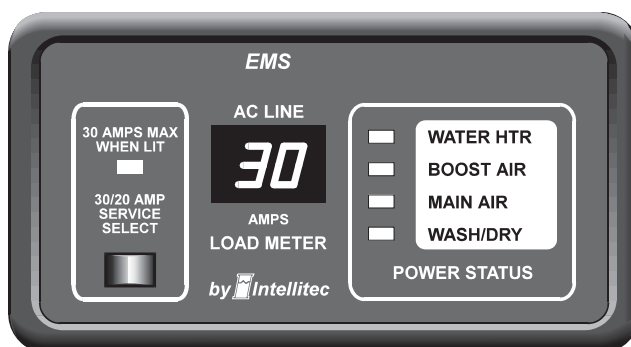
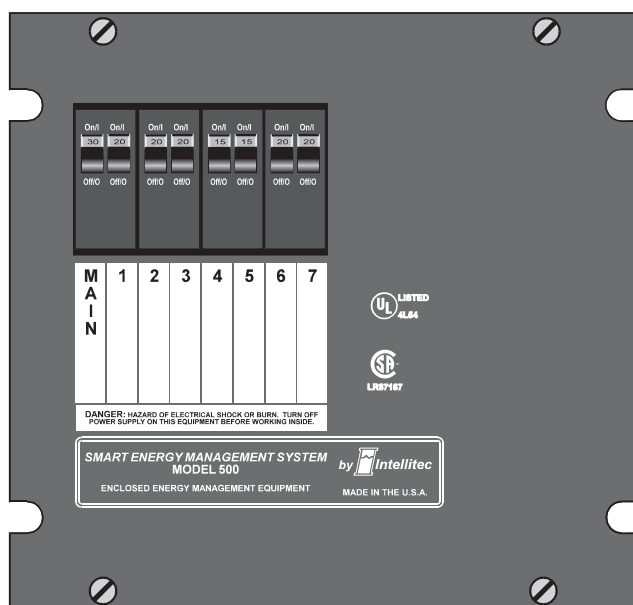


SMART EMS™

SERVICE MANUAL



PRODUCT DESCRIPTION

The **SMART EMS™** is a completely self-contained 120 volt power distribution and energy management system intended to be used in recreational vehicles. It is housed in a sheet metal enclosure with removable front panel. It provides circuit protection for all the 120 VAC loads in the RV and a system of energy management to minimize the over-loading and tripping of circuit breakers.

Circuit Breakers - the **SMART EMS™** offers slots for four single or dual, standard 120 volt circuit breakers. One of these breakers must be a 30 Amp unit that acts as a main input protection for the remainder of the branch breakers (up to 7).

Energy Management - the **SMART EMS™** offers control of up to four, 120 volt operated appliances to help keep the total 120 volt current draw to less than 30 Amps. These appliances may be any type load, but are typically heavier loads, those whose use can be "postponed" until a time when current is available for their use.

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CAUTION

The SMART EMS™ is a centralized power switching, fusing, and distribution center. Power from the 120 volt power source is fed into the box. The potential of lethal electrical shock is present in this box. Inadvertent shorts at this box could result in damage and/or injury. All servicing of this box should be done **only** by a qualified Service Technician.

Diagnostic tools required: Low current Test Light, Accurate Voltmeter (digital readout preferred), Clamp-on AC ammeter.

HOW IT WORKS

The **SMART EMS™** provides main and branch circuit protection *and* control of up to four selected appliances. The control helps to limit the total current draw of all the appliances in the RV at or below 30 Amps provided by the main power feed.

CIRCUIT PROTECTION

Circuit protection for ALL the 120 VAC loads is offered by standard, reset-able circuit breakers, provided by the installer. There are four positions available for circuit breakers. These may be single or dual units. One of these breakers must be a 30 Amp unit to act as the Main breaker for the entire system. The 120 volt power is brought into the box from either a shore cord or generator. The line side of this cable is fed through the magnetically coupled current transformer located on the EMS pcb, and connected to a 30 Amp circuit breaker that acts as the Main breaker. This breaker back-feeds power into the circuit breaker bus to feed power to the branch breakers. These can be either single or dual circuit types. All the loads in the RV are fed from the branch breakers.

ENERGY MANAGEMENT

The current entering the main circuit breaker is routed through the magnetically coupled current sensor. This sensor measures the current flowing through the main breaker, which is the total amount being drawn by all the 120 volt appliances in the RV. When this current exceeds 30 Amps (20 Amps if the threshold has been set lower), the EMS will turn off the controlled loads in an effort to bring the total current to the limit of the incoming service.

CONTROLLED LOADS

The system offers control of up to four 120 VAC powered loads. Loads that are to be controlled are connected to one of the relay circuits of the **EMS**. There are five total control relays in the EMS. **ONLY 4** of these can be used in a given application.

