service when an active SIM card is installed. The LR125 obtains this data from the router and broadcasts it on the RV-C network.

Displayed data source: Winegard router > LR125 translates to RV-C

12 Alerts

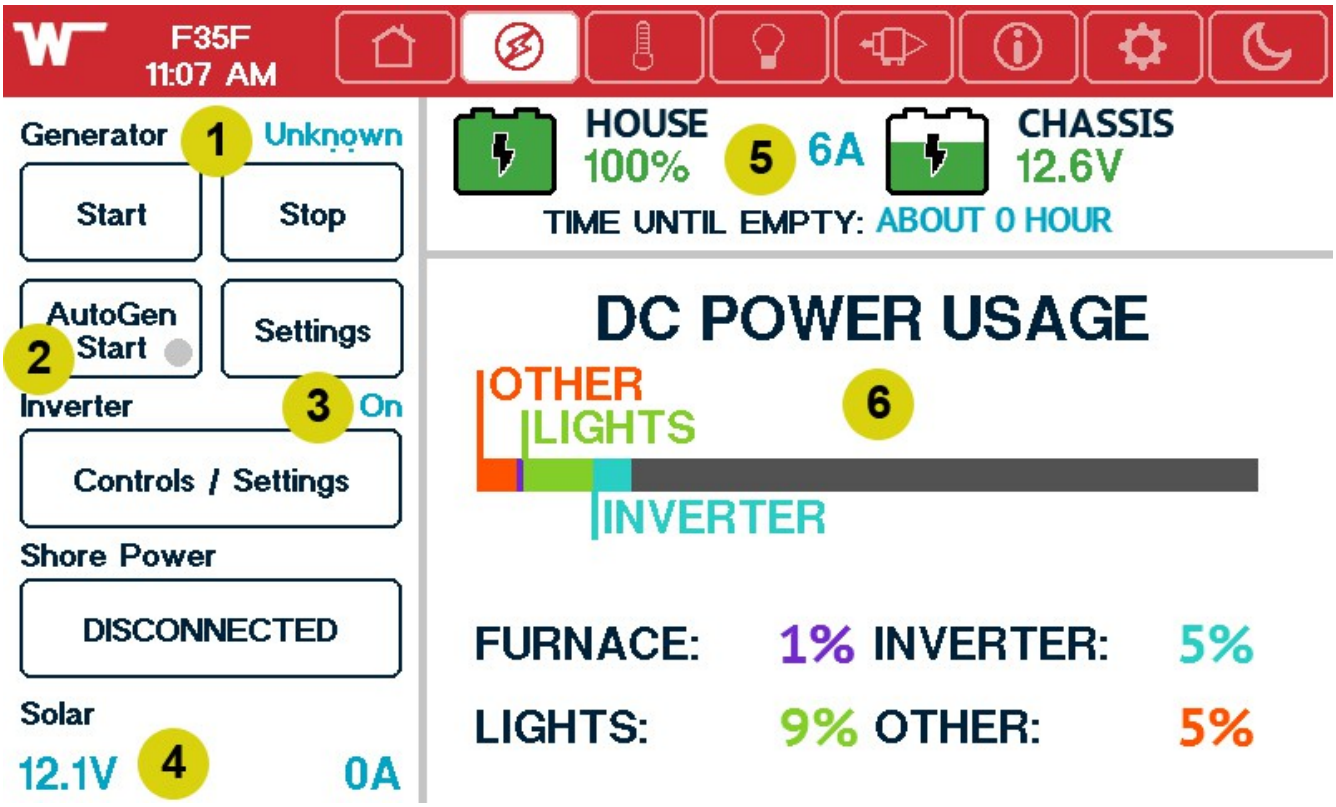
The Alerts screen displays information from RV-C diagnostic messages (DMRV) from various sources. If a fault condition exists in an RV-C device, this data is included in its DMRV.

Displayed data source: Various RV-C modules broadcast diagnostic messages

13 Auto Gen Start

Generator run status and AGS status and locks are kept and reported by the TM1010. The TM1010 also contains all of the logic for controlling AGS.

Displayed data source: TM1010



1 Generator status, 2 AGS status

Generator run status and AGS status and locks are kept and reported by the TM1010. Pressing the generator start button sends a message to the TM1010, which grounds output pin 5 temporarily, causing the generator to start. The cranking time can be set through Omniscope. When stopping the generator from the control panel, the TM1010 grounds output pin 6, stopping the generator.

