Newmar A/C Electrical Systems

This class is designed to help the R.V. Technician identify and discuss electrical systems and components found in Newmar coaches.

120 V.A.C.

There are three sources of A.C. power available to the R.V.
- Shore power – provided by R.V. Park or home service outlets.
- Generator power
- Inverter

Most R.V. Parks provide 30 amps. 120 vac service at the site. Many parks are providing 50 amps, 240 vac service to accommodate the electrical needs of newer and larger coaches. Shore power is supplied to the coach via power cord. Two sizes of power cord are found on Newmar products, 50 amp and 30 amp cords. The 50 amp cords are made up of four conductor’s #8 stranded wire and a molded plug. The 30 amp cords are made up of three conductor’s #10 stranded wire and a molded plug.
There are three sizes of power cord adaptors available. These adaptors are necessary when stepping down to use a smaller amperage outlet.

- 50 amp to 30 amp adaptor
- 50 amp to 20 amp adaptor
- 30 amp to 20 amp adaptor

**Trouble shooting tips when using adaptors**

1. Melted or damaged adaptors
   - Internal melting causing poor connection or no connection.

2. Insufficient amperage
   - Limited use of appliances
   - Tripping of breaker at the post

3. Low voltage
   - Caused by use of adaptor and long extension cords or too small wire size extension cords

It is important to educate the customer on the use of adaptors and their affects on the electrical system’s capabilities.
Automatic Transfer Switches

All late models Newmar coaches equipped with a generator will have an automatic transfer switch. The transfer switch is located in the electrical compartment and connected to the power cord. Some early models may have a recept that the shore power cord must plug into to connect the generator to the main service panel. Current models ~ when ordering generator prep will have a transfer switch installed.

The 50 amp transfer switch consists of a printed circuit control board, two electromagnetic contact blocks and terminal connecting lugs. The shore power cord is connected to one of the contact blocks and the generator is connected to the other. The generator is always wired into the priority circuit of the transfer switch. The supply leads to the main service panel are also connected to the transfer switch.

When electricity is supplied to the transfer switch "from shore power, generator or both” the control board opens or closes the contactors to select a power supply for the main service panel. The generator circuit is always a priority; a delay of approximately 40 seconds is built into the control board when the generator circuit is energized.

When work is performed or the transfer switch is replaced, always check for proper operation of the transfer switch on shore power and generator power.
5200 SERIES AUTOMATIC TRANSFER SWITCH

INSTALLATION GUIDE

INTRODUCTION
The 5200 Series Automatic Transfer Switch is designed to automatically switch your RV's AC power from the Shore Power Cord to the Generator. When the RV Shore power cord is connected to the 50-amp outlet in an RV park, power is connected through the Transfer Switch directly to the RV AC Distribution Panel and then to all 120 VAC appliances and outlets. When the RV generator is started, a timing circuit in the 5200 Transfer Switch waits approximately 30-seconds to allow the generator to get up to speed. After this time delay, Shore Power is disconnected and generator power is now fed to the RV AC distribution Panel.

INSTALLATION
DUE TO THE HIGH VOLTAGES ASSOCIATED WITH ITS OPERATION ONLY QUALIFIED SERVICE PERSONNEL SHOULD INSTALL THIS TRANSFER SWITCH! ALL APPLICABLE CODES AND STANDARDS MUST BE MET WHEN INSTALLING THIS DEVICE. SEE WIRING DIAGRAM INSIDE OF THE COVER AND ON BACK OF THIS PAGE.

The 5200 Automatic Transfer Switch can be mounted in any position provided there is room to route the Shore Power, Generator and Distribution Connection wires. The 5200 Transfer Switch is not suitable for outdoor locations and should be mounted inside the RV living quarters or the RV basement. We recommend that the Transfer Switch be mounted as close to the Shore Power and Generator power cords as practical to reduce voltage loss.

WARNING: THE 5200 TRANSFER SWITCH IS NOT IGNITION PROTECTED AND SHOULD NOT BE MOUNTED IN THE SAME COMPARTMENT AS THE BATTERIES OR FLAMMABLE MATERIALS SUCH AS GASOLINE. DO NOT MOUNT THE TRANSFER SWITCH IN THE GENERATOR OR LP GAS COMPARTMENT. A FIRE CAUSING PROPERTY DAMAGE SERIOUS INJURY OR DEATH COULD RESULT!

LIMITED WARRANTY
Progressive Dynamics, Inc. warrants each 5200 Series Automatic Transfer Switch to be free of defects in materials and workmanship under normal use for a period of 2-years after date of purchase. This warranty is only valid to the original owner within the continental limits of the U.S and Canada. Warranty claims within the first 24-months should be handled by the dealer that handles warranty claims for your RV.

SPECIFICATIONS (subject to change without notice)

- Electrical Rating: 120/240 VAC 60 HZ @ 50 amperes.
- [70 ohms resistance btwn Hot & Neutral on the Shore Power Connections]
- LO-Amp Drop-Out Protected: 90amps
- Maximum Generator rating: 12 KW
- Enclosure: UL Type 1
- Listed: Agency listed for the United States and Canada
- Weight: 6lbs  
- Dimensions: 7 1/4"L X 6 3/4"W X 41/2"H
- NOTE: Unit is not ignition protected

See our web site for additional information progressive dyn.com
5200 SERIES WIRING DIAGRAM

This Automatic Line/Generator Switch is rated for use on a circuit capable of delivering not more than 5000 RMS symmetrical amperes. 240 volts max.

WIRE RANGE: CU 6-18
TORQUE RATING: 20 IN. LBS AT CONTACTOR
USE COPPER WIRE ONLY

LOAD

GENERATOR

SHORE LINE

BONDING LUG
TORQUE RATING:
35 IN. LBS

HOT 1
NEU
HOT 2

HOT 1
NEU
HOT 2

240VAC 50A. MAX.

109972A

QUICK REFERENCE

HI-POT PROCEDURE: Connect HOT 1 [or HOT 2] of Shore Line AND NEUTRAL together...then run HiPot from Hot & Neutral to GROUND.

TROUBLE SHOOT: If after initial hook-up, Contactor does not engage...A] Check if MAIN Power is on TIMER Circuit side. B] Remove LOAD Side of ATS, Energize. If Contactor engages, then re-install load side.

VISIT OUR WEB SITE TO SEE OTHER PRODUCTS WE MANUFACTURE.

POWER CONVERTERS FOR THE RV INDUSTRY

BATTERY CHARGERS FOR THE MARINE INDUSTRY

30-AMP AC/DC DISTRIBUTION PANELS FOR THE RV INDUSTRY

50-AMP AC AND 12-VOLT DC DISTRIBUTION PANELS FOR THE RV INDUSTRY
**Main Service Panel**

The main service panel is typically located in either the bathroom or the bedroom. It is made up of terminal connections for incoming power leads, a main circuit breaker, several smaller circuit breakers and neutral and ground terminal bars. All 120 vac circuit breakers are located in the main service panel unless equipped with an inverter/converter. These units are also equipped with a sub panel. The sub panel is installed to limit AC power use when electricity is provided by an inverter. Two sizes of service panels are used in Newmar products, 50 amp double pole and 30 amp single pole. Any unit equipped with two air conditioners, or more, must have 50 amp service. Mountain Aire and down if equipped with an EMS System, the main breaker box & sub panel are all in one.

Care should be taken to balance the load placed on 50 amp services. Separating major draw items “12 amp or more” such as air conditioners, water heaters, inverter/converter, etc. Breakers positioned next to each other are on different poles. No more than three large items should be installed on a 30 amp service panel. When installing addition circuits in the service panel be sure to use correct breaker and wire size for the appliance being installed. For units equipped with energy management systems the EMS circuit board is located inside the main service panel.
NOTES:
1) FOR SPECIFIC CIRCUIT ASSIGNMENTS REFERENCE THE APPLICABLE MODELS 120 VAC CHART.
2) FOR CIRCUIT BREAKER VALUES REFERENCE THE APPLICABLE MODELS 120 VAC CHART.
3) WIRE:
   ALL 20A BRANCH CIRCUITS WIRE WITH 10-2 ROMEX TYPE NM
   ALL 15A BRANCH CIRCUITS WIRE WITH 14-2 ROMEX TYPE NM
   ALL 20A BRANCH CIRCUITS WIRE WITH 14-2 ROMEX TYPE NM

E-M.S. SHEDDING ORDER
1) Block Heater
2) Water Heater
3) Water Heater
4) MID A/C
5) REAR A/C
6) Front A/C

CIRCUIT WIRE ACCORDING TO TABLE APPLIED, A 20-AMP CIRCUIT IS REQUIRED ON GENERATOR.

AUXILIARY A/C UNITS TO BE PLACED INTO A 50 AMP SERVICE BODY ENCLOSURE.

Drawing Title: TYPICAL BREAKER BOX DETAILS
Model: EX DP & KG DP
Page: 1 of 1

Drawn by: B.M.
Checked by:
Revision:
Date: 3/9/09

By:
Date:
NOTES:
1. FOR SPECIFIC CIRCUIT ASSIGNMENTS REFERENCE THE APPLICABLE MODELS 120 VAC CHART.
2. FOR CIRCUIT BREAKER VALUES REFERENCE THE APPLICABLE MODELS 120 VAC CHART.
3. ALL 20A BRANCH CIRCUITS WIRED WITH 12-2 ROMEX TYPE NH-B,
   ALL 15A BRANCH CIRCUITS WIRED WITH 14-2 ROMEX TYPE NH-B.
Newmar Corporation Electrical Service Policy

The following policy is being followed by Newmar Corporation to determine the type of electrical service the unit will receive.

1. Any unit with 2 air conditioners must have a 50 ampere service.
2. No 30 ampere service will have more than 3 major draw items (12 or more ampere draw).
3. The following list shows the various appliances used and their ampere draw.

   Air Conditioner .................. 14 amps .................. 1680 watts
   Microwave oven .................. 13 amps .................. 1560 watts
   Water Heater .................... 12 amps .................. 1440 watts
   Dryer ............................ 12 amps .................. 1440 watts
   Washer ........................... 9.8 ....................... 1176 watts
   Food Center ...................... 3.3 amps .................. 396 watts
   Icemaker .......................... 2.5 amps .................. 300 watts
   Refrigerator ...................... 2.5 amps .................. 300 watts
   Dishwasher ...................... 11.5 amps 
   TV ................................. 1 amp
   VCR ................................ 0.15 amps
   Freezer ........................... .6 amps
   Trace 2012 Inverter ............... 22 amps (at 100 DC amp charge rate)
   Trace 2512 Inverter ............... 27 amps (at 130 DC amp charge rate)
   Magnum Inverter MS2012 ......... 15 amps (at 100 DC amp charge rate)
   Magnum Inverter MS2812 ......... 18 amps (at 125 DC amp charge rate)
   Converter .......................... 6.3 amps (variable, up to 18 amps on start up)
BEFORE YOU BLOW YOUR "BREAKER"

Take a few minutes and see how many AMPS you could be using in your RV's 30 or 50 AMP electrical system. It's surprising how fast the AMPS add up, which causes your breaker in your unit or the Campground to "Trip". Knowing the AMPS of all the electrical appliances in your RV can help you manage electrical use and prevent the inconvenience of "WHY DID I BLOW MY BREAKER". This list is the typical appliances used and the average amps required to operate them.

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Amps</th>
<th>Appliance</th>
<th>Amps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Conditioner 15,000 BTU</td>
<td>12.2</td>
<td>Battery charger</td>
<td>6.2</td>
</tr>
<tr>
<td>Computer &amp; Printer</td>
<td>.07</td>
<td>Converter</td>
<td>5.5</td>
</tr>
<tr>
<td>Curling Iron</td>
<td>.06</td>
<td>Electric Coffee Pot</td>
<td>9.0</td>
</tr>
<tr>
<td>Electric Hot Water Heater</td>
<td>12.5</td>
<td>Food Processor</td>
<td>6.0</td>
</tr>
<tr>
<td>Heating Pad</td>
<td>0.5</td>
<td>Ice Maker</td>
<td>4.0</td>
</tr>
<tr>
<td>Freezer</td>
<td>6.4</td>
<td>Hair Dryer</td>
<td>8.0</td>
</tr>
<tr>
<td>Iron</td>
<td>10.</td>
<td>Inverter</td>
<td>16.</td>
</tr>
<tr>
<td>Microwave Oven</td>
<td>12.5</td>
<td>TV</td>
<td>2.0</td>
</tr>
<tr>
<td>Radio</td>
<td>0.8</td>
<td>Toaster</td>
<td>8.0</td>
</tr>
<tr>
<td>Washer/Dryer (2 Piece)</td>
<td>16.</td>
<td>Vacuum Cleaner</td>
<td>2.0</td>
</tr>
<tr>
<td>Refrigerator</td>
<td>7.0</td>
<td>VCR</td>
<td>1.0</td>
</tr>
<tr>
<td>Electric Frying Pan</td>
<td>10.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As an example, take an average morning - if you start your air conditioner and your hot water heater is on, then you start your coffee pot, make some toast, turn on the TV - you're pulling 55 amps when all appliances are operating at the same time, you are at the maximum. Plus, if you also cook your bacon in the microwave at the same time when everything else is on! LOOK OUT! Most RV's have a switch so you can run only the microwave or the water heater at one time. - BUT SOME RV'S DO NOT HAVE THIS FEATURE. So now you have a problem!