Two of these five circuits have single pole double throw, low voltage relays, with un-dedicated contacts available. These are intended to control air conditioners or other appliances equipped with low voltage controls or thermostats. The contacts of the relays are typically wired in series with the thermostats of airconditioners so the EMS turns off only the compressor. This leaves the fan on to recirculate the air, masking the interruption of the compressor. These relay circuits could also control other 120 volt appliances if an additional control relay is added externally.

Three of these circuits are 15 Amp relays to interrupt the 120 volt power to the loads. These circuits are intended to control 120 volt appliances such as water heater, washer/dryer, coffee maker, etc. For the 120 switched loads, power is routed from the individual branch circuit breakers to one of these 120 volt relays. The controlled load is then fed from that relay.

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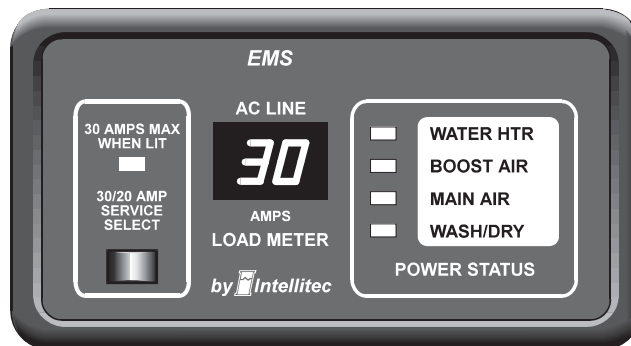
OPERATION

In operation, when the 120 VAC and 12 VDC are applied, the system will energize the relays, one at a time. **The three AC relays and two DC relays will move from the N/O to N/C position.** However, the coils of all five relays are DC. The total current is monitored. If the total should exceed the 30 Amp service limit, the system will turn off the last load that was turned on. As it does this, it calculates the amount of current that was removed, which is the value for that load. This value is placed in memory. The system has "learned" the amount of current that particular appliance draws. This feature compensates for the differences in current draw over a range of line voltage and ambient temperature, by re-learning the load each time it is turned off.

The system now waits until the total current is lower than 30 Amps by the amount in memory before it will turn that load back on. This assures that there is sufficient current to operate the load.

There is a two minute minimum delay period before the load will be turned back on again to prevent air conditioners from turning on with a head of pressure.

OPTIONAL DISPLAY PANEL



The optional display panel, can be mounted remotely and connects to the main unit with a small gauge, four wire cable.

Four Power Status LED's indicate power is applied to those loads. These LED's are on when the power is applied.

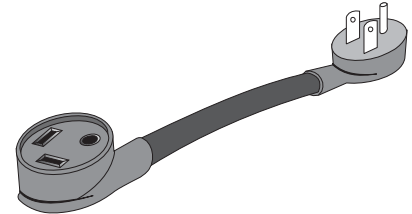
A two digit display, the Load Meter, **indicates the amount of current actually being drawn** by all the appliances in the coach.

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The Service Select button allows the current threshold to be set to either 30 Amps or 20 Amps, to match the incoming service. If the pictured adaptor is used on the incoming service, press the service select button to select the 20 Amp mode. When power is first applied, the system will always be in the 30 Amp mode. The 30/20 Amp indicator LED will be on when the system is in the 30 Amp mode. Momentarily pressing this button will switch the system to the 20 Amp mode. Momentarily pressing this button again will switch the system back to the 30 Amp mode.

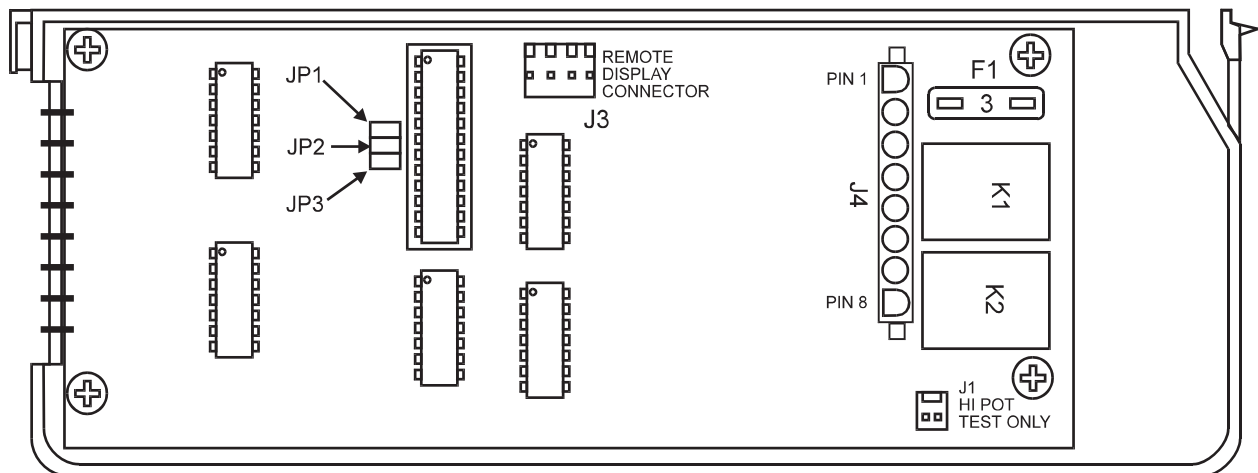
This panel can also be used to display the value of current stored in memory for each of the four loads. To display the values of current stored in memory for each of the four loads, push and hold the Service Select button. The uppermost LED will illuminate, and the stored value will appear on the Load Meter. Pushing Service Select again will cycle to the next load. After the last stored value has been displayed, the Load Meter will return to normal operation and display total current draw.