Displayed data source: TM1010

3 Inverter status

The inverter reports its own status, either directly (2000W inverter) or through an external RV-C interface (1000W inverter).

Displayed data source: Inverter

4 Solar voltage & current

Solar charging data is communicated by the Xantrex solar controller to the TM1010 on pins 8 and 9 of the main connector. These pins must be configured for RS485 communication. The TM1010 translates this data to RV-C

Displayed data source: Solar Controller>TM1010 translates to RV-C

5 Time to full / time to empty

The TM1010 calculates time-to-full and time-to-empty based on the assumed battery capacity and charging current or current draw. For more information on this calculation, see the Power Graph section.

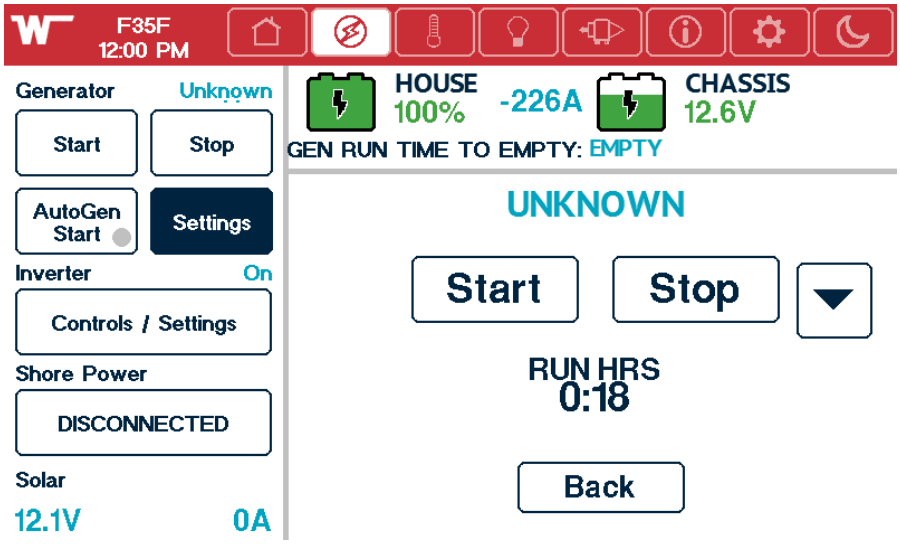
Displayed data source: TM1010

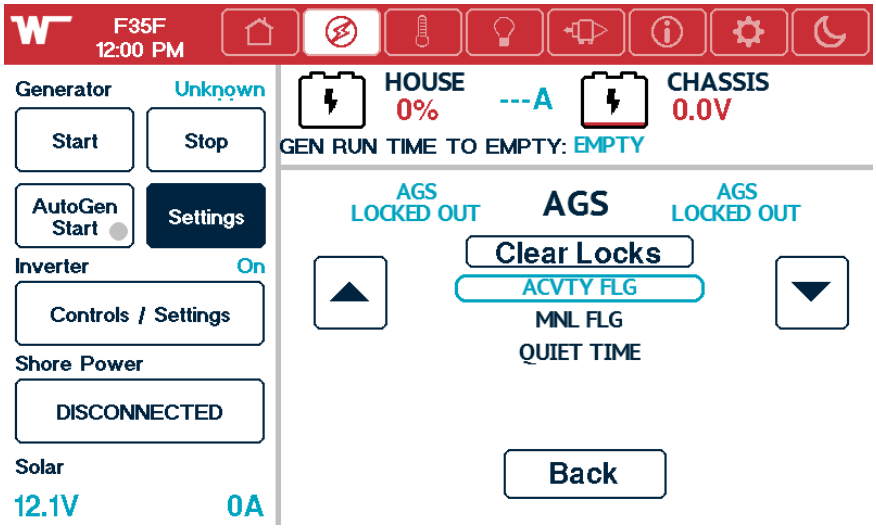
6 Power graph

Power usage figures are combined measured values, reported values, and estimates. The inverter measures and reports its current draw. Some devices, like lights, furnace, and others whose status is reported on the RV-C network, are accounted by the TM1010 using an expected current draw. For instance, if a light is expected to draw 1 amp, the TM1010 will add 1 amp to the total when it knows that the light is on.