Most electrical products show how many watts or amps it takes to operate the appliance printed on the product it self or in the instructions. If it shows the watts - divide the watts by 120 (volts) and that gives you the amps. To get the watts - multiply the amps by 120 (volts).

It's worth your time to take an inventory on the "AMPS" each of your electrical appliances uses. Then you can manage your total usage at one time and this greatly reduces the

"WHY DID I LOOSE MY POWER?"
50 AMP Power Control System E.M.S.

Note: Before too much time is spent on repairs, obtain the programming sheet for the EMS.

The 50 amp Power Control System is currently being offered as standard equipment on all Canyon Star Class A Motor Homes and as optional equipment on most other Newmar coaches. Its function is to provide circuit protection for all 120 VAC loads and as a system of energy management to minimize the over loading and tripping of circuit breakers.

It is made up of a main distribution panel with a self-contained control module and a remote display panel. Remote display panel is typically located in the dash overhead electrical control cabinet. The E.M.S. control module automatically senses the available power being supplied to the coach. The module determines whether it is connected to a 50 amp 240 VAC shore power source or a generator, (has a 12 volt sense wire) and a 120 VAC, but does not know if the power source is 30, 20, or a 15 amp shore power source. Depending on available power it can control seven possible loads. It controls air conditioner loads using low voltage switching and other 120 VAC loads, typically heavy load IE appliances. The EMS will also control the 2012 Magnum inverter charge rate, or may go to invert depending on the charging status, will only reduce the charger when the charger is a float charge.

The 2 main hot wires go through the magnetically coupled current sensor. It will then display the amperage on each line. When the current exceeds the limit on either line, the EMS will start shedding loads, and looks at the current when it shuts a load off so it knows if it has enough current available to turn the load back on.

When the EMS sheds a load, it only looks at one line to see how much of a load was shed. So if the load that was shed is not on the correct line #1 or #2 according to the “Power Control System RV
Data” sheet. The EMS will not know how much was shut off and it will shut something else off. This is why you will not be able to work on a (power control system 50 amp) without the “RV Data” Sheet. The “RV Data” sheet will tell you which line and which relay that item has to be connected to. Also, when the unit has an Oasis System with 2 water heater elements, the #2 water heater element has to be wired to the unlabeled wires on the Oasis, so that it will only shut off 1 element at a time. If you shut off the primary element on the Oasis it will shut off both elements. Then when the EMS turns the water heater back on, both will come on and over load the system. Primary element on the Oasis, to water heater #1.

Note: When adding a Magnum Auto Generator Start...

1. The inverter remote panel has to be 2.5 or higher software.
2. Also, the EMS Power Control System 50 amp software has to be 4.0 or higher, (the main board in the breaker box and the EMS Remote Panel.)
System:
The **Power Control System (PCS)** consists of two major components:
1. **PCS Central Monitor Panel** &
2. **PCS Panelboard** for 50amp service.
   - The **Panelboard** may optionally have a subpanel built in.
   - The **Panelboard** also houses the **PCS Control Module**, and has two current sensors

Overview:
The **Power Control System (PCS) Panelboard** distributes all the 120VAC power throughout the RV, whether it comes from Shore Power, Generator, or the Inverter. The **PCS Control** monitors the incoming power, and manages the power to reduce Circuit Breaker tripping. It does this by momentarily shedding power to the loads under its control when the owner turns on other more critical appliances in the RV. **PCS** restores power when the owner controlled appliance is turned off. The **PCS Central Monitor Panel** displays the status of Incoming Power, and the Controlled Loads.

When coupled with a Magnum Inverter, **PCS** reduces Battery Charge Rate prior to shedding any loads. Working together, an Inverter Assist feature is available. Normally the Inverter is at rest when Shore Power is available. **PCS** utilizes the Inverter and the Coach Battery Bank to smooth out Peak Load Demands. In other words the Inverter will temporarily provide power to some of the appliances, prior to shedding any loads.

Features:
- Monitor and Manage total RV current to avoid nuisance circuit breaker tripping.
- Manage power no matter what the source:
- Manage battery charging during high peak demands.
- Provide Inverter-Assist, additional power from battery bank to smooth high peak demands.
- Shed non-critical loads during high peak loads.
- Remote Panel displays Service Type, Load Status, and RV Current & Voltage.
- Generator Soft Start

**DANGER:**
120/240VAC present inside Panelboard posing potential lethal electrical shock. This equipment should only be serviced by a qualified Service Technician.
# Power Control System

## RV Data

### RV Reference Information

<table>
<thead>
<tr>
<th>REFERENCE ID</th>
<th>Reference ID is 18 character alpha numeric</th>
</tr>
</thead>
<tbody>
<tr>
<td>MANUFACTURER</td>
<td>NEW/MAR</td>
</tr>
<tr>
<td>MODEL</td>
<td>CSCA</td>
</tr>
<tr>
<td>DATE</td>
<td>09-13-09</td>
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(REFERENCE ID will be critical to identify Motor Home. Data in Field in case of Repair/Replacement)

### RV Specific Parameters

<table>
<thead>
<tr>
<th>Relay</th>
<th>Relay Type</th>
<th>Relay Voltage</th>
<th>Relay Connector</th>
<th>Line Assoc</th>
<th>Load Name</th>
<th>Shed Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay 2</td>
<td>Air Cond 1</td>
<td>12VDC</td>
<td>J4-3,4,5</td>
<td>2</td>
<td>Bedroom Air</td>
<td>3</td>
</tr>
<tr>
<td>Relay 3</td>
<td>120VAC</td>
<td>120VAC</td>
<td>J4-1,7,8</td>
<td>1</td>
<td>Front Air</td>
<td>4</td>
</tr>
<tr>
<td>Relay 4</td>
<td>Air Cond 2</td>
<td>12VDC</td>
<td>J4-8,9,10</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relay 5</td>
<td>120VAC</td>
<td>120VAC</td>
<td>J4-1,7,8</td>
<td>1</td>
<td>Garage Air</td>
<td>2</td>
</tr>
<tr>
<td>Relay 6</td>
<td>Air Cond 3</td>
<td>12VDC</td>
<td>J4-6,11,12</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relay 7</td>
<td>120VAC</td>
<td>120VAC</td>
<td>J5-1,7,8,12</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
1. If Relay 3, or Relay 5 is not used, power still needs to be connected.
2. If Load Name does not exist, assume Relay has no load attached, and ignore Shed Order if any.
4. If there is a gap in Shed Order, everything will be shifted to lowest possible number.
5. Two relays cannot have the same Shed Order #.
6. Shed Order number needs to be between the numbers of 1-7.
   a. Any Relay can be shed in any order.
   b. #1 will be first Load to Shed and last Load to return.
   c. Shed Order will be per list above if over-current exists for system.
   d. Shed Order may be modified if an over-current condition exists on just one of the L1 or L2 Lines.
      i. Next shed-able Load is not shed because the current on it's Line is OK
      ii. Load is skipped and next shed-able Load associated with the proper Line over-current condition is chosen.
7. 120VAC Load association to L1 and L2 is fixed and cannot be programmed.

<table>
<thead>
<tr>
<th>Generator Parameters</th>
<th>Current (Amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Onan 7kw</td>
</tr>
<tr>
<td>Line 1 Circuit Breaker</td>
<td>30</td>
</tr>
<tr>
<td>Line 2 Circuit Breaker</td>
<td>30</td>
</tr>
<tr>
<td>Combined Max Output Current</td>
<td>58</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inverter Parameters</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>None</td>
</tr>
<tr>
<td>Charger Branch Line (L1 or L2)</td>
<td>L2</td>
</tr>
</tbody>
</table>
**Power Control System**

**RV Data**

### RV REFERENCE INFORMATION

<table>
<thead>
<tr>
<th>REFERENCE ID</th>
<th>NM0190DSACWO101807</th>
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<tbody>
<tr>
<td>MANUFACTURER</td>
<td>NEWMAR</td>
</tr>
<tr>
<td>MODEL</td>
<td>2009 DUTCH STAR 3-A/C W OASIS</td>
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<tr>
<td>DATE</td>
<td>10-18-07</td>
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</table>

(REFERENCE ID will be critical to Identify Motor Home Data in Field in case of Repair/Replacement)

### RV SPECIFIC PARAMETERS

<table>
<thead>
<tr>
<th>Relay #</th>
<th>Relay Type</th>
<th>Relay Voltage</th>
<th>Relay Connector</th>
<th>Line Assoc</th>
<th>Load Name (12 Characters Max)</th>
<th>Shed Order (1-7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay 1</td>
<td>120VAC</td>
<td>120VAC</td>
<td>J5-1.2</td>
<td>Water</td>
<td>Heater</td>
<td>2</td>
</tr>
<tr>
<td>Relay 2</td>
<td>Air Cond</td>
<td>12VDC</td>
<td>J4-3.4,5</td>
<td>A / C</td>
<td># 2</td>
<td>6</td>
</tr>
<tr>
<td>Relay 3</td>
<td>120VAC/2</td>
<td>120VAC</td>
<td>J3-3.4</td>
<td>Refrigerator</td>
<td># 1</td>
<td>4</td>
</tr>
<tr>
<td>Relay 4</td>
<td>Air Cond</td>
<td>12VDC</td>
<td>J4-8,9,10</td>
<td>A / C</td>
<td>Block Heater</td>
<td>5</td>
</tr>
<tr>
<td>Relay 5</td>
<td>120VAC</td>
<td>120VAC</td>
<td>J5-6.7</td>
<td>Water</td>
<td>Heater</td>
<td>1</td>
</tr>
<tr>
<td>Relay 6</td>
<td>Air Cond</td>
<td>12VDC</td>
<td>J4-6,11,12</td>
<td>A / C</td>
<td># 3</td>
<td></td>
</tr>
<tr>
<td>Relay 7</td>
<td>120VAC</td>
<td>120VAC</td>
<td>J5-8.9</td>
<td>Water</td>
<td>Heater</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**

1. If Load Name does not exist, assume Relay has no load attached, and ignore Shed Order if any.
3. If there is a gap in Shed Order, everything will be shifted to lowest possible number.
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6. 120VAC Load association to L1 and L2 is fixed and can not be programmed.

### GENERATOR TABLE

<table>
<thead>
<tr>
<th>Model Parameters</th>
<th>Current (Amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onan 10K</td>
<td></td>
</tr>
<tr>
<td>Line 1 Circuit Breaker</td>
<td>45</td>
</tr>
<tr>
<td>Line 2 Circuit Breaker</td>
<td>45</td>
</tr>
<tr>
<td>Combined Max Output Current</td>
<td>83</td>
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</tbody>
</table>

### INVERTER TABLE

<table>
<thead>
<tr>
<th>Inverter Parameters</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charger Branch Line (L1 or L2)</td>
<td>ME2012</td>
</tr>
<tr>
<td>L2</td>
<td></td>
</tr>
</tbody>
</table>

Only has an 8K generator, 66 amp max output.
# Power Control System

## RV Data

### RV Reference Information

<table>
<thead>
<tr>
<th>REFERENCE ID</th>
<th>NM</th>
<th>MR</th>
<th>2</th>
<th>AC</th>
<th>8</th>
<th>KW</th>
<th>GEN</th>
<th>10 10</th>
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<tbody>
<tr>
<td>MANUFACTURER</td>
<td>NEWMAR</td>
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(RELERTABLE ID will be critical to Identify Motor Home Data in Field in case of Repair/Replacement)

### RV Specific Parameters

<table>
<thead>
<tr>
<th>LOAD SHEED TABLE</th>
<th>120VAC</th>
<th>120VAC</th>
<th>J5-12</th>
<th>J5-2</th>
<th>J5-3,4</th>
<th>J5-8,9</th>
<th>2</th>
<th>Water Heater 1</th>
<th>2</th>
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<tbody>
<tr>
<td>Relay 1</td>
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<td>Relay 4</td>
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<td>Relay 6</td>
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<td>Relay 7</td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Note:
1. If Load Name does not exist, assume Relay has no load attached, and ignore Shed Order if any.
3. If there is a gap in Shed Order, everything will be shifted to lowest possible number.
4. Two relays can not have the same Shed Order #.
5. Shed Order number needs to be between the numbers of 1-7.
   a. Any Relay can be shed in any order.
   b. #1 will be first Load to Shed and last Load to return.
   c. Shed Order will be per list above if over-current exists for system.
   d. Shed Order may be modified if an over-current condition exists on just one of the L1 or L2 Lines.
      i. Next shed-able Load is not shed because the current on it's Line is OK
      ii. Load is skipped and next shed-able Load associated with the proper Line over-current condition is chosen.
6. 120VAC Load association to L1 and L2 is fixed and can not be programmed.