INSTALLATION

The first step when installing an EMS, is to determine which loads will be controlled and in what order they will be shed. A typical scheme would be to control the two air conditioners, the water heater, and the washer/dryer. With these loads, the first load to be shed should be the water heater, as its loss of operation would be the least noticed, it would switch to operate on gas if needed. The next would be the bedroom air. The third would be the washer dryer, and finally the main air. Choosing this sequence would provide the least inconvenience to the occupants.

The EMS has three jumpers on the board that determine the order of shedding of the loads. These jumpers are labeled JP1, JP2, and JP3. (See figure below.)



These jumpers are all installed at the factory. Removing them will alter the order of shedding to suit the particular need of the installation. The following tables will assist in determining the proper settings for the three jumpers.

The first step is to fill in the blanks with the names of the loads you want the system to shed, in the order they are to be shed, with the first to be shed at the top. Then, fill in the second, "Load Type", column with an "A" or a "D", an "A" for a 120 VAC controlled load such as a washer/dryer, or a "D" for DC controlled load, such as a thermostat wire. You can select a maximum of 3AC\1 DC relays, or 2AC\2 DC relays.

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LOAD NAME (First to shed at top)	Load Type	1	2	3	4	5	6	7	8
		A	A	A	A	A	A	D	D
		A	A	A	D	D	D	A	A
		A	D	D	A	A	D	A	D
		D	A	D	A	D	A	D	A

Next, looking across the other eight columns, find the one that matches the "Load Type" column you just filled in. This column is then the function of the EMS.

Using the number at the top of the column, look in the table below to determine the settings of the three jumpers, JP1, JP2, and JP3. A "Y" (for yes) means the jumper should be installed and an "N" (for no) means there should not be a jumper installed.

RELAY WIRING TABLE .

Column Number	1	2	3	4	5	6	7	8
JP1	Y	Y	Y	Y	N	N	N	N
JP2	Y	Y	N	N	Y	Y	N	N
JP3	Y	N	Y	N	Y	N	Y	N
Relay Shed Order	1 2 3 5	1 2 5 3	1 2 4 5	1 4 2 3	1 4 2 5	1 4 5 3	4 2 3 5	4 2 5 3

At the bottom of each column is the Relay Shed Order. This determines which relays will be used for each load. The one at the top of the column is first to be shed. The one below it will turn off next and so forth. The loads *MUST* be wired in this order for the system to operate as desired.