The TM1010 uses a hall effect sensor to measure house DC current. This gives the TM1010 a total current draw from which known (or assumed) current draw is subtracted, the remainder of which is reported as Other on the power graph. Exhaust fans, DC refrigerators, RV-C devices and controllers, and devices which have a constant parasitic current draw are some examples of house battery loads that account for the Other portion of the power graph.

Displayed data source: Inverter reports current draw + TM2022 reports status of KIB devices > TM1000/TM1010 compiles known and assumed current draw and reports totals on RV-C network



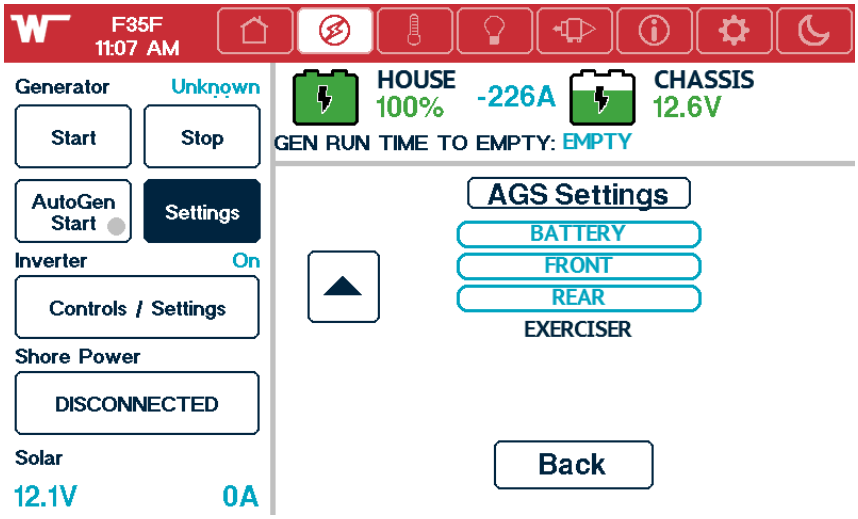


The generator can also be started and stopped from the Generator Settings menu.

AGS Locks: The TM1010 keeps lock values for three different scenarios: Activity Flag, Manual Flag, and Quiet Time. An activity flag is set when an event within the system causes the TM1010 to lock out AGS. For instance, if the vehicle is moved, the generator should not be allowed to start automatically because the conditions of the new locations cannot be known. A manual flag is set when the user stops the generator. This is set because the user's reason for stopping the generator cannot be known. Quiet time, which can be configured in the AGS settings, will create a lock at the start of quiet time and remove the lock at the end.

At the top of this pane are two AGS indicators. The one on the left is for the battery autocharger and the one on the right is for climate AGS. In the example above, they are both locked out. When active, they will read “Autocharger Enabled” and “HVAC Enabled”.

Displayed data source: TM1010



AGS Demand: This screen shows which AGS demands are enabled. Enabled demands will be highlighted. In this example, the exerciser is disabled. Each of these can be enabled or disabled from the AGS settings menu.

The AGS Settings menu contains the following settings:

Battery Autocharger: Enabled or Disabled. This allows the generator to start when the battery voltage drops below a threshold.

Trigger Voltage: Sets the low threshold voltage for autocharger AGS. If the battery voltage drops below this voltage, the TM1010 starts a countdown, after which the generator will start, if able. The countdown length is configurable in Omniscope. If the battery voltage momentarily rises above the voltage threshold, the countdown restarts.

Topoff Voltage: This is the threshold voltage for topoff. It is typically set higher than the trigger voltage but lower than the full resting voltage of the battery so that the generator will top off the battery even if its voltage has not fallen to the trigger voltage.

Topoff Run Time: The amount of time the generator will run prior to Quiet Time. For example, if Quiet Time starts at 10pm and Topoff Run Time is set to 45 minutes, the generator will run from 9:15 to 10pm.

Quiet Time Start: The time at which the generator should no longer start automatically. Typically in the evening around bed time.

Quiet Time End: The time at which AGS may resume its normal operation. Typically in the morning.

Front A/C and Rear A/C Auto Gen Start: Enabled or Disabled. This allows AGS to start the generator when an air conditioner demand exists and shore power is unavailable or inadequate. When an air conditioner wants to start

AGS Maximum Run Time: The maximum amount of time the generator should be allowed to run.