### GENERATOR TABLE

<table>
<thead>
<tr>
<th>Generator Parameters</th>
<th>Current (Amps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Onan 8K</td>
</tr>
<tr>
<td>Line 1 Circuit Breaker</td>
<td>35</td>
</tr>
<tr>
<td>Line 2 Circuit Breaker</td>
<td>35</td>
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<tr>
<td>Combined Max Output Current</td>
<td>66</td>
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</table>

### INVERTER TABLE

<table>
<thead>
<tr>
<th>Inverter Parameters</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>ME2012</td>
</tr>
<tr>
<td>Charger Branch Line (L1 or L2)</td>
<td>L2</td>
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</tbody>
</table>
### Power Control System

#### RV Data

<table>
<thead>
<tr>
<th>Reference ID</th>
<th>NMRR09CANYNST033108</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Newmar</td>
</tr>
<tr>
<td>Model</td>
<td>2009 Canyon Star</td>
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<td>Date</td>
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(REFERENCE ID will be critical to Identify Motor Home Data in Field in case of Repair/Replacement)

#### Load Shed Table

<table>
<thead>
<tr>
<th>Relay</th>
<th>Relay Type</th>
<th>Relay Voltage</th>
<th>Relay Connector</th>
<th>Line</th>
<th>Load Name</th>
<th>Shed Order</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>120VAC</td>
<td>120VAC</td>
<td>J5-1,2</td>
<td>1</td>
<td>Bedroom Air</td>
<td>3</td>
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<tr>
<td>2</td>
<td>Air Cond 1</td>
<td>12VDC</td>
<td>J4-3,4,5</td>
<td>2</td>
<td>Living Room Air</td>
<td>4</td>
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<tr>
<td>3</td>
<td>120VAC</td>
<td>120VAC</td>
<td>J5-3,4</td>
<td>3</td>
<td>Garage Air</td>
<td>2</td>
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<tr>
<td>4</td>
<td>Air Cond 2</td>
<td>12VDC</td>
<td>J4-8,9,10</td>
<td>4</td>
<td>Water Heater</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>120VAC</td>
<td>120VAC</td>
<td>J5-6,7</td>
<td>5</td>
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<td></td>
</tr>
<tr>
<td>6</td>
<td>Air Cond 3</td>
<td>12VDC</td>
<td>J4-6,11,12</td>
<td>6</td>
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<tr>
<td>7</td>
<td>120VAC</td>
<td>120VAC</td>
<td>J5-8,9</td>
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</table>

#### Generator Table

<table>
<thead>
<tr>
<th>Generator Parameters</th>
<th>Current (Amps)</th>
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</thead>
<tbody>
<tr>
<td>Model</td>
<td>Onan 5.5kw (1038)</td>
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<tr>
<td>Line 1 Circuit Breaker</td>
<td>30</td>
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<tr>
<td>Line 2 Circuit Breaker</td>
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<tr>
<td>Combined Max Output Current</td>
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#### Inverter Table

<table>
<thead>
<tr>
<th>Inverter Parameters</th>
<th>Model</th>
<th>Charger Branch Line (L1 or L2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>
Central Monitor Panel:
The PCS Monitor displays pertinent Power Control System status information. The UP and DOWN buttons are used to step through each individual Screen of information. Pressing & releasing either the UP or Down button will step to either the Previous or Next Display Screen. Once all the Screens have been seen, the next press of the Button will wrap back around through all the Display Screens once again. The SET Button only functions when the Service Type screen is displayed, to Select between 30A Service and 20A Service. (Note: 50A Service or Generator Service overrides the SET Button.) If there have not been any key presses for awhile, the PCS Monitor turns off the backlighting to save on power. The first press of any key will only turn on the back lighting.

Service Type:
No Service - PCS has 12V Battery power to run the electronics, however, it does not sense any 120/240VAC Power.

50-amp Service - PCS senses 240/208VAC between L1 and L2 to determine this mode of operation. PCS controls the loads so that the current does not exceed L1 limit of 50amps, L2 limit of 50amps, and a combined limit of 100 amps.

30-amp Service - PCS senses 0VAC between L1 and L2. PCS adds the current of the two sensors and controls the loads so that the current does not exceed 30 amps.

20-amp Service - PCS senses 0VAC between L1 and L2, and the owner selects 20A on the Central Monitor Panel. PCS adds the current of the two sensors and controls the loads so that the current does not exceed 20 amps.

Generator - PCS senses power to the Gen Hour Meter to determine this mode of operation. PCS controls the loads so that the current does not exceed the ratings of the installed Generator, for example L1 limit of 35amps, L2 limit of 35amps, and a combined Limit of 63 amps.

Operation Mode:
This Screen gives the general information about Load Status.

The First Line shows the Status of the Magnum Battery Charger. It will either be: Bat Charge Normal, under complete Magnum Control, or Bat Charge Reduced, which means an Owner activated appliance would have caused a circuit breaker to trip but instead the Battery Rate has been reduced. Reducing the Battery will be the 1st thing that PCS will attempt in order to reduce overall RV Power. Battery Charge may not be reduced if the Battery is Low, or the Magnum Inverter is on Line 1 Circuit Breaker and the Overload is on Line 2 only.

The Second Line show the Status of the Magnum Inverter. It will either show Inverter Normal, under complete Magnum Control.

Inverter Assist, PCS is requesting that the Magnum Inverter assist by temporarily generating 120VAC power from the batteries.

Inverter Assist 12A, the end of this line shows the amount of 120VAC current that the Inverter is supplying.

Inverter Assist Deny, means the Magnum Inverter can not Assist at this time, for one of many Magnum Inverter reasons, i.e. Battery Low, Over-current, etc. (See Magnum Owner’s Manual).

The Last Line shows if any Loads have been Shed to prevent circuit breaker tripping.
Load(s) Shed = 0, depending on the model RV, there can be up to 7 Loads that PCS can control.
Load Status:
Where the last Screen gave general information about all the controlled Loads, these next two screens gives detailed information about the status of each Load under PCS control.

Water Heater OFF 11A, indicates that the Water Heater power has been temporarily turned OFF, and the current at the instant the Water Heater was turned off last was 11amps.

Refrigerator ON 7A, indicates that the Refrigerator has power. Again the 7amps of current is NOT the present current draw, but rather the current at the instant the Refrigerator was turned off last.

A/C #2 ON, indicates that the A/C #2 has power. Since there is no current displayed, that only indicates that this load has not been turned OFF even once since the Battery has been reconnected and 12V power applied to PCS. PCS has never had a chance to "Learn" the current. The Current Displayed, is re-learned each and every time that the Load is turned OFF.

Looking at the list, it appears that PCS does not turn off Loads in Order Preference. PCS will always start shedding loads from the top of the list when PCS in 30A or 20A Service. However, in 50A Service, or running on the Generator there are two Main Breaker, Line 1 & Line 2. PCS will only shed loads if there is an overload detected on its associated Line. In other words, if shedding the Load will not help, skip it and move on. If then sometime in the future an overload is detected on the other Line, PCS will start at the top of the list again. The same is true with Magnum Battery Charge Reduction and Inverter Assist. Magnum can only help on the Line it is wired to, so if it will not help to Assist, don't bother.

Power Management:
When the current exceeds the limit, because possibly the owner has turned on the Microwave, the PCS will independently limit the current on each line by performing the following in order: Reduce Magnum Battery Charge Rate, Inverter Assist, Load Shed. (If the Magnum Inverter is wired to the opposite leg, only Load Shedding will occur.

As each appliance is shed, PCS learns the current for that specific appliance, to ensure that there will be sufficient headroom to turn the appliance back on and be under the current limit. To ensure that Air Conditioner compressor pressure is bled, and to reduce quick cycling, there is a 2 minute delay from the time a Load has been shed, to the time power is restored.

Once the total RV current has dropped, for example because an owner operated appliance has been turned off, the PCS will reverse the above procedure, returning power to appliances whose operation was not immediately critical.

Line Status:
PCS not only monitors total RV current but also has two built in Volt Meters, and monitors the voltage on each of the Lines.

L1 121Volts 15Amps, indicates that Line 1 has 121Voltsrms and is presently drawing 15 amps.

!BrownOut!, if the display indicates Brown Out, the Display will hold the lowest captured voltage that may have occurred while the RV owner is away. Pressing any switch clears the display, and resumes displaying the present readings.

Wiring Status:
Similar to an Outlet Tester that is plugged into outlets in your home to test for proper wiring, PCS monitors the wiring status of the Camp Ground Outlets you may plug into.

WARNING, IF THE DISPLAY EVER INDICATES WiringStatusError IMMEDIATELY, unplug the RV from the outlet, and have the outlet inspected by a qualified technician.

The other lines on the Display to the right indicate proper wiring for 50A Service. For 30A Service L1=L2.
**Inverter Assist Feature:**

The PCS works with the MAGNUM Energy Inverter/Charger to bring the RV industry a revolutionary new concept. In the past, energy management systems operated when 120VAC was available and inverters operated when 120VAC was not available from either shore power or generator. The **Power Control System** brings these two worlds together. First, PCS will communicate with the Magnum Inverter/Charger and reduce Battery Charge Rate during periods of RV high current demands.

While plugged in or when the generator is running, the PCS will allow the RV to have more power than available on the shore power or generator, for short periods of time. When the PCS senses that 120VAC power has reached its maximum current, the PCS communicates to the MAGNUM inverter requesting additional power be generated from the battery. If more demands are put on the RV with additional appliances, or with the RV batteries are low, the PCS will shed non-critical loads and avoid nuisance tripping of circuit breakers.

**Generator Soft Start:**

When the Generator is first turned on, PCS will shed all the controlled loads. The loads are sequenced back on. This is done to allow the generator to come up with minimum load, and to reduce the current the Transfer Switch must handle. Note: PCS applies the same 2 minute delay to turning loads on is when Power Management Load Shedding occurs.

**RV Data Parameters:**

The RV manufacturer has full flexibility to set up the RV Data Parameters through a Windows Program and Program Dongle. The following parameters are downloaded into each PCS system. Load Names, Load Shed Order, Load-Relay Association, Generator Size, Inverter Information. These parameters can not be set or changed by the dealer or owner. Each RV Data Set has a unique 18-character Reference ID, where the first digits are the manufacturer's code, the last digits are the revision date, and the remaining middle characters have some model designation.

**RV Data Synchronization:**

The RV Data Parameters are stored in both the PCS **Central Monitor Panel** and the PCS **Control Panel**. Should dealer or field replacement of either unit become necessary, a blank unit can be installed and the RV Data will be synchronized or transferred from remaining unit. During Power-Up the Monitor and Controller check their RV Data and one of four screens can appear.

1. Everything is Synchronized and the Monitor Version, Controller Version, and ID are displayed.
2. RV Data is transferred from Controller to Monitor
3. RV Data is being transferred from Monitor to Controller
4. RV DATA in Monitor and Controller is different and the PCS System can not continue. This can happen for example if a Monitor from one RV is installed in a different model RV.

If for any reason the Controller stops to function, no problem with the Limp Home Feature, all Controlled Loads will continue to operate. Care will have to be used not to turn on too many appliances, overload the system, and trip breakers.
Indoor Panelboard Installation Instructions
CAT. NO. 00-10020-000 PANELBOARD & SUB PANEL
CAT. NO. 00-10020-100 PANELBOARD

Remove Branch KO’s
Remove Branch Knock-Out’s; place screwdriver as shown and tap end to remove KO. If KO is not completely removed, twist out with pliers.

Main wires
Mains must be installed through this opening using a 1” connector. If a 1-1/4” connector is required, remove Knock-Out ring; place screwdriver as shown and tap end to remove KO ring. If KO is not completely removed, twist out with pliers.

Mount Box
Flush mount box into a 15-5/8” X 8-5/8” opening. Remember to leave 17-1/2” X 10-1/2” minimum clearance for the cover. Using six (6) #8 screws (not provided) attach box to wall using the mounting holes shown. Note: Box may be mounted as shown or rotated 90° clockwise.

Wire Main, Branch & optional Sub-Panel Circuits
The following breakers are suitable for MAIN and Branch breakers:
- Cutler-Hammer: BR, BD, GFCB, Filler Plate BRFP
- Siemens: QP, QT, Filler Plate QF3
- GE: THQL
- SquareD: HOM, HOMT
Make certain circuit breakers are in the OFF position prior to installation.

IMPORTANT:
Tighten all electrical connections before energizing. Follow Torque Specifications on the Inside Cover Label.

DANGER:
120/240VAC present inside Panelboard posing potential lethal electrical shock. This equipment should only be serviced by a qualified Service Technician.

700 South Road Lisle, IL 60532 www.PrecisionCircuitsInc.com 630-240-9832 Rev052207
Remove Cover Twist-Outs
Twist and remove to create openings for positions where breaker has been installed.

Install Cover
1) Slide Cover slots over Box tabs.
2) Rotate Cover down to Box
3) Screw Cover to Box using two (2) 8-32 X7/16" screws provided.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Precision Circuits Inc.

Route Comunication Cables
1) If only installing the Power Control System, use above wiring diagram.
2) If utilizing the optional Inverter Assist feature, use the below wiring diagram.

WIRING IF INSTALLING EITHER UNIT ALONE
WIRING IF INSTALLING BOTH UNITS
Connector wiring and pinout does not change only cables lengths and plug-in locations
PCS Control Installation Instructions
CAT NO. 00-10020-500 50AMP PCS CONTROLLER
Install only in Power Control System Panelboards CAT NO's. 00-10020-000, 00-10020-100
Read & follow Panelboard Instructions for complete Installation

1) Prepare Main Supply Cable by removing outer Jacket and cutting and stripping wires to lengths shown.

2) In the same manner used for the Branch Circuit Knock-outs, remove the rectangular KO to provide access to the 12VDC, and communication connections.

3) Install Circuit Breakers into Panel Board.

4) Using 1” Connector, (1-1/4” if KO ring is removed) install Main Supply Cable into AC Panel Board knock-out shown, and secure main cable to housing.

