MidNite Solar MNBH Disconnect Panel
User's Manual

P/N 10-192-1 REV C

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Contents

IMPORTANT SAFETY INSTRUCTIONS

SAVE THESE INSTRUCTIONS - These instructions contain important safety and operating instructions for the MidNite Solar MNBH.

If you do not fully understand any of the concepts, terminology, or hazards outlined in these instructions, please refer installation to a qualified dealer, electrician or installer. These instructions are not meant to be a complete explanation of a renewable energy system.

GENERAL PRECAUTIONS

If service or repair should become necessary, contact MidNite Solar Inc. Improper servicing may result in a risk of shock, fire or explosion. To reduce these risks, disconnect all wiring before attempting any maintenance or cleaning. Do not work alone. Someone should be in the range of your voice or close enough to come to your aid when you work with or near electrical equipment.

Remove rings, bracelets, necklaces, watches etc. when working with batteries or other electrical equipment. Power from solar panels makes a very effective arc welder with dire consequences if one of the welded pieces is on your person.

SAFETY WARNINGS used throughout this document are as follows:

WARNING !

Warnings identify conditions or practices that could result in personal injury or loss of life.

CAUTION !

Cautions identify conditions or practices that could result in damage to the unit or other equipment.

MNBH DISCONNECT INSTALLATION GUIDELINES AND SAFETY INSTRUCTIONS

The following important restrictions apply unless superseded by local or national codes:

For routine, user-approved maintenance:

Turn off all circuit breakers, including those to the solar modules, batteries and related electrical connections before performing any maintenance.

Standards and Requirements

All installations must comply with national and local electrical codes. Professional installation is recommended.

Wiring must be done in accordance with the National Electrical Code ANSI/NFPA 70. Use Class 1 wiring methods for field wiring connections to terminals of a Class 2 circuit. Use only 14-1/0 gauge AWM wire. Select the wire gauge used based on the protection provided by the circuit breakers/fuses.

This manual provides safety guidelines and installation information for the MNBH Disconnect Panel. It describes in general terms how the MNBH Disconnect Panel connects to and controls MidNite Solar disconnecting combiners, but does not give details on combiner installation or connections to other equipment than the MNBH Disconnect Panel. Refer to the MidNite Solar Disconnecting Combiner User's Manual for details on installing your specific combiner.

This manual does not provide brand specific information about other components in the system such as photovoltaic panels, batteries, inverters, etc. Contact the manufacturer of all other components in the system for relevant technical data.

INTRODUCTION

The MidNite Solar MNBH Disconnect Panel is a firefighter / service technician's control device designed specifically for disconnecting rooftop photovoltaic (PV) panels and their inherently hazardous voltages from the building's interior wiring in case of emergencies or system maintenance. The MNBH Disconnect Panel works in conjunction with MidNite Solar disconnecting combiners to provide workers the ability to disconnect power at the combiner before sending personnel onto the roof. Disconnecting power requires the simple press of a single button. The panel's LED display gives system status and an automated speech synthesis system gives further situation specific instructions.

SPECIFICATIONS

Power:	120 volt 50-60Hz AC power from a (recommended dedicated) circuit. 1.5 watt nominal. 1.6 Amp internal fuse (non replaceable) Connector accepts up to AWG #12 wire. Chassis lug for safety ground wire.
Solar Power:	+48 volts DC (20mA nominal) from the combiner current limited (145mA max).
Remote Trip Input:	Normally Open (N.O.) switch closure to GND. Internally pulled to +48 VDC when inactive. Do not connect to a DC voltage. Interface using a relay.
Aux Relay Output:	1 form C relay contacts: Rated 1A @ 120VAC / 24 VDC
Batteries:	9 volt, rechargeable, NiMH, 180mAh or greater, Varta P/N 5122 V7/8H or equiv. (Qty=4) 3.0 volt, lithium coin-cell, CR1216 (Qty=1)
Display LEDs:	Solar ON – Green Solar OFF – Yellow AC In – Green Battery Low – Red
Environmental:	Temperature -40C to +85C (exclusive of batteries) -40C to +65C (in storage with batteries installed – less than 30 days) -20C to +65C (operating) 0C to +65C (batteries charging)
Weight:	4 lb 8oz. (2.05kg)

DESCRIPTION

The MNBH Disconnect Panel is packaged in an attractive weather resistant enclosure designed for mounting near rooftop access points such as doors and ladders, however it may be mounted at any location up to 500 meters from the combiner. There can also be up to three additional MNBH panels to provide PV disconnect capability in other areas of the building, as required by the installation.