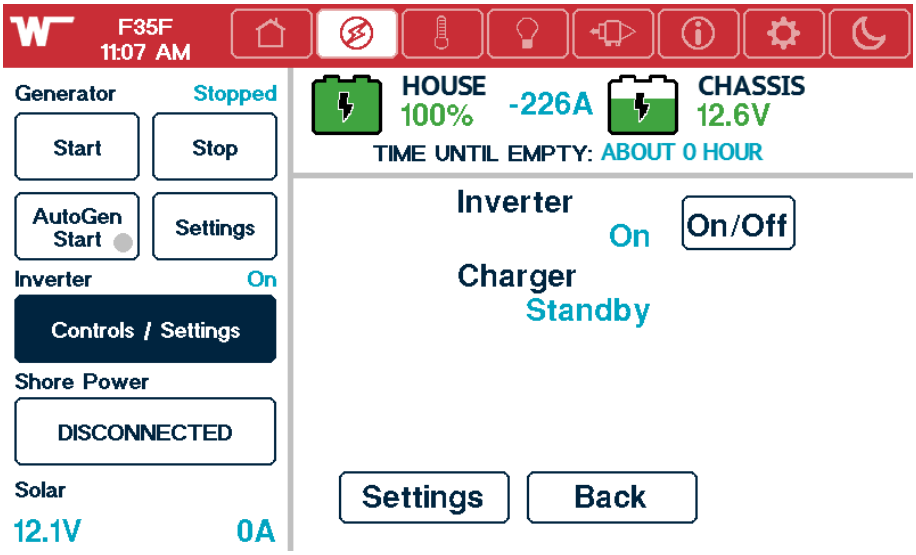
During autocharge, the generator may stop earlier if a full charge is achieved.

Scheduled Exercise: Enabled or Disabled. This is a way to keep the generator in good operating condition by exercising it at a scheduled interval. This is typically used when the RV is in storage and will not be permitted when AGS locks are active.

Scheduled Exercise Start: The time at which the generator should start

Scheduled Exercise Run Time: The duration of the exercise

Scheduled Days For Exercise: More than one day may be selected. Active days will have a border around them.



Inverter / Charger Status: The inverter reports its status on the RV-C network either directly through its CAN port or remotely using an RV-C interface. The inverter status can be On, Standby, or Off. Standby means that the inverter is enabled but is not currently providing any inverted power. The inverter may be turned on or off from the touch panel unless it has entered a sleep mode due to extended inactivity. In such cases, only certain events, such as placing a load on the inverter or charging via the generator can wake up the generator.

The charger status can be On, Off, Standby, Bulk, Absorb, or Float.

Displayed data source: Inverter when active, TM1010 when inactive

The Inverter Settings menu contains the following:

Inverter Status: The user may turn the inverter on and off from this screen.