5) Bend Ground Wire towards back of box, run along the back, and connect to Ground Block.

6) Bend White Neutral Wire towards back of box, run along the back and connect to Neutral Block.

Note: Bend Ground and Neutral wires to clear the Current Sensor Cup for the next step.

Note: it is critical to maintain L1 & L2 relationship throughout the entire installation. For example, the Black wire must go through the L1 Current Sensor hole, connect to the L1 Main circuit breaker, and the PCS Control L1 screw terminals must be connected to the L1 Branch breakers.

7) Slide the Black-Line1 and Red-Line2 wires through Current Sensor Cup holes.

8) Continue to slide the Sensor Cup/Barrier Wall assembly into the housing guides, until the Wall touches the back of the box.

9) Secure Current Sensor/Barrier Wall Assembly to Housing using 8-32 X 7/16” screw provided.

11) Both Black and Red wires should be below the level of plastic post for easier cover attachment.

12) Wire PCS Control Screw Terminal Block per the diagram.

**Screw Terminal Block Torque: 9-in-lbs**

Note: The three Voltage Sense terminals must always be wired for proper voltage sensing and operation, even if corresponding relays are not used.

Tip: Things like Water Heater, whose circuit breaker is occasionally turned off, should not be wired to Relay 3 or Relay 5.

13) Make 12VDC connections through the rectangular knock-out located in the back of the box per the diagram on the right and pin-out below.

- 01 GROUND
- 02 COACH BAT
- 03 AIR COND 1 NO
- 04 AIR COND 1 COM
- 05 AIR COND 1 NC
- 06 AIR COND 3 NO
- 07 GEN SET RUN
- 08 AIR COND 2 NC
- 09 AIR COND 2 COM
- 10 AIR COND 2 NO
- 11 AIR COND 3 NC
- 12 AIR COND 3 COM

Mating Connector: MOLEX MINI-FIT JR 12-PIN, #39-01-2120
Contact: MOLEX MINI-FIT JR 5556 18-24 AWG, 39-00-0039

Four different Air Condition Compressor wiring options are shown on the right. Relay Contacts are drawn in Non-Shed or Operation Mode.
120V Energy Management features usually found in high end Class A Motor homes are now made affordable for all RV's including Class C and Trailer Market. The Mini-PCS monitors the total AC current of an RV and prevents circuit breaker tripping by momentarily shedding up to four loads. As the owner turns on additional appliances such as a Microwave, Coffee Pot, or Hair Dryer, the Mini-PCS can shed two 120VAC appliances such as the Refrigerator and Water Heater, then if additional reduction in power is required the second air conditioner, and lastly the first air conditioner is shed. As the owner selected appliances are turned off, the Mini-PCS will automatically turn power back on to each of the shed loads in reverse sequence. The Mini-PCS will constantly monitor 120VAC RV power and shed and restore power to the four controlled loads.

The I/O Module is installed inside any circuit breaker panel and fits into a standard 3/4" knock-out hole. The screw terminals are used to make the 120VAC connections. Outside the circuit breaker panel a data cable is connected through the 3/4" knock-out which goes to the Display Panel. The Display Panel has a Data connector and also another connector to control the air conditioner units through low voltage signals.

Key Features:
1. Helps owners who are use to 50amp service, deal with the common situation of camp grounds where only 30amp service is available.
2. Limits total current to 30 amps, when 50amp service is not available.
4. Monitors current draw for entire RV including owner added loads.
5. Learns controlled appliance current draw.
6. Allows 2 air conditioners to run on 30 amp service when other appliances are not in use.
7. I/O Module fits into a standard 3/4" knock-out
   Two Relays capable of 120VAC 18 Amp load.
8. 120VAC Sense
   I/O Module has built in 120VAC sense circuitry so that it knows when shore power is available and does not draw on the battery when dry camping. No AC wall adaptor or other sensors required.
9. Display Panel has built in relays to control two air conditioners, no other modules required.
10. All relays are normally closed allowing full operation of appliance in case of fault.
Operation:

30-amp Service - PCS senses 0VAC between L1 and L2. The I/O Module has a current sensor which monitors the current on the neutral wire. When the current exceeds the 30-amp limit, because possibly the owner has turned on the Microwave, the Mini-PCS will limit the current by shedding appliances. Once the total RV current has dropped, for example because an operator operated appliance has been turned off, the Mini-PCS will reverse the above procedure, returning power to appliances whose operation was not immediately critical. Appliance shed order is easily determined by the manufacturer by wiring the appliances to the appropriate number relay.

20-amp Service - Mini-PCS senses 0VAC between L1 and L2, and the owner selects 20A on the Remote Display. Mini-PCS performs the same functions as above except that it limits total current to 20amps.

Generator - MINI-PCS senses power to the Generator Hour Meter. In this mode Mini-PCS assumes enough power is available and goes to sleep. It displays the fact that Gen-Set is running, that all Loads are powered.

50-amp Service - MINI-PCS senses 240VAC between L1 and L2 to determine this mode of operation. In this mode Mini-PCS assumes enough power is available and goes to sleep. It displays the fact that 50-amp Service is available and that all Loads are powered.

I/O Module - Features include:
- Current Sensor
- Two 18amp Relays
- Power Line sensing
- Two Screw Terminal configurations available

Remote Display - Features include:
- Displays Service Type
- Displays the Status of the Controlled Appliances
- Custom Load Names available

Specifications:

<table>
<thead>
<tr>
<th>Part Numbers</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>00-10024-000</td>
<td>Mini-PCS I/O Module, w/Vertical Terminals</td>
</tr>
<tr>
<td>00-10024-100</td>
<td>Mini-PCS I/O Module, w/Right Angle Screw Terminals</td>
</tr>
<tr>
<td>00-10025-000</td>
<td>Mini-PCS Display Panel, 3 Loads, W/H, A/C-2, A/C-1</td>
</tr>
<tr>
<td>00-10025-100</td>
<td>Mini-PCS Display Panel, 4 Loads, W/H, A/C-2, A/C-1</td>
</tr>
<tr>
<td>00-10025-500</td>
<td>Mini-PCS Display Panel, Amp Meter, 4 Loads, W/H, A/C-2, A/C-1</td>
</tr>
</tbody>
</table>

Service type: 120/240VAC max
Relays: (2) DC 18VDC, 1.0A (Display Panel, Thermostat) (2) AC 240VAC, 18A, 1HP (I/O Module)
Delay: 2 minute minimum off time on all loads
Environment: Indoor, Out of direct weather
Dimensions: 6.25" wide, 3.0" high, 1.0" deep
Mounting Hole: 5.45" wide, 2.91" high (centered with .15" clearance), 1.88" mount holes

Minimum               Typical            Maximum
Volts DC             9.0VDC              12.0VDC              16.0VDC
Volts AC             90VAC/line         240VAC              135VAC/line
Ambient Temperature  -40°C                -85°C

Display Panel Low Voltage Connector:
01 AIR COND 1 NC
02 AIR COND 1 COM
03 NO CONNECT
04 AIR COND 2 COM
05 AIR COND 2 NO
06 AIR COND 1 NO
07 GEN SET RUN
08 COACH BAT
09 GROUND
10 AIR COND 2 NC

Mating Connector: MOLEX MINI-FIT JR 10-PIN, #39-01-2100
Contact: MOLEX MINI-FIT JR 5558 18-24 AWG, 39-00-0039

View of connector is from contact insertion side

Four different Air Condition Compressor wiring options are shown above. Relay Contacts are drawn in Non-Shed or Operation Mode.

Option 1, A/C ads with Ground Signal
Connect to Ground No Connect to A/C Cond

Option 2, A/C ads with +12V Signal
Connect to +12V No Connect to A/C Cond

Option 3, A/C operates with Ground Signal
Connect to Ground No Connect to A/C Cond

Option 4, A/C operates with +12V Signal
Connect to +12V No Connect to A/C Cond

I/O Module Screw Terminal Block Torque: 9-in-lbs
Note: The three Voltage Sense terminals must always be wired for proper Service Type detection, even if corresponding relays are not used.
The Relay Module can be used to safely control (on/off) any 120V appliance using 12V signals. The Relay Module is just a simple SPDT relay that has been repackaged, having both Normally Closed (NC) and Normally Open (NO) contacts available through screw terminals. With the Common (COM) and NC contact, connected to a TV, Block Heater or Awning, it can be used as an Ignition Lock-out feature. Using the NO and COM contacts, the Relay module can control a Water Heater.

Key Features:
1. UL Listed.
2. Safe Isolation of 120V and 12V wiring.
3. Can be used in any listed electrical enclosure with a ½” knock-out.
Specifications:

<table>
<thead>
<tr>
<th>Part Numbers:</th>
<th>00-10026-000</th>
<th>15 amps 3/4hp w/Vertical Terminals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>00-10026-100</td>
<td>15 amps 3/4hp w/Vertical Terminals</td>
</tr>
<tr>
<td></td>
<td>00-10026-200</td>
<td>15 amps 1/2hp w/Vertical Terminals</td>
</tr>
<tr>
<td></td>
<td>00-10026-300</td>
<td>15 amps 1/4hp w/Right Angle Screw Terminals</td>
</tr>
<tr>
<td></td>
<td>11-10026-000</td>
<td>Available Pigtails for Low Voltage connector</td>
</tr>
</tbody>
</table>

Environment: Indoor, Out of direct weather

Must be mounted inside listed electrical enclosure.

Dimensions: 1-1/8" x 1-1/8" x 2-1/4" inside enclosure

Mounting Hole: 1/2" standard electrical knockout

Low Volt connector: Amp Mini-Universal Mate-N-Lok #172165-1 (Matrel connector)

<table>
<thead>
<tr>
<th>Relay Coil Volts DC</th>
<th>Min-Hold</th>
<th>2.0VDC</th>
<th>Min-Operate</th>
<th>9.0VDC</th>
<th>Typical</th>
<th>12.0VDC</th>
<th>Maximum</th>
<th>16.0VDC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay Coil Amps DC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.03amps</td>
<td></td>
<td>0.1amps</td>
<td></td>
</tr>
<tr>
<td>Contact Volts AC</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>120VAC</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO &amp; NC Contact Rate Model 000 - 100</td>
<td>15amps 3/4hp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO &amp; NC Contact Rate Model 200 - 300</td>
<td>15amps 1/2hp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screw Terminals Torque</td>
<td></td>
<td>9-in-lbs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Screw Terminal Wire Range</td>
<td></td>
<td>22awg</td>
<td></td>
<td>12awg</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient Temperature (UL Rated)</td>
<td></td>
<td>-40°C</td>
<td></td>
<td>+60°C</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Installation:
1. Install inside any listed electrical enclosure, ensuring that the Screw Terminal side of the Relay Module is inside the enclosure when complete. Also there must be 1/4" clearance from any part of the module to any adjacent metal walls or exposed electrical conductors. (Clearance to the mounting wall is built into the Relay Module itself).
2. Remove 1/2" knock-out in enclosure.
3. Remove the supplied lock-nut, install Relay Module through the knock-out hole; from inside enclosure, and reinstall and tighten the lock-nut.
4. Wire the appliance to be controlled to the Screw Terminal Block, tightening to the proper torque specification.
5. Connect the low voltage wires to the relay coil through the 2 pin connector outside the enclosure.
6. Check wiring and cover the enclosure prior to applying power.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to Precision Circuits Inc.

**IMPORTANT:**
Tighten all electrical connections before energizing. Follow Torque Specifications above

DANGER: 120/240VAC surrounding Relay Module posing potential lethal electrical shock. This equipment should only be serviced by a qualified Service Technician.
# Power Control System
## RV Data

### Reference Information
- **Reference ID**: 18 character alpha numeric
- **Recommended usage**:
  - 1-3 Manufacturer
  - 4-12 Model Name and/or #
  - 13-18 Date

(REFERENCE ID will be critical to identify Motor Home Data in Field in case of Repair/Replacement)

### RV Specific Parameters

<table>
<thead>
<tr>
<th>Relay</th>
<th>Relay Type</th>
<th>Voltage</th>
<th>Connector</th>
<th>Assoc.</th>
<th>Shed Order</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay 1</td>
<td>120VAC</td>
<td>120VAC</td>
<td>J5-1,2</td>
<td>Water</td>
<td>1</td>
</tr>
<tr>
<td>Relay 2</td>
<td>Air Cond 1</td>
<td>12VDC</td>
<td>J4-3,4,5</td>
<td>Heat</td>
<td>2</td>
</tr>
<tr>
<td>Relay 3</td>
<td>Air Cond 2</td>
<td>12VDC</td>
<td>J5-3,4</td>
<td>Rear</td>
<td>5</td>
</tr>
<tr>
<td>Relay 4</td>
<td>Air Cond 3</td>
<td>12VDC</td>
<td>J4-8,9,10</td>
<td>Block Heater</td>
<td>6</td>
</tr>
<tr>
<td>Relay 5</td>
<td>Air Cond 4</td>
<td>12VDC</td>
<td>J5-6,7</td>
<td>Front</td>
<td>1</td>
</tr>
<tr>
<td>Relay 6</td>
<td>Air Cond 5</td>
<td>12VAC</td>
<td>J4-6,11,12</td>
<td>Middle</td>
<td>4</td>
</tr>
<tr>
<td>Relay 7</td>
<td>120VAC</td>
<td>120VAC</td>
<td>J5-8,9</td>
<td>Water</td>
<td>3</td>
</tr>
</tbody>
</table>

**Note:**
1. If Load Name does not exist, assume Relay has no load attached, and ignore Shed Order if any.
3. If there is a gap in Shed Order, everything will be shifted to lowest possible number.
4. Two relays can not have the same Shed Order #.
5. Shed Order number needs to be between the numbers of 1-7.
   - Any Relay can be shed in any order.
   - #1 will be first Load to Shed and last Load to return.
   - Shed Order will be per list above if over-current exists for system.
   - Shed Order may be modified if an over-current condition exists on just one of the L1 or L2 Lines.
     - Next shed-able Load is not shed because the current on it's Line is OK
     - Load is skipped and next shed-able Load associated with the proper Line over-current condition is chosen.
6. 120VAC Load association to L1 and L2 is fixed and can not be programmed.