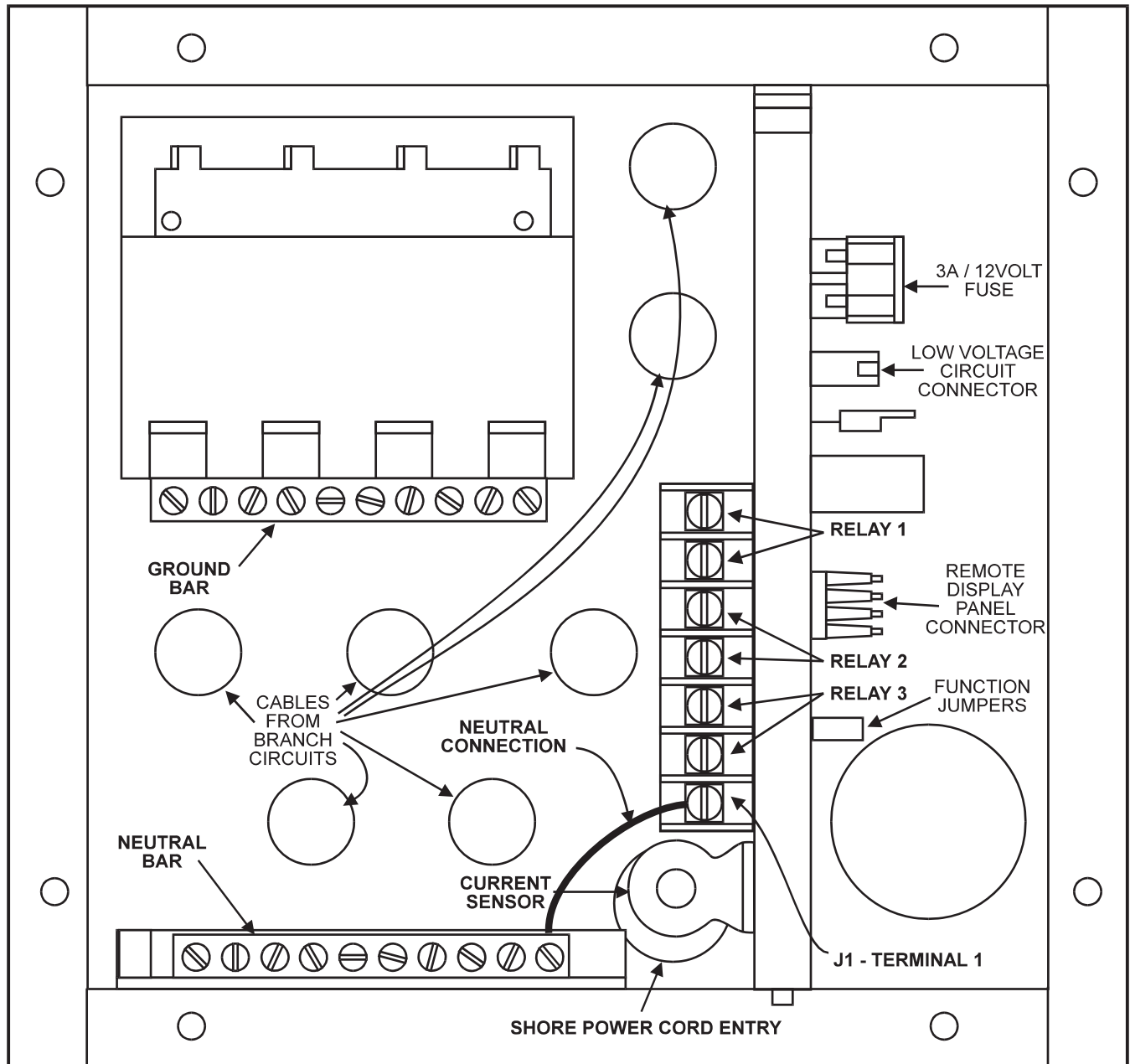
Finally, the number and size of the circuit breakers should be selected to meet the needs of the installation. The breakers can be either single or dual types. One of these breakers *MUST* be a 30 Amp unit to act as the Main breaker. The breakers must be obtained and then installed in the box. (See information on breaker types later in this manual.)

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PLACEMENT

The EMS should be installed in a convenient location where it can get air circulation to keep it from over heating. There should be a minimum of 7" of depth behind the mounting surface to provide enough room for the box and wiring.

A hole should be cut in the mounting panel as shown.

This opening must be cut carefully to be sure the mounting screws will have enough wood to hold, and there is enough clearance around the box for the front cover screws.

The wiring to the box should be routed through the holes in the back and secured using approved cable connectors. The wires should be copper conductors **ONLY**, with the appropriate size and insulation to meet N.E.C.

The 10 gauge main cable should be brought through the large hole in the lower center of the box. The remaining wires should be routed through the remaining holes in the back of the box.

The wires should be stripped and the ground wire of each cable connected to the GROUND bar, terminal strip. The white or neutral wires should all be connected to the NEUTRAL bar terminal strip. **Each terminal screw should be tightened to 16in.-lb. of torque.** (See the box drawing.)

If removed during installation, the white jumper wire should be re-installed between the NEUTRAL bar and J1, terminal 1 of the EMS module. (See box drawing, page 6.)

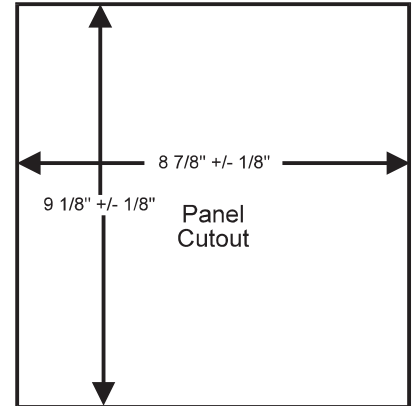
The Black or "hot" lead should be routed through the hole in the current sensor and then to the screw terminal on the 30 Amp Main breaker.

The black or "hot" leads of all the uncontrolled loads should be connected to their associated breakers.

To connect the 120 volt controlled loads, jumper wires should be connected from the respective circuit breakers to the associated screw terminals on the EMS control module. The black wires to the controlled loads should be connected to the proper screw terminals on the EMS module. Be sure these wires are under the screw terminals and they are tight.