The MNBH Disconnect Panel has four LEDs which show the current state of the system and features a large push button inside of a magnetically latched access door. Reflective side labels clearly identify the MNBH panel as the solar shutoff point. The door is simply opened and the big red button pressed to disconnect PV power at the combiner. The MNBH panel also features a voice announcement system that audibly gives the appropriate instructions to remind personnel in the area that there may still be voltages present near the PV panels. Internal rechargeable batteries provide temporary backup power in case of external power cutoff or failure. The MNBH panel also has a remote trip input and a software activated relay to allow the unit to be interfaced to other equipment such as an alarm system.

THEORY of OPERATION

The heart of the system is the disconnecting combiner, which features an electrically trippable disconnect switch, which cuts the power internally when opened. When the button at the MNBH panel is pressed the combiner disconnect switch is opened. The connection between the buss bar and the DC power wiring exiting the combiner is broken. Power will be off beyond the combiner. However, during the day voltage will still be present from the PV panels up to the combiner. The trip signal from the MNBH panel is applied via a 600 volt rated CAT-5 cable from the combiner to MNBH units, typically located at ground level.

Power for tripping the disconnect switch is stored in a long life electrolytic capacitor located in the combiner power supply. The capacitor is purposely oversized to be able to store enough energy to trip the disconnect switch numerous times without recharging, even after years of service. In normal operation the capacitor is charged every day by solar power. Backup charge circuits in the MNBH panel monitor the combiner capacitor voltage and recharge it as needed during times of darkness or whenever power is removed, such as for maintenance.

As well as monitoring the combiner capacitor voltage, the MNBH panel monitors the combiner's disconnect switch position and power supply voltage. Once the MNBH panel has sent the command to open the combiner disconnect switch, it continues to monitor the disconnect switch and updates the LED status when the disconnect switch is known to be open. If the button is pressed and the green LED goes off and the yellow LED comes on, you can be assured that the combiner disconnect switch has opened.

Combiner power input to the MNBH panel is derived from solar power and is not present at night, so the presence of voltage indicates daytime. This is used to decide whether to play the daytime or nighttime message. A third message is provided for the unlikely event that the disconnect switch does not open or

is slow responding. The software will detect this condition and audio annunciator will give voice instructions for turning the power off manually at the combiner.

INSTALLATION

SELECTING A LOCATION

NOTE: All wiring must comply with local and national codes. The following instructions are typical in nature. Details may vary. Professional installation is recommended.

The MNBH panels should be located near roof access doors or ladders and one should be located at the central solar control point such as the inverter, charge controller or battery cabinet. The MNBH panel closest to the combiner should be the one chosen for the cable connection to the combiner. This first panel is referred to as the primary unit. Any others are referred to as secondary units. Up to three secondary units can be wired to the primary unit, as needed.

POWER REQUIREMENTS

Each MNBH Disconnect Panel requires its own local AC power connection. It is recommended that the AC power circuit be dedicated for the MNBH panel(s). The wiring should be enclosed in conduit and installed in accordance with local codes. An internal box lug is provided for the safety ground.

MOUNTING

Mount the MNBH panel to the wall in the desired location. No brackets or mounting plate is necessary. Waterproof sealant is recommended on the four mounting screw locations. Electrical connections are made to the building wiring and external equipment using screw-terminal connectors along the bottom edge of the main board. Connections to the combiner and other MNBH panels are made via the RJ-45 (Ethernet-style) jacks. Cables and other wiring can be pulled to the MNBH panel through standard thin wall conduit. Knockouts in the chassis support backside or bottom cable entry.

MAKING CONNECTIONS

Power

The MNBH panel requires a nominal 120 volt AC connection to the building wiring and a cable connection to the combiner. Connect the AC hot wire (typically black or red) to TB3 pin 1. Connect the AC Neutral (white) to TB3 Pin 2. Connect the safety ground (green) to the chassis box lug below the main board.

Remote Trip Input

An optional remote trip input is provided to interface an alarm output from other devices such as fire alarm systems, door interlocks and security systems to the MNBH panel. All that is required is a simple (normally open) disconnect switch closure such as a relay. Connect the controlling device's switch wires to TB1 pins 1&2. If no remote trip input is needed simply leave the remote trip pins disconnected.

Note that TB1 pin 1 is connected to the logic GND and may be used as a reference for voltage measurements for MNBH control signals, however it is not connected to earth ground.