### Generator Table

<table>
<thead>
<tr>
<th>Generator Parameters</th>
<th>Current (Amms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Onan 10K</td>
</tr>
<tr>
<td>Line 1 Circuit Breaker</td>
<td>45</td>
</tr>
<tr>
<td>Line 2 Circuit Breaker</td>
<td>45</td>
</tr>
<tr>
<td>Combined Max Output Current</td>
<td>83</td>
</tr>
</tbody>
</table>

### Inverter Table

<table>
<thead>
<tr>
<th>Inverter Parameters</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>ME2012</td>
</tr>
<tr>
<td>Charger Branch Line (L1 or L2)</td>
<td>L2</td>
</tr>
</tbody>
</table>
Converters

All Newmar R.V.'s are equipped with a converter or an Inverter/Converter combination. Converters are used to convert 120 VAC into 12 VDC. Converters supply the coach with 12 VDC power to operate 12 VDC appliances, equipment and to charge the coaches' batteries. Newmar uses three sizes of converters, 45, 55 and 75 amp models. Units that require more power may have two 45 amp converters totaling 90 amps. Whenever changing a converter use the same size converter. The wiring and mini breakers in the coach may not be of adequate size to handle a larger converter.

Trouble shooting tips for converters

   1. Over heating
      - Caused by cooling fan
          malfunction or inadequate
          ventilation. Over heating
          may cause damage to the
          converter.

   2. Frequency interference
      - Lines or static on television or
          radio due to converter damage
          or malfunction

Inverter/Converter

Many Newmar R.V.'s are equipped with inverter/converter combination units. These units serve as a three-stage battery charger and an inverter to supply 120 vac to selected circuits. Units equipped with inverter/converter combinations will also be equipped with a 120 vac sub panel. The sub panel is located next to the main service panel, or if the unit has an EMS. MA and down the main and sub panel are all in one. The sub panel is used to
limit the circuits powered by the invertors. This is necessary to avoid rapidly draining the coach battery while inverting or overloading the inverter. AC current is supplied to the inverter/converter by a 30 amp breaker in the main service panel. When 120 vac is present, the inverter/converter allows AC power to pass through the unit and feed the sub panel. The inverter/converter uses a built in transfer switch to accomplish this. When AC power is not present, the inverter “when turned on” will invert DC voltage from the coach battery to AC voltage and feed the sub panel. DC power is supplied directly from the coach battery bank. A 300 amp fuse link is in line on the positive lead from the batteries, this fuse link is located in the battery compartment approximately 18 inches from the battery connection. Inverter(converters are equipped with a built in service breaker. The inverter/converter can be controlled by a panel on the unit or by remote panel. The remote panel is typically located in the dash overhead control cabinet. The remote panel is used to control the inverter and battery charging functions, and monitors these functions. The remote is also used to access menu and set up modes.

Note: If a remote panel is plugged into the inverter, the remote panel takes priority.

**Inverter/Converter Trouble Shooting Tips**

1. Overheating
   - Caused by cooling fan failure
   - Improper ventilation
   - Causing damage or malfunction of the unit.

2. Irregular operation of equipment
   - Digital clocks and some electronic equipment may not function properly due to modified sine wave. This is normal.
600-Watt Inverters

These units are inverter only. They are used to invert DC power to AC power. They are typically used to power entertainment equipment “TV, VCR, DVD, etc.” And are usually found in a storage compartment. They may or may not have a remote on/off switch located inside the coach. These units have a transfer switch built into the unit to allow AC power to pass through when present. AC power is provided to the unit from an outlet in the storage compartment. DC power is provided to the inverter from mini breakers located in the coaches’ electrical compartment. These units have built-in circuit breaker usually 7.5 amps and have limited power capabilities.

Inverter trouble shooting tips

1. Overheating from improper ventilation causing damage or malfunction of the unit.
2. Breaker Tripping due to over loading of circuit.
   - Re-set breaker on the front of the inverter.

Note: XA-FW’s do have a 1200 watt inverter/converter option, so the inverter is also the battery charger, it is a 70 amp charger built in.

- Make sure you install the correct model in the XA-FW.
120v Service - Common Circuits

1. Air Conditioner .................. 12-2 wire .................. 20 amp breaker
2. Microwave ...................... 14-2 wire .................. 15 amp breaker
3. Water Heater .................... 14-2 wire .................. 15 amp breaker
4. Light Line ....................... 14-2 wire .................. 15 amp breaker
5. Appliance Line ................... 12-2 wire .................. 20 amp breaker
6. Washer/Dryer (1 pc) ............. 12-2 wire .................. 20 amp breaker
7. Washer ............................ 14-2 wire .................. 15 amp breaker
8. Dryer .............................. 12-2 wire .................. 20 amp breaker
9. Magnum 2012 Inverter
   Power going to .................... 10-2 wire .................. 30 amp breaker
   Power coming from ............... 10-2 wire .................. 30 amp breaker
10. Appliance line
    Aire Series ...................... 12-2 wire .................. 20 amp breaker
    Star Series ...................... 14-2 wire .................. 15 amp breaker
11. Kitchen Circuit
    Aire Series Only ................. 12-2 wire .................. 20 amp breaker
12. Converter ....................... 12-2 wire .................. 20 amp breaker

Also, most optional features (such as heat pads, block heaters, dish washers, etc.) will have their own breaker.

Where the Wires Run - Rules of Thumb

1. Circuits, which can be connected from a standing position on the ground outside of the unit, are generally wired horizontally through the side wall.
2. Circuits, which cannot be connected from a standing position on the ground outside of the unit, are generally wired horizontally through the roof wrap of the unit to the others running horizontally across the roof.
3. Power line from power cord to breaker box runs through the floor on most towables.
POSSIBLE CHARGING ISSUES

1. BOTH BATTERY BANKS NOT CHARGING WHEN ON SHORE POWER OR WHEN DRIVING(ALTERNATOR)

2. BOTH BATTERY BANKS NOT DICONNECTING WITH NO CHARGE AND CANNOT START COACH, EVEN WITH BATTERY BOOST

Newmar has been having some issues with the solenoids we use for the charging system. On late model Class A Newmar coaches, some of the solenoids have been found to have corrosion at the contact points. The pictures show a cross section of a solenoid we had the issue with. We cut a cross section of one of the bad solenoids (see pictures). If you look, you can see the green corrosion on the contacts. It will cause an intermittent operation with the solenoid. To test, remove either the house or chassis battery cables. Hook up a light to the open post and put power to the coil of the solenoid. You must use something with an actual draw to properly test contacts, a meter may show continuity but the solenoid might still be bad. It is possible that the bad solenoid could have caused harm to the Bidirectional Isolator Relay Delay (B.I.R.D.). You can open up the cover of the B.I.R.D. and visually look to see if it shows signs of burnt spots on the circuit board.

PART NUMBERS

SOLENOID WITH POSSIBLE ISSUES    #44482
NEW SOLENIOD                    #122684

SATELLITE PREP AND SOLAR PREP LOCATIONS

Satellite prep on most coaches will be in front of the front roof AC. If the coach has 3 AC’s, it will most likely be located in between the front and center AC.

The solar prep for the coaches is “usually” set across from the stool room vent if possible. Sometimes they put the wires behind the vent in the stool room if there is no room. Wires are looped to the front overhead behind the electrical panel for a controller to be added for the solar prep, if the customer would like. Those wires end at the batteries.

BLOCK HEATER

King Aire, Essex, Mountain Aire and Dutch Star all have a switch in the front overhead for the block heater. All lower models are NOT equipped with this switch. The block heater on these coaches is only wired into the breaker panel and can only be turned on/off at the breaker panel. The breaker powers a receptacle that you can use to plug in your block heater.
12 VDC

BATTERIES

TYPES:

1. LIQUID LEAD – consists of a plastic container with cells molded into it. Each cell will feature a grid of lead plates along with an electrolyte based on sulphuric acid.

2. AGM (Absorbed Glass Mat) – are just like flooded batteries, except the electrolyte is being held in the glass mats, as opposed to freely flooding the plates. Very thin glass fibers are woven into a mat to increase the surface area enough to hold sufficient electrolyte on the cells for their lifetime.

3. Gel Cell – has gelified electrolyte.

BATTERY BANKS

Parallel battery wiring is where two or more batteries are hooked together in parallel (i.e. both/all positive battery terminals are wired together, and both/all negative battery terminals are wired together. This results in a battery voltage which is the same as that of the individual batteries (typically 12V in most cars). The reason for doing this is to boost battery capacity- two identical batteries wired in parallel give twice the electrical storage capacity of one battery. No increase in voltage is obtained with parallel wiring.

Series wiring is where two or more batteries are hooked together in series (i.e. positive terminal of the first battery is hooked to the negative terminal of the second battery). The resulting voltage is the sum of the individual battery voltages - if two 6V batteries are hooked together, the resulting voltage will be 12V. No increase of storage capacity is obtained with series wiring.

Read more: http://wiki.answers.com/Q/What_is_parallel_car_battery_wiring#ixzz1DU8j8icg

In situations where multiple batteries are connected in series, parallel or series/parallel, replacement batteries should be the same size, type and manufacturer (if possible). Age and usage level should be the same as the companion batteries.
What are the most common causes of premature battery failures?

A. Deep discharges  
B. Misapplication  
C. Using an undersized battery overcharging  
D. Loss of electrolyte due to heat or  
E. Corrosion  
F. Freezing (any fully-charged vehicle battery will not freeze until the temperature is -75 degrees F. Frozen batteries are not warrantable.)  
G. Failure to charge a battery during a period of 6 months or more

BATTERY MAINTENANCE

This is a VERY important issue and is often overlooked by many RV technicians and/or owners.

1. Batteries should be cleaned with a baking soda and water solution. (Couple of tablespoons to a pint of water)

2. Cable connections need to be cleaned and tightened. (Many battery and/or voltage problems are often caused by dirty and loose connections).

3. Serviceable batteries need to have their fluid levels checked. (Use only distilled water. Make sure to not overfill. This may result in acid overflow, and cause customers to think that their batteries are overcharging)

NOTE: To prevent corrosion, coat connections with high temperature grease. Most people do not know that just the gases from the battery that condensate on metal parts cause most corrosion.

As batteries age their maintenance requirements change. This means longer charging time and/or higher finish rate (higher amperage at the end of the charge). Usually older batteries need to be watered more often. And, their capacity decreases.

Inactivity can be extremely harmful to all lead acid batteries.
Battery Safety and Handling Guidelines

Whenever you’re handling or working with a lead-acid battery, consult your vehicle and battery owners’ manual for instructions and safety precautions.

Lead-acid batteries contain hydrogen-oxygen gases than can be explosive and sulfuric acid that can cause severe burns.

To help avoid risk of danger and injury, observe these precautions when handling or working with a lead-acid battery:

- Wear ANSI* approved safety glasses or goggles and a face shield.
- Wear proper clothing to protect your face, hands and body.
- Make sure work area is well-ventilated.
- Never lean over battery while boosting, testing or charging.
- Cigarettes, flames or sparks could cause a battery to explode. Keep all ignition sources away from the battery.
- Always shield eyes and face from battery.
- Do not charge or use booster cables or adjust post connections without proper instructions and training.
- KEEP VENT CAPS TIGHT AND LEVEL.
- In event of accident, flush with water and call a physician immediately.
- KEEP OUT OF REACH OF CHILDREN.

*ANSI – American National Standards Institute
The voltage measurements are only approximate. The best determination is to measure the specific gravity, but in many batteries this is difficult or impossible. Note the large voltage drop in the last 10%.

<table>
<thead>
<tr>
<th>State of Charge</th>
<th>12 Volt battery</th>
<th>Volts per Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>12.7</td>
<td>2.12</td>
</tr>
<tr>
<td>90%</td>
<td>12.5</td>
<td>2.08</td>
</tr>
<tr>
<td>80%</td>
<td>12.42</td>
<td>2.07</td>
</tr>
<tr>
<td>70%</td>
<td>12.32</td>
<td>2.05</td>
</tr>
<tr>
<td>60%</td>
<td>12.20</td>
<td>2.03</td>
</tr>
<tr>
<td>50%</td>
<td>12.06</td>
<td>2.01</td>
</tr>
<tr>
<td>40%</td>
<td>11.9</td>
<td>1.98</td>
</tr>
<tr>
<td>30%</td>
<td>11.75</td>
<td>1.96</td>
</tr>
<tr>
<td>20%</td>
<td>11.58</td>
<td>1.93</td>
</tr>
<tr>
<td>10%</td>
<td>11.31</td>
<td>1.89</td>
</tr>
<tr>
<td>0</td>
<td>10.5</td>
<td>1.75</td>
</tr>
</tbody>
</table>

Why 10.5 Volts?