J5 - 7 terminal block - Will accept up to 12 GA or 14 GA copper wire **ONLY**.

<u>Terminal</u>	<u>Function</u>
1	Neutral
2	From Circuit Breaker 3
3	Output of Relay 3
4	From Circuit Breaker 2
5	Output of Relay 2



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The 12 VDC voltage connections are made through the 8 pin Mate-N-Lok plug on the low voltage side of the control module. The connections are as follows:

<u>Pin</u>	<u>Function</u>
1	+ 12 Volts
2	Ground
3	Relay 4 Normally Open
4	Relay 4 Common
5	Relay 4 Normally Closed
6	Relay 5 Normally Open
7	Relay 5 Common
8	Relay 5 Normally Closed

The +12 volts should be supplied from a source fused at 3 Amps minimum and capable of delivering up to 1 Amp of AVERAGE current. Protecting this connection with a higher rated fuse is acceptable since the EMS is internally protected with a 3 Amp fuse.

The relay connections are typically made to the thermostat wires of the air conditioners. The normally open contacts are wired in "series" with the thermostat. This means that the thermostat wire is cut and the two ends are wired to the Common and the Normally Open contacts of the relay/s. In this way, the EMS can interrupt the operation of the compressor, just as the thermostat does. The low voltage wires are brought into the box through the large hole in the lower right-hand corner of the back of the box.

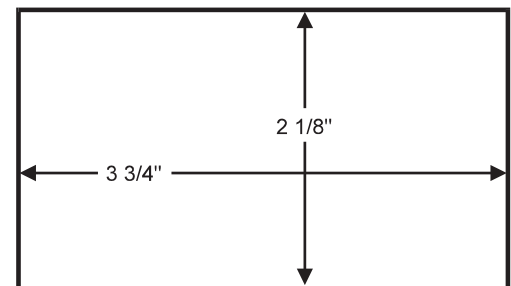
OPTIONAL REMOTE PANEL

If a remote panel is to be used in the installation, it should be installed now. Select a convenient location for the panel, where it can be easily viewed by the owner. Cut a hole for the panel as shown.

Route the harness from the hole for the display panel to the EMS (up to 40 feet of cable is acceptable). Plug the cable into the EMS, assuring it is properly seated on all four pins. (Note: This cable is polarized, the latches of each end of the connector mate to each other, and will go on easily in the right direction, but can be forced on in the reverse direction.)

Now the EMS should be moved into the mounting hole, being careful not pinch any of the wires. It should be screwed in place using four # 8, round head screws into the 4 holes in the side flanges. The front covers should be screwed into place with 4 screws into the holes in the top and bottom flanges.

The Remote Panel should be plugged onto the harness observing the polarity as before. The panel should then be installed in the hole and screwed in place using two # 6, flat head screws through the holes in the panel. The white function label should be lettered to correspond to the order of load shedding and installed. The cover label should be placed against the front panel in the trim bezel snapped on to hold the label in place.



Remote Panel Cutout

SMART EMSTM

SERVICE MANUAL

PERFORMANCE TEST

The system is now ready for testing.

HI-POT TEST

At the installers preference, to assure there are no potential shorts, a Hi-Pot test can be performed on the installation. To do this, +12 volts must be applied to the system. A jumper wire must be installed to tie the two pins of the "Hi-Pot Test" plug, J1, to turn the system on without the presence of 120 volt power. This plug is located on the right side of the EMS Control module (See top view drawing.) The relays on the module should be heard clicking as they pull in. (If the system is equipped with a Display Panel, the LED's should light and the numeric display should read "0".) The Hi-Pot test should now be conducted in accordance with standard procedures for the tester being used. Assuming the system passes, the covers should be taken off and the jumper removed from J1. If not, the problem must be corrected before proceeding further.

SYSTEM TEST

All the 120 volt loads should be turned off or disconnected. Both 120 volt AC and 12 volt DC power should now be applied to the system. When this is done, the relays should be heard pulling in, one at a time. If the system is equipped with a Display Panel, the numeric display should read "0" and the four LED's should be come in order. If the system is not equipped with a display panel, a clamp-on type ammeter should be used to measure the current being supplied by the 30 Amp shore power cord.

Connect or turn on one of the controlled AC loads. It should operate and the numeric display or the clamp-on ammeter should show the amount of current that load is drawn. Turn that appliance off and repeat this with each of the others.

To test the load shedding, turn on all the controlled appliances. The total current drawn should exceed 30 Amps. (If not, add additional loads to the non-controlled receptacles.). When the total amount of current exceeds 30 Amps, the loads should begin to turn off to bring the total below 30 Amps.

CIRCUIT BREAKERS

There are 4 positions for the circuit breakers in the box. The circuit breakers can be single or dual types. One must be a 30 Amp to be used as the Main Breaker.