Combiner and Secondary MNBN Panels

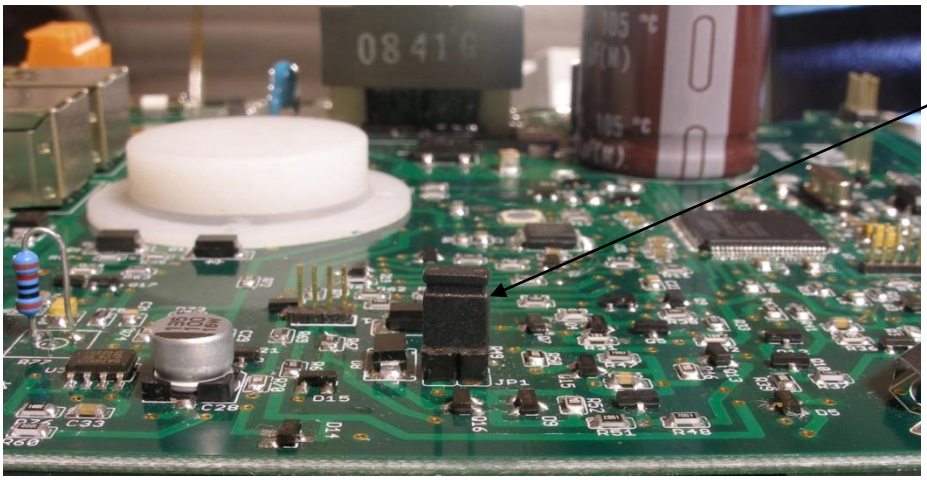
There are two Ethernet-style RJ-45 jacks on the MNBH main board. These are not network connectors. These connectors carry low-voltage, signals, power and voltage sensing leads to monitor and trip the disconnecting combiner. They only work with MidNite Solar disconnecting combiners and MNBH panels. They are wired identically. Either connector may be used for the cable run to the combiner. The other is available for connection to additional MNBH panels, if needed (optional). This feature allows up to three additional MNBH panels to be connected to a single combiner in a series string. The cables are straight through cables (not crossover) and are wired according to the T568B standard. The cable connecting secondary MNBH panels to the primary panel or to each other can be any (low voltage) CAT-5 cable that meets local code. However, because of the high voltages inside the combiner the CAT-5 cable that connects the primary MNBH panel to the combiner must be rated for 600 volts and be UV rated for weather and sun exposure. MidNite Solar or your installer can provide more information on cable requirements.

Aux Relay Output

The Aux Relay is active whenever the MNBH panel is in Alarm mode, an internal state that begins when the button is pressed while combiner disconnect switch is closed and ends when the switch is closed again. The yellow Solar Off LED corresponds to Alarm mode as long as the combiner disconnect switch was opened by pressing the button. Note that shutting off the power manually at the combiner will illuminate the Solar Off LED but does not cause the MNBH panel to go to Alarm mode, so the Aux Relay will not activate.