Throughout this FAQ, we have stated that a battery is considered dead at 10.5 volts. The answer is related to the internal chemistry of batteries - at around 10.5 volts, the specific gravity of the acid in the battery gets so low that there is very little left that can do. In a dead battery, the specific gravity can fall below 1.1. Some actual testing was done recently on a battery by one of our solar forum posters, and these are his results:

*I just tested a 225 ahr deep cycle battery that is in good working order. I put a load on it 30a for 4 hrs it dropped its voltage to 11.2 I then let it cool down for 2 hrs*
then put the load back on again in 1hr 42 mins it dropped to 10.3v
35 mins under 30a load 9.1v (273w)
10 mins later max output current 11.6a 8.5v (98.6w)
5 mins later max output current 5.2 amps 7.9v (41w)
3 mins later 7.6v and 2.3a (17.5w)

This shows after it gets below 10.3 v you only have 35 mins of anything useful available from the battery.
battery is now dead and most likely will not fully recover

Cycles vs. Life

A battery "cycle" is one complete discharge and recharge cycle. It is usually considered to be discharging from 100% to 20%, and then back to 100%. However, there are often ratings for other depth of discharge cycles. The most common ones are 10%, 20%, and 50%. You have to be careful when looking at ratings that list how many cycles a battery is rated for unless it also states how far down it is being discharged. For example, one of the widely advertised telephone type (float service) batteries have been advertised as having a 20-year life. If you look at the fine print, it has that rating only at 5% DOD - it is much less when used in an application where they are cycled deeper on a regular basis. Those same batteries are rated at less than 5 years if cycled to 50%. For example, most golf cart batteries are rated for about 550 cycles to 50% discharge - which equates to about 2 years.

Battery life is directly related to how deep the battery is cycled each time. If a battery is discharged to 50% every day, it will last about twice as long as if it is cycled to 80% DOD. If cycled only 10% DOD, it will last about 5 times as long as one cycled to 50%. Obviously, there are some practical limitations on this - you don't usually want to have a 5 ton pile of batteries sitting there just to reduce the DOD. The most practical number to use is 50% DOD on a regular basis. This does NOT mean you cannot go to 80% once in a
while. It's just that when designing a system when you have some idea of the loads, you should figure on an average DOD of around 50% for the best storage vs cost factor. Also, there is an upper limit - a battery that is continually cycled 5% or less will usually not last as long as one cycled down 10%. This happens because at very shallow cycles, the Lead Dioxide tends to build up in clumps on the the positive plates rather in an even film. The graph above shows how lifespan is affected by depth of discharge. The chart is for a Concorde Lifeline battery, but all lead-acid batteries will be similar in the shape of the curve, although the number of cycles will vary.

**Lifespan of Batteries**

The lifespan of a deep cycle battery will vary considerably with how it is used, how it is maintained and charged, temperature, and other factors. In extreme cases, it can vary to extremes

**Amp-Hour Capacity**

All deep cycle batteries are rated in amp-hours. An amp-hour is one amp for one hour, or 10 amps for 1/10 of an hour and so forth. It is **amps x hours**. If you have something that pulls 20 amps, and you use it for 20 minutes, then the amp-hours used would be 20 (amps) x .333 (hours), or 6.67 AH. The generally accepted AH rating time period for batteries used in solar electric and backup power systems (and for nearly all deep cycle batteries) is the **20 hour rate**. This means that it is discharged down to 10.5 volts over a 20 hour period while the total actual amp-hours it supplies is measured. Sometimes ratings at the **6 hour rate** and **100 hour rate** are also given for comparison and for different applications. Sometimes the 100 hour rate is given just to make the battery look better than it really is, but it is also useful for figuring battery capacity for long-term backup amp-hour requirements.

This means that the faster a battery is used (discharged), the LOWER, the AH capacity. Conversely, if it is drained slower, the AH capacity is higher.

("State of Charge", "Why 10.5 volts?", and "Cycles of Life", "Lifespan of Batteries", "Amp-hour Capacity", info was provided by Northern Arizona Wind and Sun)
CHARGING SYSTEMS

All late model Essex and King Aire's use Silverleaf systems with the White Rodgers Solenoid. In 2014, the Mountain Aire will also be using Silverleaf. It is a computerized system that controls all aspects of charging.

All late model Mountain Aire and Dutch Star Diesel Pushers use the Battery Isolation Manager (BIM). This is an all in one system that is made by Precision Circuits.

Class A models use the Bidirectional Isolator Relay Delay (BIRD) with a solenoid.

The Bay Star Sport has a manual switch to disconnect power, which is located in the overhead above the entry door. This is similar to the ones in the fifth-wheels. All others have a single lighted switch that is in the front overhead to turn off house voltage.

BATTERY DISCONNECT

Newmar uses Intellitec’s disconnect relay (Newmar P/N – 52989) on the coach battery bank to disconnect loads in case of storage [see additional pages from manufacturer for function and diagnostics]. Keep in mind that not all loads are disconnected. There some loads (radio memory, entry steps, LP detectors, etc.) that are connected to the “hot” side of the disconnect relay. This is very important to remember when a coach is put into storage and is not plugged into shore power.

NOTE: when an older coach is being stored, and is plugged into shore power....DO NOT use the “battery disconnect”. If the “battery disconnect” is used, the chassis batteries will not receive a charge from the converter. This is due to the coach battery sense wire being “disconnected”, meaning the B.I.M. or the B.I.R.D. will not engage.
THINGS TO REMEMBER

- There are too many variables that come into play when dealing with the lifespan of a battery.

- There is only 1 “usable” volt in a 12 VDC system

- **D.O.D.** = Depth-Of-Discharge: The percent of rated capacity to which a cell or battery is discharged. It is the reciprocal of a battery’s state of charge. Example: a battery that has a depth of discharge of 45% has a state of charge of 55%.

- **S.O.C.** = State Of Charge. (The condition of a battery in terms of rated capacity remaining at a given point in time.)

- **Ampere (amp)** = a unit that defines the rate of flow of electricity (current) in a circuit.

- **VDC** = volts direct current

- **VPC** = volts per individual cell (approx. 2.10 vdc)

- **AH** = amp hours: The unit of measure for a battery’s electrical storage capacity, obtained by multiplying the current in amps by the time in hours of discharge.

- **RC** = Reserve Capacity. BCI(Battery Council International) defines it as “the number of minutes a new; fully-charged battery at 80°F (27°C) can be discharged at 25 amps and maintain a voltage equal to or higher than 1.75 volts per cell” (i.e., 10.5 volts for a 12-volt battery). This rating represents the time the battery will continue to operate essential accessories in the event of a charging system failure.

- **OCV** = Open-Circuit Voltage: The no-load voltage of a cell or battery measured with a voltmeter.

- **CCV** = Closed-Circuit Voltage: The voltage of a battery when the cell or battery is under a specific discharge load and time interval.
Battery Disconnect provides a simple and safe means of remotely disconnecting batteries of an RV or boat. With a touch of a remote switch, the batteries will be completely disconnected, preventing unwanted drain when the RV or boat are put into storage.

The heart of the system is a unique latching relay developed specifically for this purpose. While this relay is capable of carrying heavy currents, it requires NO power to stay open or closed. It only draws power during activation. The relay is sealed against the environments and is designed to withstand the shock and vibration experienced in the most severe RV or boat applications.

THE RELAY - How It Works

The Battery Disconnect Relay is a mechanically latching switch that operates by the momentary application of battery voltage to the coil terminals in one direction for latching (closed) or the other direction for unlatching (open).

To close the relay, +12 volts is applied to the "I" terminal and ground to the "S" terminal of the relay. When this is done, the plunger is pulled into the coil and the contacts are connected. While this happens, the rod magnet suspended above the plunger is attracted (opposite poles attract) to the top of the plunger by the magnetic field. See FIGURE 1

When the voltage is removed from the coil, the plunger gets pushed upward by the return spring, but cannot move because the rod magnet is in the way. See FIGURE 2

Warning: The Battery Disconnect system connects directly to the vehicle's positive battery terminal. Inadvertent shorts across the battery or to ground, may cause severe damage and injury. Use extreme caution when working with these wires. Always wear safety glasses when working with the battery connections.
**RELAY CLOSING**
Positive polarity applied to coil.
Current flowing in coil.
Plunger pulled in to coil.
Rod magnet attracted to plunger by opposite polarity.

**RELAY CLOSED**
Power removed from coil.
Magnet blocks plunger from coming up, maintaining contact.
To open the relay, +12 volts is applied to the "S" terminal and ground on the "I" terminal. When this is done, the plunger is again pulled into the coil. However, since the magnetic polarity of the coil is reversed, the rod magnet is repelled (like poles oppose), and swings out of the way. See FIGURE 3

When the voltage is removed from the coil, the plunger gets pushed upwards by the return spring, breaking the connection between the two large terminals. See FIGURE 4.
**RELAY OPENING**
Negative polarity applied to coil.
Current flowing in coil.
Plunger pulled in.
Rod magnet opposed by plunger
same polarity magnetic field,
swings out to side of housing.

**FIGURE 3**

**RELAY OPEN**
Power removed.
No current flowing in coil.
Plunger pushed up by return spring
while magnet is off to the side.
Contacts open. Magnet comes
to rest at side of plunger.

**FIGURE 4**
THE SYSTEM

A typical motor home may use one or two relays to disconnect the batteries. These relays are usually independent and operate from a switch panel located inside the coach. A harness is used to connect from the panel to the relays. The Intellitec/Nuvatec panels are offered in four models. They are:

BD0 - Single battery system, with a cable and monitor panel with an on/off indicator

BD1 - Single battery system, with a cable and monitor panel with an on/off indicator and digital voltmeter

BD2 - Dual battery system, with cable and monitor panel with two on/off indicators and ignition interlock relay.

BD3 - Dual battery system, with cable and monitor panel with two on/off indicators, digital voltmeter, and ignition interlock relay.

Note: BD1 panel can be interchanged with BD0, and BD3 and BD2 can be interchanged with BD2

The dual relay panels include an ignition interlock relay that opens the power circuit to the chassis battery relay when the ignition is turned on, to prevent the battery from being accidently opened when the engine is running.

A typical circuits is shown in FIGURE 5 and FIGURE 6. The switches are each double pole, double throw, momentary, center off. Operating the switch in either direction will cause the relays to open or close, depending on the polarity of the voltage applied.

FUSES

There are two 5 Amp fuses for the system, mounted on each relay. Looking at the relay with cap at the top, the fuse on the right feeds the LED indicator and if so equipped, the digital voltmeter. The fuse on the left feeds the power to the switch that operates the solenoid.
# BATTERY DISCONNECT

## SERVICE MANUAL

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause/Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay won't engage</td>
<td>Check fuses on relay</td>
</tr>
<tr>
<td></td>
<td>Check battery voltage, must be greater than 10.5 volts.</td>
</tr>
<tr>
<td></td>
<td>While switch is engaged, check for voltage across the coil terminals (+ on the &quot;I&quot; terminal and ground on the &quot;S&quot; terminal), if 0 volts, replace panel, if + voltage, replace relay.</td>
</tr>
<tr>
<td>Relay won't disengage</td>
<td>Check fuses on relay</td>
</tr>
<tr>
<td></td>
<td>Check battery voltage, must be greater than 10.5 volts</td>
</tr>
<tr>
<td></td>
<td>While switch is engaged, check voltage across the coil terminals (+ on the &quot;S&quot; terminal and ground on the &quot;I&quot; terminal) If 0 volts, replace panel, if + voltage, replace relay.</td>
</tr>
<tr>
<td>Light on panel remains on although relay is off</td>
<td>Check wiring</td>
</tr>
<tr>
<td></td>
<td>Is coach plugged in, unplug coach</td>
</tr>
<tr>
<td></td>
<td>Is engine running, turn engine off</td>
</tr>
<tr>
<td>Light is off although relay is on</td>
<td>Check wiring</td>
</tr>
<tr>
<td></td>
<td>Check fuses on relay</td>
</tr>
<tr>
<td>BD1 or BD3 No voltmeter reading</td>
<td>Check wiring</td>
</tr>
<tr>
<td></td>
<td>Check voltage on yellow/green wire, If + voltage, replace panel</td>
</tr>
</tbody>
</table>

Intellitec

131 Eisenhower Lane North
Lombard, IL 60148
630.268.0010 / 1.800.251.2408

www.intellitec.com
SINGLE BATTERY DISCONNECT
MODELS BD0 & BD1

NOTE: "I" TERMINAL + FOR USE
"S" TERMINAL + FOR STORE

NOTE: MOVE SWITCH DOWN FOR USE
UP FOR STORE
Intellitec's **Bi-Directional Isolator Relay Delay-Diesel 2™** offers a new approach to charging batteries in an vehicle which uses a diesel engine with up to a 200 Amp alternator. Adding a small dash-mounted switch will allow emergency starts of diesel engines, requiring up to 1200 Amps of starter current. Unlike prior systems that only allowed charging the auxiliary battery from the engine's alternator, the **Bi-Directional Isolator Relay Delay-Diesel 2™** charges both batteries when either one is being charged. When the vehicle is being driven, both batteries will be charged from the engine's alternator. When the vehicle is plugged into shore power, both batteries will be charged from the converter or battery charger. If neither battery is being charged, the batteries are fully isolated. The controller also senses heavy loads on either battery to prevent the wrong battery from being inadvertently discharged.