The following breakers are suitable for MAIN and BRANCH breakers:

Bryant - BR, BD, GFCB, Filler Plate FP-1B
ITE Gould - QP, QT, Filler Plate Qf3

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The replacement circuit breakers must be of the same type and rating.

FUSE

F1 - 3 Amp ATO type, for EMS circuitry only. DO NOT replace with a fuse of higher rating. This could result in severe damage to the circuitry or create a possible fire hazard.

PLUGS - PINS & FUNCTIONS

J1 - 2 pin plug used for High Pot Test Only. When shorted together, will operate EMS relays without the presence of 120 VAC.

J3 - 4 pin Molex KK .156 - Display Panel Connector Mating Housing Molex 09-50-3041

<u>Pin</u>	<u>Function</u>
1	Power
2	Data
3	Ground
4	Select Line

J4 - 8 pin in-line Mate-N-Lock Mating housing AMP 640586-1

<u>Pin</u>	<u>Function</u>
1	+ 12 Volts
2	Ground
3	Relay 4 Normally Open
4	Relay 4 Common
5	Relay 4 Normally Closed
6	Relay 5 Normally Open
7	Relay 5 Common
8	Relay 5 Normally Closed

J5 - 7 terminal block - Will accept up to 12 GA or 14 GA copper wire ONLY.

<u>Terminal</u>	<u>Function</u>
1	Neutral
2	From Circuit Breaker 3
3	Output of Relay 3
4	From Circuit Breaker 2
5	Output of Relay 2
6	From Circuit Breaker 1
7	Output of Relay 1

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Trouble Shooting

If the following problems occur, proceed with their analysis in the order in which the steps are listed.

I. No 120 volt appliances working.

A. Check incoming power source.

1. Make sure the shore power cord is plugged into the outlet.
2. Check the circuit breaker at the shore power outlet to be sure it is set. Turn it off and then back on to be sure.
3. Check the 30 Amp Main circuit breaker in the EMS™ box to be sure it is set. Turn it off and then back on to be sure.
4. Using a circuit checker, be sure the 30 Amp shore power outlet has 120 volts available.

B. Check Change-Over relay, if so equipped.

1. Measure the voltage at the incoming side of the Main 30 Amp breaker. If voltage is NOT the same as the incoming line, repair the change-over. (Refer to the change-over service literature for trouble shooting.)

II. 120 volts available at non-controlled appliances and receptacles. Controlled appliances do not operate.

A. Check the 12 volt power to the EMS™ module.

1. Check 12 volt fuse in 12 volt distribution panel. Replace if necessary.
2. Check 12 volt, 3 Amp fuse on EMS™ module. Replace if necessary.

B. Check 120 volt circuit breakers in EMS™

1. Reset circuit breakers if necessary.
2. Check for presence of voltage at branch circuit breakers with voltmeter.
3. Check for presence of voltage at EMS™ terminals with voltmeter.
4. Check wire from EMS™ module to neutral bar is installed.

III. Some controlled appliances turn on, others do not.

A. Reduce total current, appliance may be shed.

B. Check wiring to and from EMS™ module.

1. Check wiring from circuit breakers to EMS™ module.
2. Check wiring from EMS™ module to controlled appliance.
3. Check for power at associated EMS™ relay terminal.

IV. Branch circuit breaker trips when power is applied.

A. Check wiring for shorts.

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Trouble Shooting

V. Air conditioner doesn't work.

- A. Check thermostat wiring and settings.
- B. Check air conditioner

VI. Shedding order incorrect.

- A. Check jumper setting per Figure on page 5.
- B. Check relay wiring per Figure on page 5.

VII. Remote Display out or strange characters.

Check wiring between EMS and display panel.

Pin	Function	Voltage
1	Power	12V
2	Data	Ground
3	Ground	Ground
4	Select Line	Ground, 12V when pressed