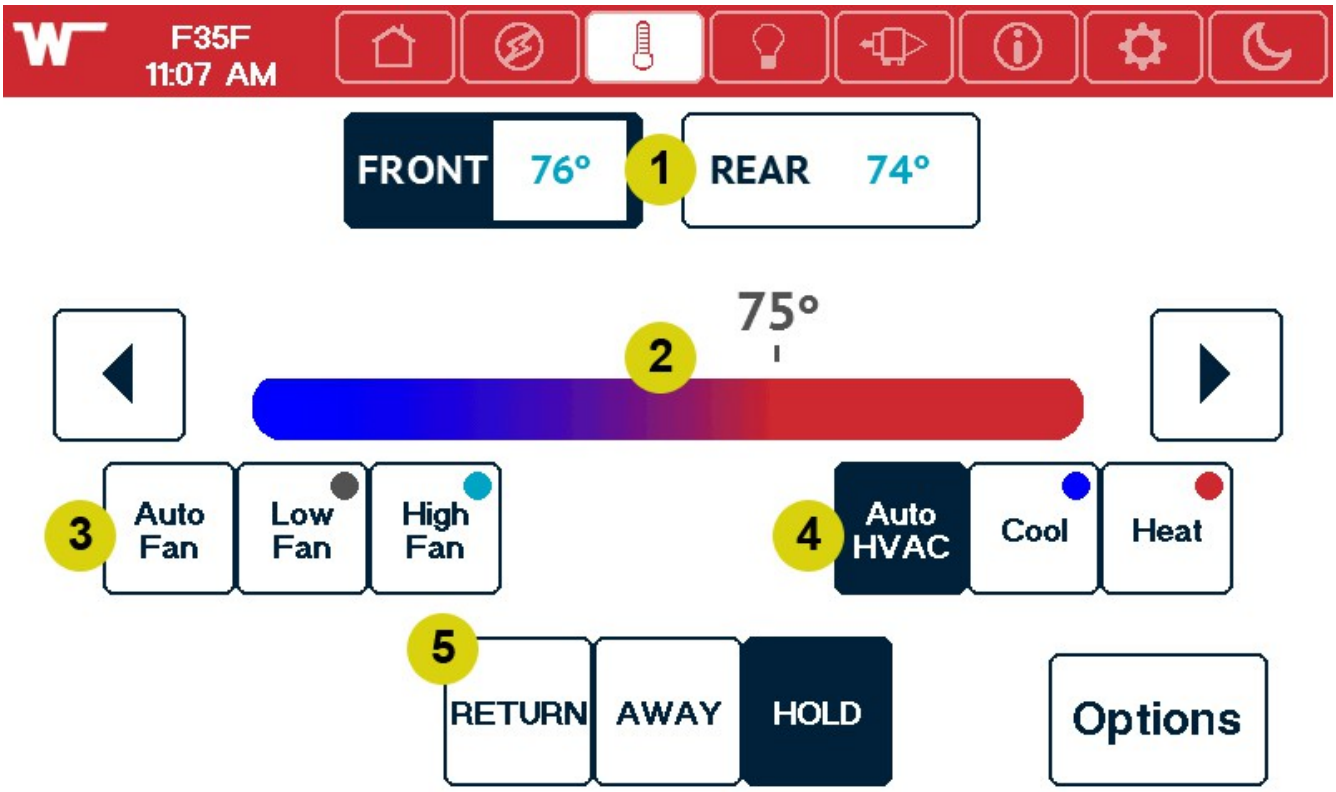
Charger Status: This cannot be changed by the user.

Charger Amps: DC amps being used to charge the battery.

Shore Breaker Size: This normally only needs to be changed when plugging into breakers smaller

than 30A. The TM1010 can automatically detect whether the RV is plugged into a dual-phase source (50A) or single phase (30A) but does not know whether the single phase source is smaller than 30A.

Additional settings in this menu are protected by the Settings Lock Code in the Advanced Settings menu and should not be changed without a deeper understanding of their function.



1 Zone temperatures, 2 Set point

The TM2022 measures front and rear zone temperatures using thermistors connected at its Temp 1 & Temp 2 plugs. Temperature set points for each zone are stored in the TM2022. A deadband is configurable through Omniscope and is typically set to 1 degree.

Displayed data source: TM2022

3 Fan speed

The TM2022 uses its two A/C output plugs to control the fan speed on the air conditioners (Low: pin 2, High: pin 3, Off: no voltage on either pin) as well as the compressor (pin 4) and heat strip (pin 5) for each air conditioner.

Displayed data source: TM2022

4 HVAC mode

Auto HVAC: The TM2022 decides whether heating or cooling are needed and activates accordingly. Cool: Allows the air conditioners to cool as needed. Heat: allows the air conditioners or furnace to heat as needed. The status dots will be gray when disabled. Disabling either heating or cooling also disables Auto HVAC. When heat is active, the TM2022 will activate either the heat strip, the furnace, or both,

depending on the Heat Mode setting in the Climate Options menu.