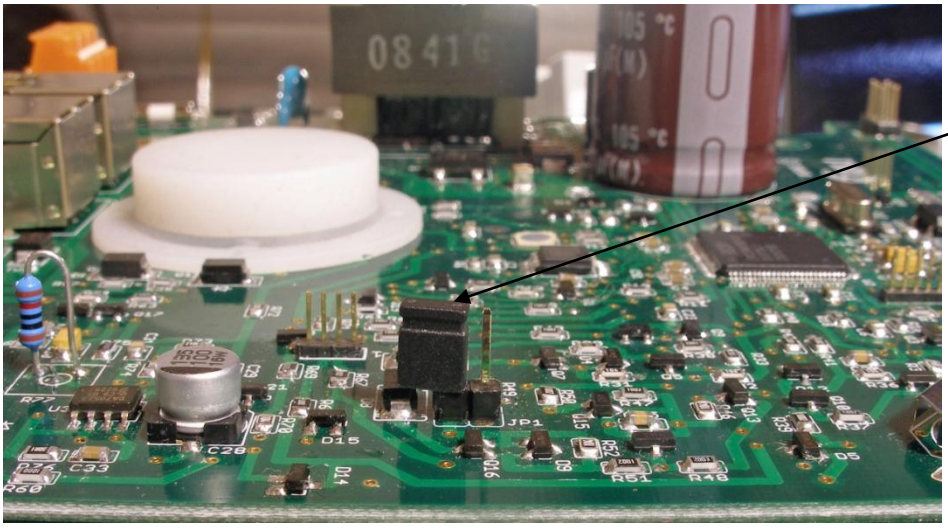
INSTALLATION PROCEDURE

1. Unpack the Unit. Inspect for damage.
2. Open the MNBH panel's large door and remove the six #8 flat head Philips screws holding the case on. Carefully remove the case and place it in a safe location so it will not be damaged.
3. Test the unit by TEMPORARILY installing the shunt on JP1, located on the right side of the main circuit board. The SOLAR ON/OFF and the BATTERY LOW LEDs should flash. After several seconds the voice annunciator should say, "The combiner cable appears to be damaged or unplugged…" If this test fails the batteries may be completely discharged. Batteries that have been discharged for a long time may be permanently damaged and should not be placed into service. While good batteries will charge from line power, it is recommended that all batteries be fully charged before putting the system into service. Use a good quality "smart" charger such as the Tenergy model TN346. Avoid inexpensive "timer" based chargers. If the unit does not operate with fully charged batteries call MidNite Solar's technical support for assistance.



Shunt JP1 Location
Viewed From Right
(Shown Installed)

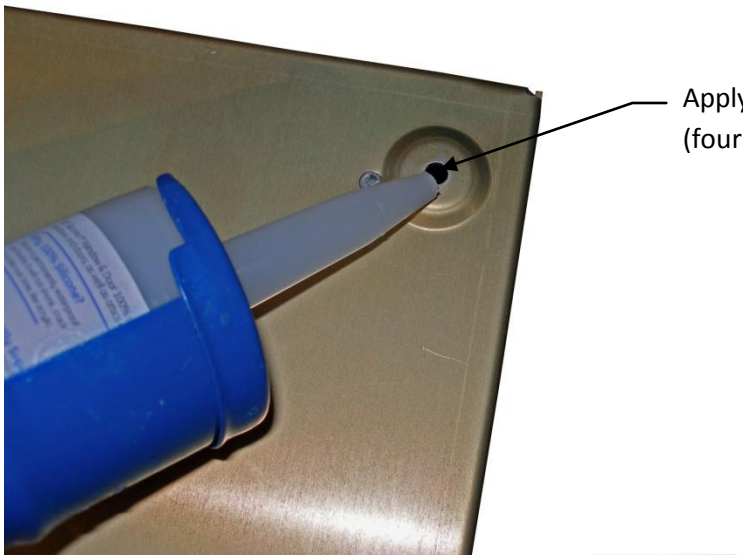
4. REMOVE the shunt from JP1 and place it in the shipping position until the entire installation procedure is completed to conserve battery power.



Shipping Position
Place jumper on only one pin to disconnect battery from circuit.

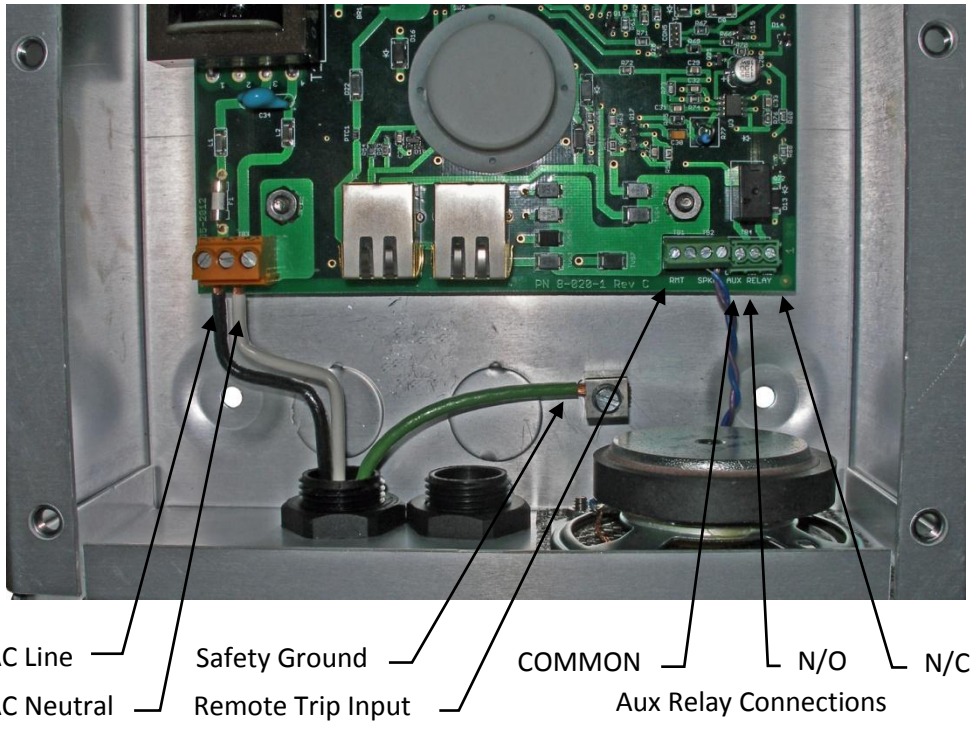
5. Identify the MNBH Disconnect Panel mounting location and secure the chassis to the wall, sealing the mounting screws with caulk, as necessary.