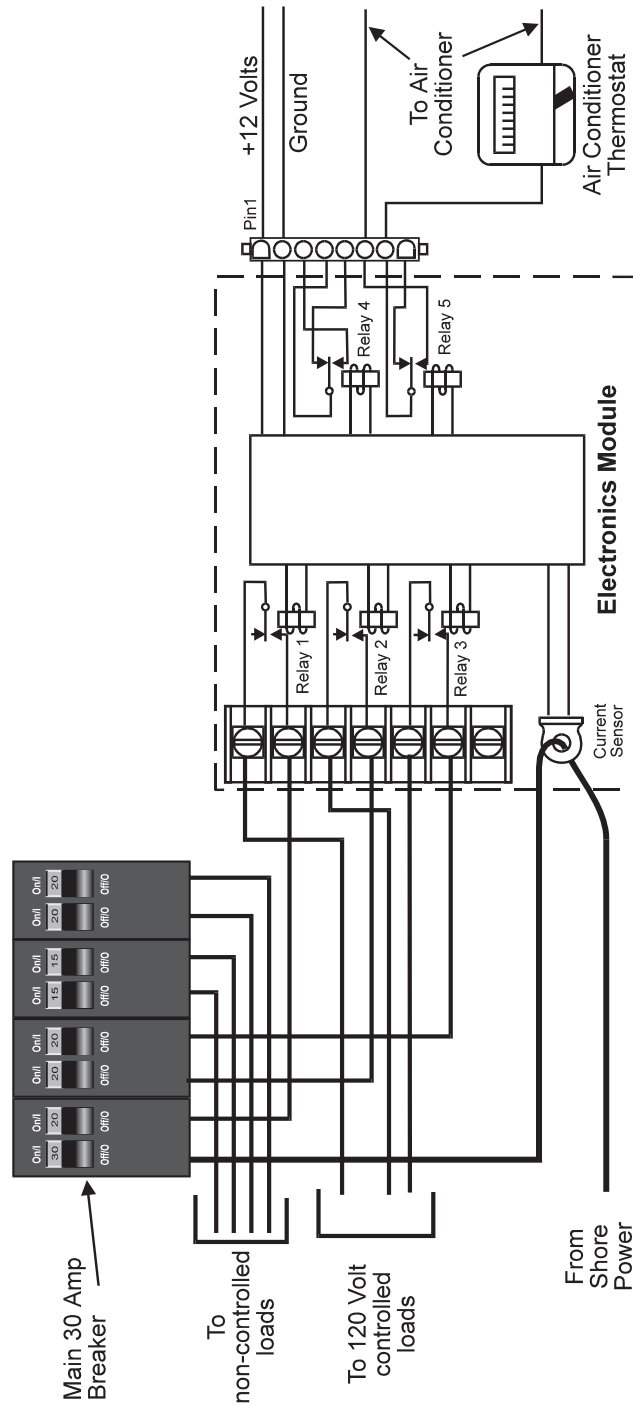
Wiring 1 → 1 2 → 2 3 → 3 4 → 4

Both the EMS and Display have internal protection.
Shorts or mis-wiring should not cause the units to fail.

SMART EMS™

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Typical Installation
with one DC controlled load and
three AC controlled loads



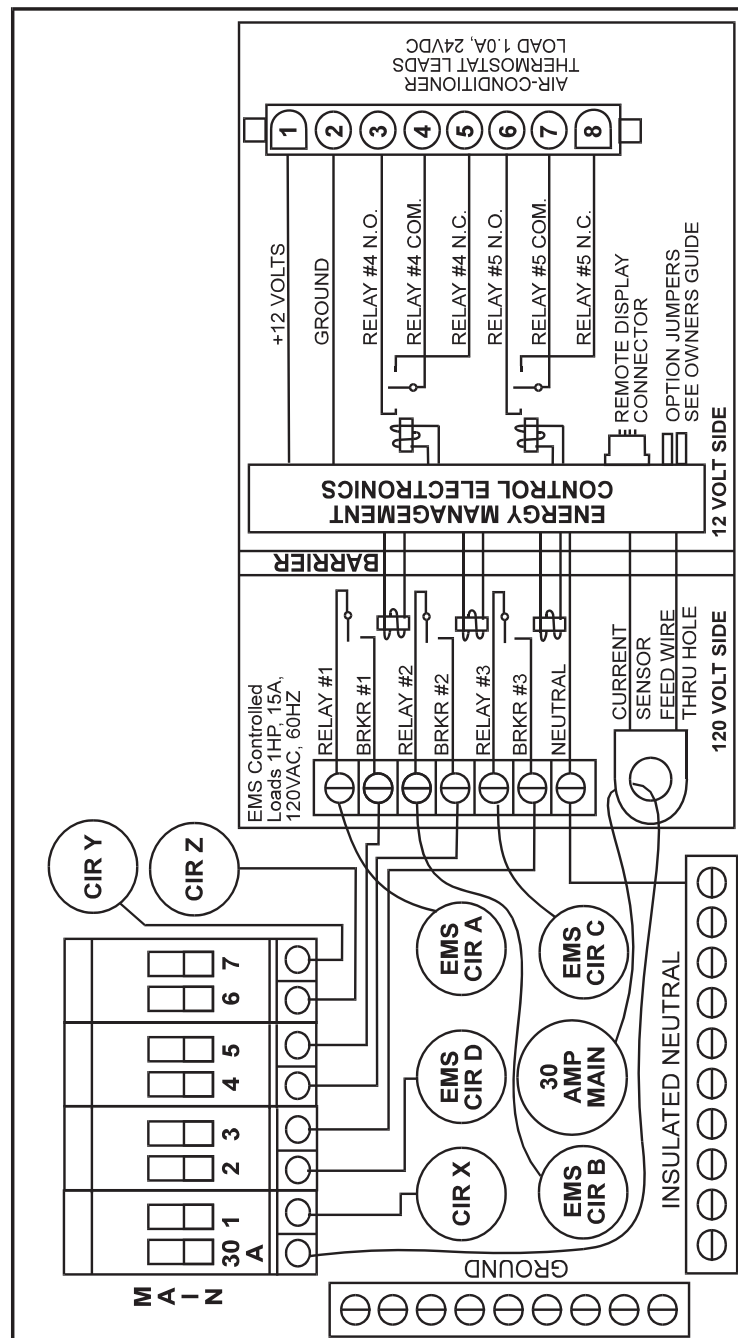
Note: Neutral and Safety Ground Wiring not shown for clarity