Displayed data source: TM2022

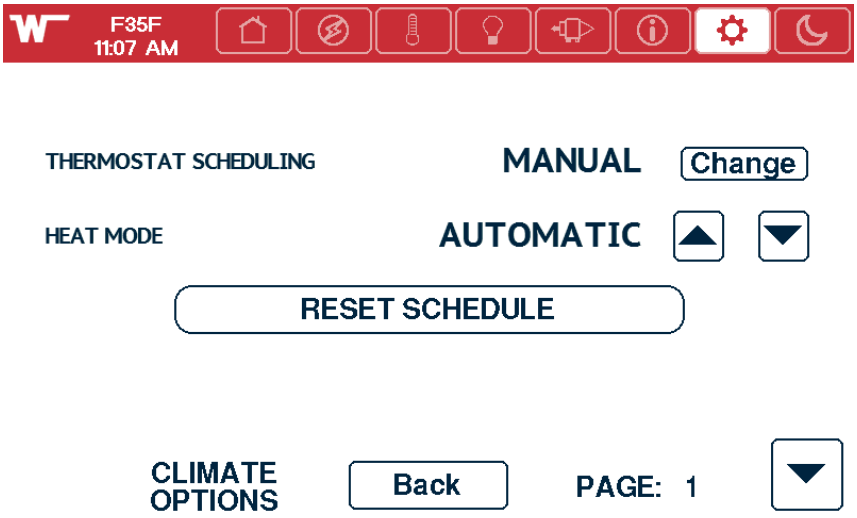
5 Scheduling modes

Return / Day / Night: Pressing this button activates scheduling, which allows a user to set and store separate daytime and nighttime temperature settings. Day/Night start and end times are set in the Options menu. Temperature settings will automatically switch to day or night values at the set times.

Away: Alternate temperatures may be set for use when the RV is not in use. For instance, if the user does not wish to keep the interior of the RV at a comfortable temperature, but wishes to maintain minimum and maximum temperatures to prevent freezing or other damage, these may be set here. Pressing the Away button will revert to these settings. The Day / Night button will change to read Return. Pressing return will restore normal in-use temperature settings.

Hold: If scheduling is not desired, pressing hold will disable scheduling and the set temperatures will only be affected by directly changing them using the arrow buttons.

Displayed data source: TM2022



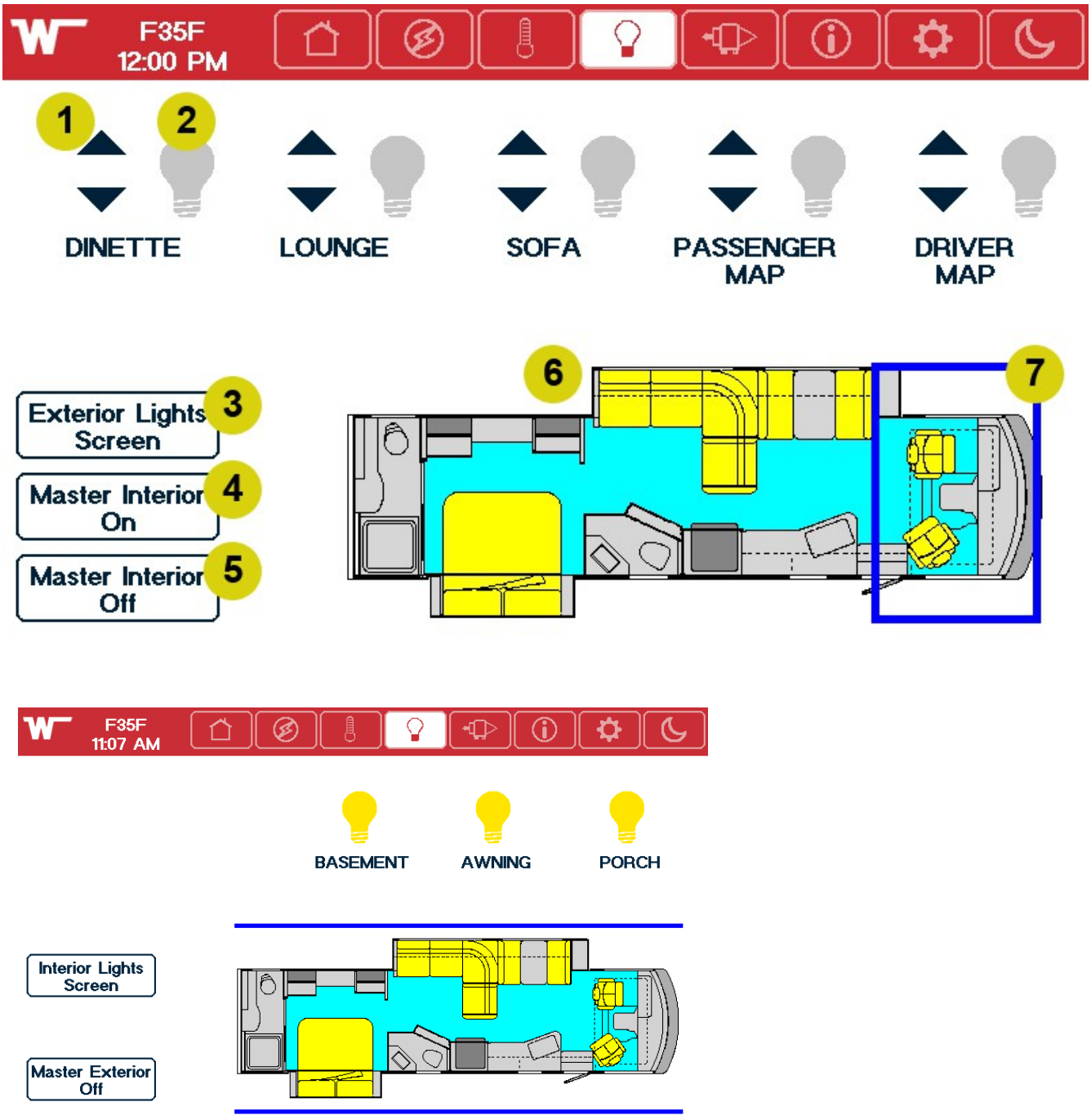
Thermostat scheduling: This is the same as pressing the Hold or Day / Night / Return buttons on the previous screen and will change those buttons accordingly.