The unit is housed in a plastic enclosure for mounting in an engine compartment, out of direct water spray. To connect the two batteries together under proper conditions, it operates in combination with an intermittent duty solenoid, similar to ones used as diesel starter solenoids. In order to use this type solenoid for continuous duty, the controller will engage it with full voltage and then reduce the coil voltage to approximately 4 volts to hold it in.

It operates by sensing the voltages on both batteries. When either of these voltages exceeds 13.1 volts for approximately 2-½ minutes, which happens when either battery is being charged, the control will close the isolator solenoid, connecting the two batteries together, charging them both. (Normal charging voltages are from approximately 13.8 to 14.4 volts.)

After the solenoid has been closed, the system continues to sense the voltage. If the ignition switch is off and the battery voltage drops below 12.5 volts for approximately 1 minute, the solenoid is opened to prevent the chassis battery from being discharged by the auxiliary loads. This might occur when the converter is heavily loaded.

If the ignition switch is on, the control allows the voltage to drop below 12.0 volts for approximately 1 minute, before the solenoid is opened to insure the alternator's full output is available for important chassis functions.
Bi-Directional Isolator Relay Delay-Diesel 2

How Does It Work?

The Bi-Directional Isolator Relay Delay-Diesel 2™ constantly senses the voltage on the auxiliary and chassis batteries. If either voltage is above 13.1 volts, which indicates the batteries are being charged, the control closes the isolator relay. This parallels the batteries, charging them both. If the ignition is off and the voltage falls below 12.5 volts for approximately 1 minute, the relay will open to prevent the auxiliary loads from discharging the chassis battery. When the voltage goes back above 13.1 volts, the relay will close again.

If the ignition is on and the voltage falls below 12.0 volts for approximately 1 minute, the relay will open to prevent the auxiliary loads from over-loading the alternator and discharging the chassis battery. When the voltage on the chassis goes back above 13.1 volts, the relay will close again. Allowing the batteries to stay connected together to a lower voltage helps charge a heavily discharged auxiliary battery more quickly with the varying output of the alternator.

A Gen Set lock-out input is provided to isolate the batteries to prevent conflicts if both the converter/gen-set and alternator are trying to charge the batteries at the same time. When this conflict occurs, it can cause the dash alternator indicator light to illuminate in error and may cause 120 volt circuit breakers to trip.

If the Gen Set is running, the chassis battery and coach battery will be isolated. In this case the chassis battery will be charged by the alternator and the coach battery will be charged by the Gen Set. In the event that the chassis engine is not running, the chassis battery is isolated and will not be discharged by auxiliary loads.

SPECIFICATIONS

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part Number</td>
<td>00-00839-100</td>
</tr>
<tr>
<td>Standby Current</td>
<td>Less than 2 milliamps</td>
</tr>
<tr>
<td>Ambient Temperature Range</td>
<td>-40C to +85C</td>
</tr>
<tr>
<td>Normal Input Voltage Range</td>
<td>10 to 18 volts</td>
</tr>
<tr>
<td>Short Term Over Voltage Protection</td>
<td>+26 volts</td>
</tr>
<tr>
<td>Reverse Voltage Protection</td>
<td>- 300 volts</td>
</tr>
<tr>
<td>Positive Voltage Spike Protection</td>
<td>+150 volts</td>
</tr>
<tr>
<td>Operating Environment</td>
<td>Out of direct weather</td>
</tr>
<tr>
<td>Coil Resistance</td>
<td>2.2 ohms minimum</td>
</tr>
<tr>
<td>Solenoid Type</td>
<td>Intellitec P/N 77-90006-120</td>
</tr>
</tbody>
</table>

SYSTEM CONNECTIONS

[Diagram of system connections]

Intellitec
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www.intellitec.com

P/N 53-00839-100 Rev. 072005

Intelligent Use of Technology
Battery Isolation Manager Operation

Overview:
The Battery Isolation Manager (BIM) monitors the Battery Voltage of both the Chassis and Coach Batteries over long periods of time. If it senses a charging voltage, it connects the two batteries together. If the charging system is drastically overburdened, the batteries will be isolated, however, if the BIM sees a long term charging of both batteries it will allow the batteries to remain connected and allow the charging system to do its job. Once the batteries have reached a Float Charge state for one hour, the BIM will isolate the batteries to prevent overcharging, and will only reconnect the batteries for charging if one of the Battery drops to approximately 80% charge, and the other is being charged. If the batteries are not being charged, BIM isolates the two batteries to prevent an electrical draw in one system from depleting the other battery. The long term monitoring of the batteries prevents the annoying Relay clicking that exists in simpler Isolation Modules today.

Key Features:
1. Control is integral to Isolator Relay for simpler installation
   a. Waterproof, IEC 60529, IP66 IP67, Salt Spray ASTM B 117 96 Hours Salt Spray
   b. Approved for use in Battery Compartments
   c. 225 Amps Continuous
2. Microprocessor based
   a. Monitors battery state over long periods of time
   b. Not just simply voltage dependent
3. Bi-Directional Charging
   a. Charge Coach Battery when Alternator is charging Chassis Battery
   b. Charge Chassis Battery when Converter is charging Coach Battery
4. Isolate Batteries to prevent discharging or overcharging of Batteries, or when neither battery is being charged
5. Prevents
   a. Equalization cycles from Damaging Chassis Battery, by isolating at voltages over 15.5Volts
   b. Annoying clicking of Isolator Relay by monitoring battery state over longer periods of time, not just simply voltage dependent. (Present controls that turn on at 13.3V and turn off at 12.8V cycle every 20 seconds when the charger goes into float mode)
   c. Overcharging of Coach Battery during long drives by shutting down every hour and only turning back on when Coach Battery needs charging
   d. Overcharging of Chassis Battery during long periods of Shore Power by shutting down every hour and only turning back on when Chassis Battery needs charging.
   e. Generator/Charger and Alternator Interference by shutting down when Ignition and Generator are sensed.
6. Provides Emergency Start with Dash Switch
   a. 100°F cooler than competition.
   b. Uses only 4Watts of power versus 25Watts.
Detailed Operation:
1) Relay is turned on if:
   a) Ignition is on for 20 seconds &
      i) 2 minutes have passed since Relay last turned off &
         Coach Battery less than 12.6V &
         Chassis Battery is greater than 13.2 &
         Chassis Battery is Less than 15.5V &
         Generator is off
   b) Ignition is off
      i) 10 minutes have passed since Relay last turned off &
         Chassis Battery less than 12.6V, &
         Coach Battery is greater than 13.0V &
         Coach Battery is less than 15.5V
   c) Generator is On & Ignition is On then the Alternator and Battery charger are fighting each
      other and Relay should be turned off. automatically

2) Relay is turned off if:
   a) Ignition goes from on to off state
   b) Relay has been on for 1 hour
      (prevent overcharging and allow to view separate voltages)
   c) Anytime Ignition and Generator are both on.
   d) Anytime either Battery goes above 15.5 volts for 30 seconds
   e) (Coach battery charge can drop to support the engine, in start and stop situations)
      While the Ignition is on, the time the Relay will remain on is Voltage dependent
      i) High end of time 12.8 volts = 40 minutes
      ii) Time is scaled between above and below values
      iii) Low end of time 11.8 volts = 5 seconds
   f) (Thou shalt never discharge Chassis battery for Coach functions)
      While the Ignition is off, the time the Relay will remain on is Voltage dependent and shorter
      than while the Ignition is On
      i) High end of time 12.8 volts = 10 minutes
      ii) Time is scaled between above and below values
      iii) Low end of time 11.8 volts = 5 seconds

3) Relay Coil will be driven with approximately 4Volts DC. The Solenoid will be turned on hard with
   full battery voltage, and then the voltage will be throttled back to reduce battery power and Relay
   heat.
EXTERIOR FUSE LOCATIONS AND DESCRIPTIONS

LOCATED INSIDE SHORE CORD COMPARTMENT

BATTERY

DISCONNECT

SOLAR PANEL PREP IN-LINE FUSE HOLDER (NO FUSE LOADED)
BD RELAY (2)5 AMP FUSES LOCATED ON BOTTOM OF RELAY

LOCATED INSIDE FRONT COMPARTMENT DRIVER SIDE

1. SOCKET RELAY OUT
2. 12V RELAY OUT
3. 12V RELAY IN
4. 12V RELAY IN
5. 12V RELAY IN

NEWMAR #107126

GND

3 AMP ELECTRIC JACK Fuse IS ALSO LOCATED;
INSIDE FRONT DRIVER SIDE STORAGE COMPARTMENT
NEXT TO JACK CONTROL MODULE

NEWMAR CORP
P.O. Box 30,
Nappanee, IN 46550

Title block—STB

FUSE LABELS AND LOCATION

Model: 2009 SPARTAN CHASSIS
Sheet: 1 OF 1

Drawn by: B. M.

Checked by:

Revision: By:

Date: 2/26/08

Date:

Revision:

Date:
DIESEL PUSHER:
FUSE PANEL LOCATED IN FRONT CARGO COMPARTMENT DRIVER SIDE

EXCEPTION: LONDON ARC DIESEL BUS
LOCATED IN FRONT COMPARTMENT PASSENGER SIDE
12V wires come from the house fuse panel to the closest component or switch on that line. The color of the wire determines what line it is on. The fuse panel tells what color is on what line. Connections from rough wire to the chassis are usually made at the driver A-Pillar.

The 110V side goes from the breaker box, located next to the house fuse panel, to each recept on that line. Most 110V wires run alongside the side of the roof, under the wrap. Then wires will drop straight down to the recept from the roof.

You can log on to comnet2.newmarcorp.com to reference questions you may have about electrical issues. Go to TECHNICAL REFERENCE—TECHNICAL INFORMATION. From there, go to the tab that you want to reference.

NEWMAR SERVICE SCHOOL 2011
Chart 6-1 outlines application criteria for use of multiple conductors within terminals (or connectors):

<table>
<thead>
<tr>
<th>Terminal Size</th>
<th>Allowable Conductor Combinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 ga.</td>
<td>1-18 ga.</td>
</tr>
<tr>
<td></td>
<td>2-20 ga.</td>
</tr>
<tr>
<td>16 ga.</td>
<td>1-16 ga.</td>
</tr>
<tr>
<td></td>
<td>2-18 ga.</td>
</tr>
<tr>
<td>14 ga.</td>
<td>1-14 ga.</td>
</tr>
<tr>
<td></td>
<td>2-16 ga.</td>
</tr>
<tr>
<td></td>
<td>3-18 ga.</td>
</tr>
<tr>
<td>12 ga.</td>
<td>1-12 ga.</td>
</tr>
<tr>
<td></td>
<td>2-14 ga.</td>
</tr>
<tr>
<td></td>
<td>3-16 ga.</td>
</tr>
<tr>
<td></td>
<td>4 or 5-18 ga.</td>
</tr>
<tr>
<td>10 ga.</td>
<td>1-10 ga.</td>
</tr>
<tr>
<td></td>
<td>2-12 ga.</td>
</tr>
<tr>
<td></td>
<td>3-14 ga.</td>
</tr>
<tr>
<td></td>
<td>4 or 5-16 ga.</td>
</tr>
</tbody>
</table>

Where connectors or terminals with integral insulation grips are used, it is important that the conductor's insulation fully enters the insulation grip. Cutting off or misuse of the insulation grip so that it is gripping the conductor core instead of the insulation is not considered acceptable.

Connections soldered directly to an electrical device need not be insulated.

Soldering conductor strands to an insulation grip type terminal in lieu of using the insulation grips is not considered acceptable since flexing of uninsulated core conductor strands is not prevented.
6-1.15 Access

This section requires all wiring connections to devices to be accessible. Accessible means no permanent construction is to be removed in order to reach the wiring connection of the device. Connections hidden by permanent construction that is glued, stapled or nailed in place will not be considered accessible. Wiring connections to devices will be considered accessible provided they can be reached by removing construction screwed in place, as shown in Figure 6-1.14. Wiring connections that are accessible when the device itself is removed will be considered accessible.

Figure 6-1.14
Accessibility to device connections.
Chapter 8 Testing

8-1 Operational Test

This paragraph applies to recreation vehicles and conversion vehicles and requires that an operational test of all low voltage circuits be conducted to demonstrate that all equipment is connected and in electrical working order. This test is to be conducted after all production activities that may damage conductors, such as installation of fasteners or hole cutting, have been completed.
Chapter 5 Conductor Protection, Routing and Securing

5-1 Conductor Protection

All wires (conductors) are to be protected against physical damage and they are to be supported. Physical damage will apply to contact with sharp metal edges, screw points, heat sources, moving parts such as water pump pulleys, power cord storage areas, or any other element(s) that may potentially inflict damage. Potential damage is of particular concern in all storage areas or open spaces where items are likely to be stored.

Conductors in the engine compartment must be routed and supported to prevent damage from moving parts and heat sources. Close attention needs to be given to areas containing gear shift and steering linkages, belts, pulleys and engine manifolds. Routing of conductors in the same areas where OEM conductors are routed will provide sufficient protection.