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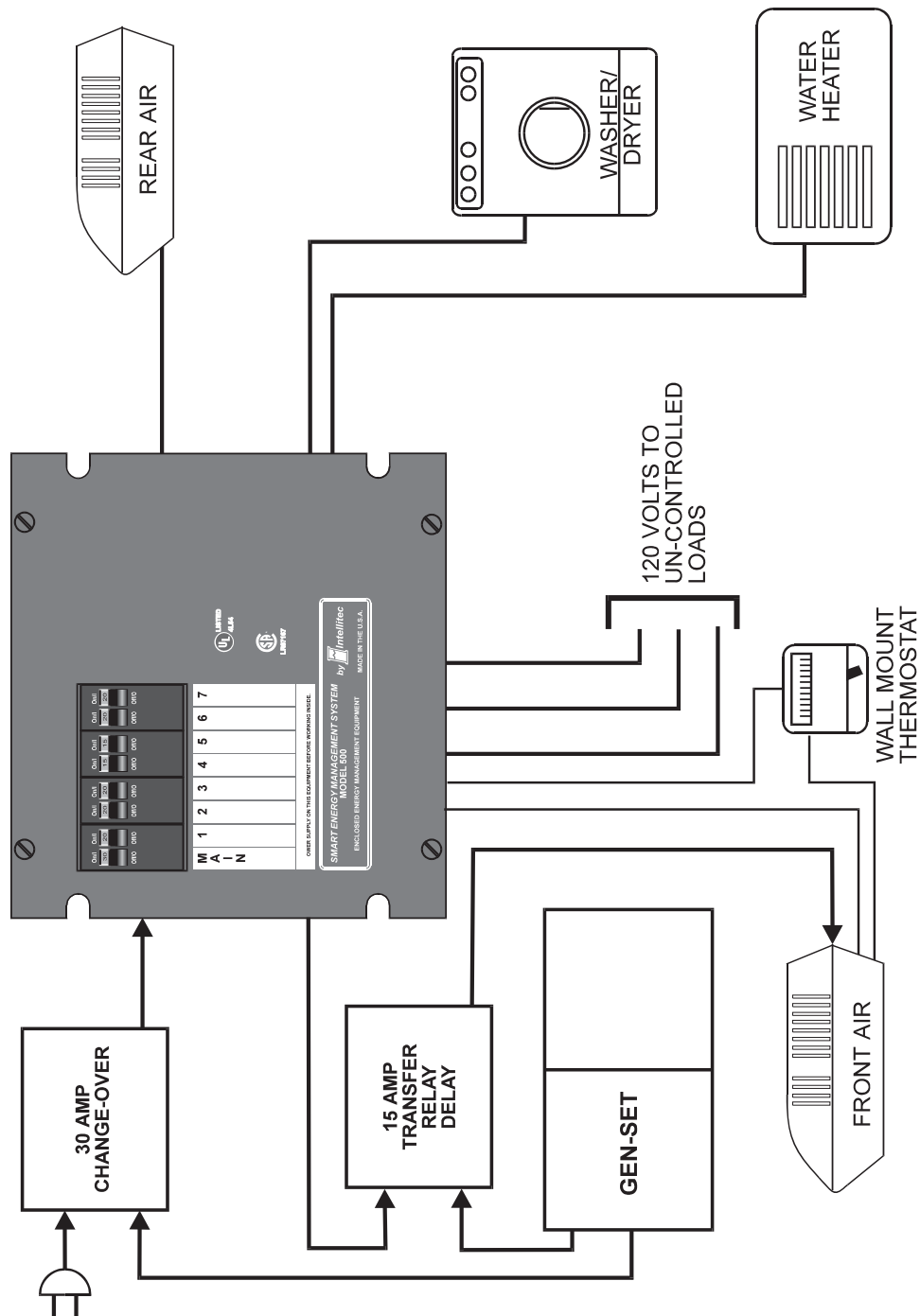
TYPICAL WIRING DIAGRAM



All 120VAC Shore Power must pass thru EMS Current Sensor.

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