Heat Mode:
Automatic: Allows the TM2022 to select either the furnace (secondary) or the heat strip (primary) as the heat source depending on outside temperatures. If the outside temperature is below 40 degrees, the more efficient furnace will be selected.
Primary Only: Only the heat strip will be used.
Secondary Only: Only the furnace will be used.
Both On: Both the heat strip and furnace will be active.

Reset Schedule: Returns all thermostat scheduling settings to factory defalt values.

Displayed data source: TM2022

Additional settings in this menu set the start times for Day, Night, and Away, as well as temperatures for each zone during these times. When using the Away setting, there is only a single temperature which uses the same deadband as the other settings. If this setting is used for storage, the user will need to determine whether there is a greater risk of freezing or overheating and set the HVAC to heat or cool. Setting Auto HVAC will maintain a temperature and will use more energy.



Lighting Control:

Turning lights on and off requires coordination between several elements. The simplest operation occurs when a light is controlled from a KIB lighting keypad. In this case, A message is sent from the keypad to the KIB module controlling the light via KIB's V-Bus network. Controlling lights from the HMS requires additional steps, though from the user's perspective, it is just as simple. When the user presses a button on the HMS to turn a light on or off, a message is sent from the HMS via RV-C to the TM2022, which interprets the message and rebroadcasts in on V-Bus. This is illustrated in more detail below.

1 Dimmer buttons, 2 Light status

The up and down arrows next to each light increment or decrement through a configurable number of steps in its dimming sequence. The number of steps can be set through Omniscope using the HMS tool. Setting the number of steps to 1 removes the up and down arrows and the light will operate as fully on or fully off. The HMS converts these steps to a percentage and passes this information along via RV-C to the TM2022, which then interprets and relays the command to the KIB V-Bus. A KIB lighting controller adjusts the pulse-width modulation (PWM) on its output accordingly. The module broadcasts the status of each of its outputs at regular intervals. So when a light is turned on or off, the TM2022 can see its status on V-Bus and relay the status back to the HMS. Therefore, if a light icon on the HMS indicates that a light is on, it is not merely indicating that the HMS has sent the command to turn it on, but that the KIB module has sent confirmation that the light is actually on. A status LED will also be lit on the lighting control module's output for that light.

Displayed data source: HMS command on RV-C > TM2022 interprets to V-Bus > Light module broadcasts status > TM2022 interprets to RV-C

3 Exterior lights screen

This button brings up an additional lighting screen for awning, porch, and basement lights. The lights included on this screen can be configured through Omniscope by changing the “Outside Light Start” setting in the HMS tool.

4 Master interior On, 5 Master interior Off

Lights within the KIB system are added to various groups. Master on and off functions are group commands and only lights that are included in those groups will be affected. If a light does not turn on with the Master On button or off with the All Off button, it is because that light has not been added to that group. This cannot be configured through Omniscope because it is not controlled by an RV-C device but can be configured through KIB's V-Bus Studio.