Chassis Sealing Detail (back side view)



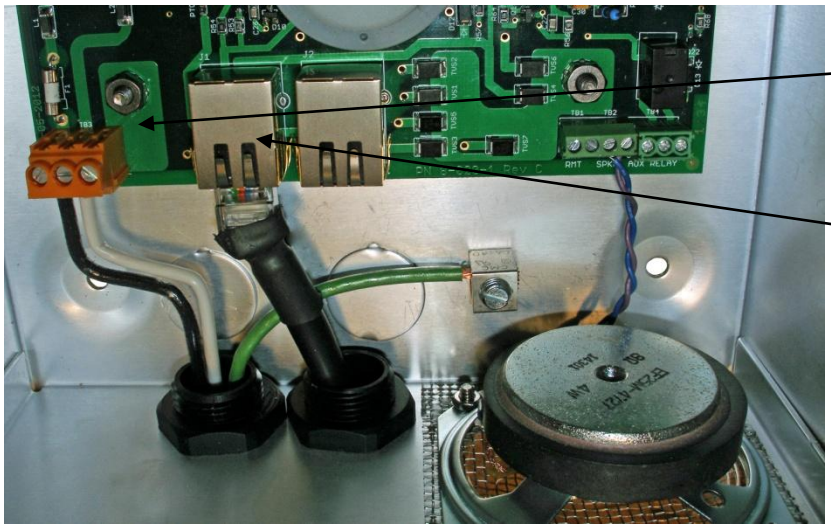
6. Route the 120 volt AC power circuit from the building's distribution panel via appropriate conduit as required into the MNBH disconnect panel.

Main Board Connection Detail – Power / Remote Trip / Aux Relay



7. Connect the line side (black or red) of the 120 volt AC power to TB3 pin 1. Connect the neutral side (white) to TB3 pin 2. Connect the safety ground (green) to the chassis box lug located below the main circuit board. TB3 pin 3 pin 3 on the PCB is also a chassis ground connection (shown open).

Main Board Connection Detail – Combiner and Secondary MNBH Panel Connections



8. Connect the 600 volt UV rated CAT-5 control cable to the combiner at J1. Use a small amount of silicone grease on all cable ends to protect the connections.
9. In a similar manner, connect the CAT-5 cable to any other MNBH units to J2.
10. Connect the optional remote trip output from any other equipment such as alarm or fire detection systems to the MNBH panel's Remote Trip input at TB1 pins 1&2. If either of the wires coming from the external equipment is grounded, connect that wire to TB1 pin 1.
11. Optionally, connect the alarm input to any other equipment such as an alarm system the MNBH panel's Alarm Out connector, TB4. The common is pin 1, the normally open contact is pin 2, and the normally closed contact is pin 3.

12. When installation is complete and the system is ready to be energized, remove the small plastic battery isolator from battery holder BH1, located at the upper right corner of the main logic board.

Battery Holder BH1 Detail

Remove plastic isolator

13. Install the shunt on JP1. (Refer to step 3.) Replace the case and test the system. Apply caulk sealant to the case to wall interface along the top edge of the case especially if the wall is not smooth such as lap siding or corrugated metal.

Sealing the MNBH Panel Case to Wall Interface

OPERATION

SELF-TEST

All LEDs except the AC IN LED will flash on and off once when the unit is powered up or reset. This is part of the internal self-test. After approximately ten seconds the system will enter its normal operating mode and the LEDs will show the solar power, local AC/DC power and battery status.

SOLAR ON LED

The green LED on the left indicates that the combiner disconnect switch is closed. If there is any sunlight present, high voltages will be present throughout the system.

SOLAR OFF LED

The yellow LED indicates that the combiner disconnect switch is open. In daytime there will still be hazardous voltages present on the PV string wiring up to the combiner. If the power was disconnected by pressing the button at the MNBH panel, the red handle will still be in the ON position.