An owner is inclined to use all open spaces within the unit, whether it was intended to be storage space or not. With this in mind, special attention needs to be paid to the protection of low-voltage conductors in all areas. Careful routing of wires, such as along the upper corners of compartments will usually provide acceptable protection. Covering boards, water tubing, channels, or convoluted tubing will provide additional protection for wires that are likely to be exposed. Auto loom of the braided fabric type is not generally acceptable as it does not provide sufficient protection.

Where low-voltage conductors pass through the skin of the vehicle, care must be exercised to avoid contact with the sharp edge of the metal. The use of grommets or agents such as silicone are acceptable if the wire(s) is centered and the silicone completely surrounds the conductor, as shown in Figure 5-1 - #1. Several exterior lights have an integral protective flange that extends past the metal edge and provides adequate protection, as shown in Figure 5-1 - #2. When these are used, additional protection is not required.
In routing of conductors, any hole or slot, in other than wood, is to be insulated by the installation of an acceptable liner. These may include grommets, shown in Figure 5-1 - #5, water hose, minimum two wraps of duct tape, (masking tape not
acceptable) convoluted tubing, shown in Figure 5-1 - #3, or adhesive-type rubberized caulks that totally surround the conductors. Holes or slots provided by the automotive chassis manufacturer and designed for wire routing will not require a liner providing the edges are rolled, shown in Figure 5-1 - #4, thus producing a smooth contact point that the wire can safely touch.

Convoluted Tubing

Figure 5-1 - #3

Rolled Edges

Figure 5-1 - #4

Factory provided holes with rolled edges do not require additional protection for conductors.

Figure 5-1 - #5

Holes for conductors must be provided with grommets or other means of conductor protection.

When routing a conductor through open paths in the vehicle's chassis that requires installation between two or more chassis parts such as between the roof panel and roof strut or between the wall strut and the exterior skin, the conductors are to be securely mounted in such a fashion as to ensure protection against vibration or relocation into any position that could potentially subject the conductor to damage as a result of abrasion or pinching.
Conductors are required to be supported. Conductor support can be accomplished in a number of ways. Dedicated wire supports or cable clamps could be used. Support is provided where conductors pass through grommeted or bushed holes in the chassis.

Support is also provided by any horizontal surface that acts to support the conductors. For the purposes of support, tape will be acceptable (duct tape, masking tape, etc.). In most cases, the conductors only need to be supported until wall or ceiling panels are put in place; at which point they are supported by the wall or ceiling panels. Insulated stapled, nylon wire ties or equal, as shown in Figure 5-1 - #6, are also acceptable means of support.

When 12-volt conductors are stapled to the structure of the vehicle, an extra wrap or layer of material needs to be used to assist in protecting the conductor's insulation. One method commonly used with wood structures is insulated staples. Insulated staples can include 120-volt staples of the type that use a plastic “bridge” between the securing nails or metal staples that have a “cardboard” protector beneath the head. This reduces the potential of damaging the conductor insulation.

![Figure 5-1 - #6](image)

**Figure 5-1 - #6**
Low Voltage Conductor Support

No specific distance requirement on support is mandated. Therefore conductor support will only be required in conjunction with other portions of this standard.
5-2 Conductor Routing

The intent of this requirement is to prevent bundling of wires from different power sources, as shown in Figure 5-2. Contact at crossover points should cause no problems.

Therefore, this paragraph is violated only if the 12-volt and 120-volt conductors, due to routing, run parallel or through the same hole in studs, floors, or partitions. Further, “crossover” means, as a guideline with obvious tolerances, not more than 45 degrees from perpendicular. Conductors of different power sources are not to be clamped or secured at the same point.

In addition to routing to maintain the 1/2 inch separation, an equivalent method may be employed that might include using 12-volt jacketed conductors, spacers, special heavy tape for the purpose, or conduit. Also, the encasement of either the 12-volt or 120-volt conductors in plastic convoluted tubing will be considered sufficient separation, even when the other non-encased conductors are routed immediately adjacent to or secured along with the plastic convoluted tubing encased conductors.

![Diagram of acceptable methods of circuit separation](image-url)
5-3.1 Strain Relief

This section requires conductors of components that move with relation to each other to be provided with a means of strain relief, such as providing a loop or slack in the conductors. Also the last supporting clip used on the conductors of a moving component must be securely mounted to ensure the strain relief is permanent. An example would be the installation of motor driven “drop down” accessories in the overhead. The conductors from these components must be provided with enough slack beyond the final supporting clip to ensure they will not be damaged when the component moves.
5-3.2 Accessibility

This section requires at least 4" of free conductor to be provided after the last point of conductor securement. This is to permit service and accessibility of every device. This means devices mounted into wall or ceiling panels must be capable of being pulled forward, out of their mountings, to a distance where the device is at least 4" from the finished wall or ceiling surface as measured along the wire.
6-1.1 Splicing

Conductors are to be spliced and joined with splicing devices or by soldering. Merely twisting two conductors together and taping them is not acceptable. Splice devices are not required to be listed.

A splice device is any device used to join conductor(s) to conductor(s), or conductor(s) to equipment. For practical purposes, splicing devices can be divided into two categories: 1) connectors and 2) terminals.

Connectors are devices that join and fasten two or more conductors together. Such devices include, but are not limited to, solderless connectors such as "scotchlocks," "butt connectors," "t-taps," and "mating connectors," such as those shown in Figure 6-1.1 - #1.

![Figure 6-1.1 - #1 Examples of Connectors](image)

Terminals are devices attached to the end of a wire (or to a device) for the convenience of making connections. Examples, such as those shown in Figure 6-1.1 - #2, include, but are not limited to, "ring terminals," "captive spade terminals," and "blade terminals."
6-1.1 Splicing - Continued

Eyelet Terminal

Ring Terminal

Captive Spade Terminals

Other Terminals

Figure 6-1.1 - #2
Examples of Terminals
551.47(F) Raceway and Cable Continuity

The sheath needs to be continuous between outlet boxes and other enclosures and extend into the boxes by at least 1/4". (314.17(C)).

This paragraph also applies to damaged sheathing of nonmetallic sheathed cable. If the cable sheathing is damaged (i.e., cut or ripped) without portions of the sheathing missing, and the conductor's insulation remains undamaged, as shown in Figure 551.47(F), taping of the sheathing is an acceptable fix. The general guideline on a cut that can be repaired in this fashion is about 12". However, the field inspector will have the final say as to whether fixing or replacing is required.

![Cut or Damaged Sheath](image)

Note: 3 to 5 wraps of listed electrical tape

In July 1986, HUD took the position that nonmetallic sheathed cable repair in manufactured housing was not permitted. In a “B” letter from HUD, the following was stated:

“(HUD) would pursue (damaged NMS cable)...with U.S. and others to determine whether such repair was acceptable.... While all parties contacted were of the opinion that a repair of a minor cut, with suitable electrical tape, would not constitute a hazard or affect the intent of Article 300.12 of the National Electrical Code (NEC), for continuous cable, none of the sources could conclude that the repair was covered by the listing of the cable or by the NEC.”

While HUD will not allow this practice, the RV industry will be permitted to make minor repairs as described above as a safety hazard does not exist.

April 2008
This paragraph applies to protection of cables that pass through wood studs or framing members of floors, walls and ceilings where the cable is less than 1-1/4" from the inside and/or outside surface, as shown in Figure 551.47(G). This requirement was established to protect the romex from nails or screws used during construction or later to hang things on walls. Steel plate protection, if used, is necessary for both sides of the cable where stud or frame is less than 1-1/4". Steel tubing (min. #16 MSG 0.0598" or 1.52 mm) is also acceptable.

When protection is required, the steel protectors need to extend fully through (at least flush on both sides) the stud or frame.

When using steel protection parts for conductor protection, be sure that the surfaces are free from burrs. In the stamping or cutting process, sharp burrs may be on edges and these can cut or gouge the conductor’s protective insulation or jacket.

Another potential area of concern is where nonmetallic sheath cable passes through framing members of cabinets. Typically, the cable may be feeding an 120-volt light or a down facing receptacle. Because the framing of cabinets are typically 3/4" cleat stock or similar, steel protection as outlined in this requirement is impractical to use. Therefore, in this or similar areas only, steel protection will not be required providing the cable is routed to the back or front of the cabinet, where it is unlikely to interfere with cup hooks or paper towel holders installed by the consumer. The cable is also to be protected in accordance with 551.47(K).
1-1/4" or more requires no additional protection.

Min. 16 MSG steel sleeve extending through stud.

Min. 16 MSG steel plate used on dado or notches.

Aluminum or steel tubing requires protection from sharp edges and burrs.

Careful routing of the non-metallic cable in cabinets requires no additional protection.

Figure 551.47(G)

Remember, if the nonmetallic sheath cable is routed through holes or slots in metal members, bushings or grommets are required to protect the cable. Steel protection would not be required in this case.
551.47(H) Bends

Excessive bending of nonmetallic sheath cable will fatigue the copper conductors. The requirement does not apply to single conductors once they enter an outlet box or other fixture.
551.47(l) Cable Supports

Where cable connections or clamps are used, the cables need to be supported within 12" of outlet boxes, junction boxes, and panelboards. The 12" are to be measured in a straight line from the device to the means of support.

Support can be provided by passing through studs or by laying the conductor on the floor or other horizontal surface. Acceptance of cables lying on the floor depends on the actual location. If it is in a storage compartment and behind covering boards, additional support or securement is not necessary. If the cable runs through an area that is not a storage area and the cable is not confined to a specific space, additional stapling may be needed. Actual "fastening" is not mandatory if support is otherwise provided. Additionally, support is necessary at maximum 4-1/2' intervals throughout the cable runs.
551.47(J) Nonmetallic Box Without Cable Clamps

See section 551.47(I) Cable Supports on page E-59 of this handbook. These same criteria apply with the 12" being reduced to 8" for this application, as shown in Figure 551.47(J) - #1. However, at 8", cable clamps are not required to secure the cable to the box. In the event that clamps are provided but not used, they must be secured to prevent accidental contact with live parts or removed.

8" is measured along the wire.
Cables running through holes in wood or metal studs, rafters or joists are considered to be supported and secured.

Figure 551.47(J) - #1

This paragraph also addresses wiring devices with integral enclosures, such as the self-contained receptacle and switch devices. The extra loop of cable required for the installation of these devices is not considered as part of the 8" support requirement. For example, if the installation instructions mandate a 6" cable loop, then 6" of conductor is exempted from the support requirement and the support would need to be within 14" (8" + 6") of the device as measured along the wire, as shown in Figure 551.47(J) - #2. The installation instructions of these devices specify the length of the loop to be provided. (See section 551.40(A) General Requirements on page E-22 of this handbook and 300.14 of the NEC for additional information.)
Self Contained (Device) Receptacle

All measurements are made along the wire.
6" Required by installation instructions
8" Required by 551.47(J) NEC

Cables running through holes in wood or metal studs, rafters or joists are considered to be supported and secured.

*Figure 551.47(J) - #2*
551.47(K) Physical Damage

By definition, exposed (as applied to wiring methods) means on or attached to the surface or behind panels designed to allow access.

Any nonmetallic cable in an area accessible to the RV owner for storage or in a traffic area, is considered exposed and subject to physical damage. This requirement applies even if the accessible area is marked "Not for storage" or similar. Therefore, protection by covering boards, guard strips, conduit, electrical nonmetallic tubing or equivalent, is necessary in these locations, as depicted in Figure 551.47(K). Also, careful routing of wires along the upper corners of compartments will provide acceptable protection. The upper corners of storage compartments are considered to be the top two (2) vertical inches of the compartment. This two inch measurement includes the top cleat that is the upper frame member of the compartment. A wire routed along the floor area or subject to damage cannot be protected by convoluted tubing. However, NMS cable routed along the floor or in a corner and covered by covering boards or guard strips is considered acceptable.

"Covering boards" and "guard strips" are not defined within the Standard. Typically, the term covering board has been associated with strips of wood used to cover exposed romex. Non-metallic sheathed cable routed closely between two pieces of cleat stock would be considered protected provided it does not extend beyond the outer edges of the cleat stock.
When metal studs or framing members are employed the cable is to be protected by bushings or grommets securely fastened in the opening prior to the installation of the cable (Ref. 551.47(G)). When steel tubing is used for cable protection, bushings or grommets are not required.
551.47(M) Metal Faceplates Grounded

Metallic faceplates are grounded when secured to the receptacle outlet or switch. The metal faceplates connected with metal screws are grounded to the yoke of the device. It is important that switches with an equipment ground screw or grounded metal boxes be used when employing metallic face plates to ensure compliance. This is also a good reason for ensuring that the screw(s) supplied with the devices is used. If a plastic screw were substituted for the metal screw, grounding may not be ensured.
551.47(N) Moisture or Physical Damage

This paragraph addresses exterior wiring. Nonmetallic sheathed cable (romex) by itself is not approved for exterior use and cannot be used without the use of the conduit or tubing specified within this paragraph.

The paragraph allows the use of the following for protection of non-metallic sheathed cable (romex) used on the vehicle exterior:

1. Rigid metal conduit
2. Intermediate metal conduit

Also, the following are allowed to be used for protection of non-metallic sheathed cable, where routed closely against the frame:

1. Electrical metallic tubing
2. Rigid non-metallic conduit
3. Other raceway or cable identified for the application

Liquid-tight flexible conduit listed for direct burial will be considered acceptable for use in under chassis applications.
551.47(O) Component Interconnections

This paragraph provides for concealing of an electrical fitting or connection but requires that these connections be listed and identified for this purpose.