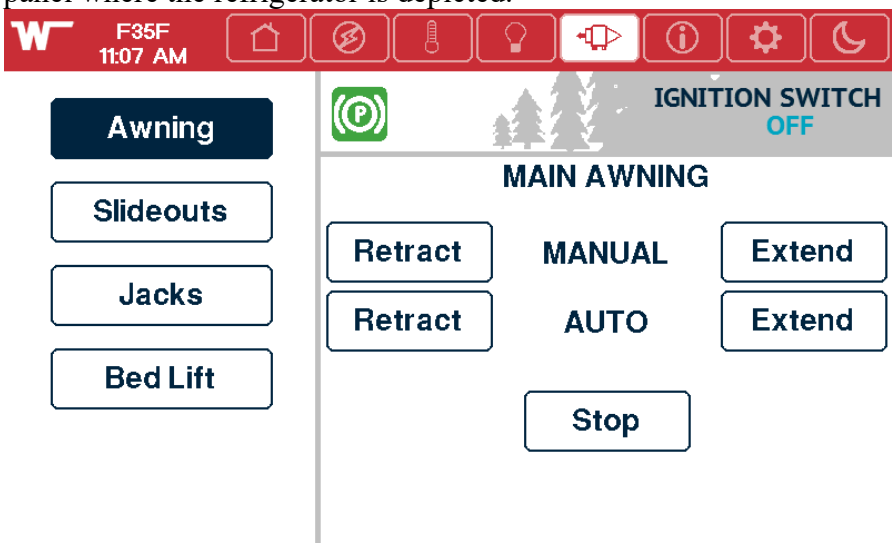
6 Floor plan

HMS firmware includes the floor plan art for all Winnebago models which use that model of HMS. Selecting the floor plan at the end of the Monitor Settings menu will automatically update the floor plan art on the lighting screen.

7 Light zone

Pressing the touch panel within the floor plan image will move the light zone box, highlighting different lights which are located within that zone. The location of these lights and their proximity to a selected location within the floor plan image are configurable through Omniscope. Each light is given an index number between 0 (front of RV) and 100 (rear of RV), which determines its location. If a light should be included in a group centered around an index value, its index can be adjusted to be closer to

that index value. For instance, if the refrigerator is located at the center of the RV, a light directly in front of the refrigerator should have an index of around 50. If its index is too far from that value, the light will not show up on the list above the floor plan image when the user presses the area of the touch panel where the refrigerator is depicted.



Awnings:
When an RV-C awning is controlled from a KIB keypad, a message is sent on V-Bus, which is then translated and rebroadcast by the TM2022. This RV-C message is then seen by the awning controller. When the awning is controlled from the HMS, a message is sent directly from the HMS and does not require the assistance of the TM2022. During automatic extend or retract operation, the RV-C awning controller, which is calibrated at installation, extends or retracts continuously until it determines that it has reached its limit, and stops on its own. During manual control, a steady stream of RV-C extend or retract messages keeps the awning moving until the messages stop.

When a non-RV-C awning is controlled from a KIB keypad, a V-Bus message activates a relay, which sends power to an awning motor controller. When controlled from the HMS, a V-Bus message is sent by the TM2022 to activate the KIB relay.

Slideouts, Bed Lift:
Slideout and bed lift control is accomplished in much the same way as lighting control. When controlled from a KIB keypad, a V-Bus message is sent to a KIB relay board, which activates a relay, sending power to a larger relay, which activates the motor for the slideout or bed lift. When controlled from the HMS, an RV-C message is broadcast, which the TM2022 translates to V-Bus. The same sequence then applies.

Interlocks are configured to prevent the slideouts from extending until the park brake is set and ignition switch is on. For the bed lift, the ignition must be off. These interlocks are configurable through Omniscope using the TM2000 tool.

Jacks:
Jack operation varies depending on the leveling system. When equipped with Equalizer jacks, the Jacks screen will mirror the layout of the Equalizer control panel with up and down arrows for each of the four jacks. During auto-leveling, the operation may be interrupted at the HMS by pressing the retract button. The equalizer system is RV-C, so it can accept these additional commands.

When equipped with a Lippert leveling system, control is limited at the HMS to Auto-Level and All Retract. The Lippert system is not RV-C and is instead controlled by extend and retract wires at output pins 1 and 2 on the TM1010. Operation cannot be interrupted, so the user must wait until leveling has completed before retracting the jacks. In either case, interlocks are handled by the jack controller.