AC IN LED

The green AC IN LED indicates that local AC power input is on. In normal operation this LED should be ON.

Due to the large energy reserve stored in the MNBN power supply, the AC IN LED will remain on for several minutes after power is removed. There is no delay when power is applied.

LOW BATTERY LED

The MNBH Disconnect Panel's internal batteries are continually monitored and recharged automatically as needed. The LOW BATTERY LED should remain off in normal operation. The LOW BATTERY LED indicates that the batteries have discharged to an unacceptably low level. This will occur if external power has been removed for several hours. In this case the LED may remain on for a while after AC power is restored. However, it typically will not remain on longer than 20 minutes. If the LOW BATTERY LED comes on unexpectedly or remains on for a long time after restoring AC power, a problem may exist with the batteries or charging circuits. The unit should be inspected and repaired as necessary.

VOICE SYSTEM

When the MNBH panel completes its self test it will detect the combiner and if the switch is closed it say that "The combiner circuit breaker is closed." Once the combiner capacitor is fully charged, the MNBH will say, "The system is ready." Note that if there is no charge on the capacitor this may take a few minutes. Thereafter, the voice system will only speak when the button is pressed or the combiner circuit breaker is closed, or a problem is detected with the system that requires attention.

There are three main messages that explain the situation on the roof. The message for daytime alarms includes the warning that there are still voltages present up to the combiner. The nighttime message does not include this warning. There is a third possibility, which is that the combiner disconnect switch

does not open when the button is pressed. This unlikely situation can happen if the cable to the combiner is damaged. The voice message explains how to manually disconnect power at the combiner.

The voice message repeats until the circuit breaker is closed, which must be done manually at the combiner. To cancel the voice announcement at the MNBH panel, press and hold the red button for five seconds.

OPTIONAL GOOD MORNING MESSAGE

The MNBH Voice System has an optional message that sounds like a rooster crowing each morning when the solar panels begin to produce power. This feature is provided to ensure users that the system is operating and is in normal power production mode. This feature is disabled when shipped and may be enabled or (disabled if enabled) as follows:

1. When in the normal operating mode, press the red button at the MNBH panel to disconnect solar power at the combiner.
2. When the voice message finishes. Press and hold the red button five seconds panel to cancel any further announcements. The combiner disconnect switch will be open.
3. After the “Good-Bye” message, press the button three times within two seconds to toggle the state of the “Good Morning” message. An acknowledgement is played if successful. If the “Already Open” message plays, you have missed the two second window or have not pressed the button the correct number of times.
4. Repeat steps 2 and 3 for each MNBH panel in the system then close each combiner disconnect switch by turning the red handle fully off and back on. The MNBH panel setting will be retained as long as the units have power. If all power is lost the option will revert to disabled.

MAINTENANCE

CAUTION!

Nickel-Metal Hydride batteries produce high currents when short circuited.

Follow the instructions carefully to avoid damage to the batteries or unit.

BATTERIES

There are four rechargeable 9-volt Nickel Metal Hydride (Ni-MH) batteries in the MNBH panel. They are found on the LED-Battery board (P/N 8-026-10), located inside the unit at the top of the main logic board. There is also a 3.3-volt lithium coin-cell battery located on the main logic board at the top left corner below CON1.

The 9-volt batteries are series connected to form a 36-volt battery. Together they serve as a backup power source for the MNBH panel in case of power failure or firefighter's disconnection of the AC grid. They were included in the MNBH panel design for triple redundancy to assure that the combiner disconnect switch trip capacitor will always be kept charged. These batteries operate the MNBH logic and supply reserve power to recharge the combiner circuit breaker trip capacitor. In normal operation the batteries are kept charged by solar power in the daytime and from the AC/DC power source at the MNBH panel at other times. The only time the batteries actually supply power the unit is when no other power is available.

If all external power is removed and there is no emergency, (i.e. - the MNBH panel's voice system is not operating), the batteries will power the unit for up to 16 hours depending upon the temperature, battery age and the initial charge of the batteries. If there is an emergency situation and voice messages are playing the batteries life will be less because of higher current demand. They will recharge automatically when external power is restored.

The coin cell battery, B1, allows the MNBN's internal microprocessor to keep track of time and go into low power mode to conserve batteries in the rare event of a complete power failure. In normal operation there is no current drawn from the coin-cell battery. It should last 5 years or more. However, since it is a low cost component it is recommended that the coin-cell battery be replaced at the same time as the 9-volt batteries.

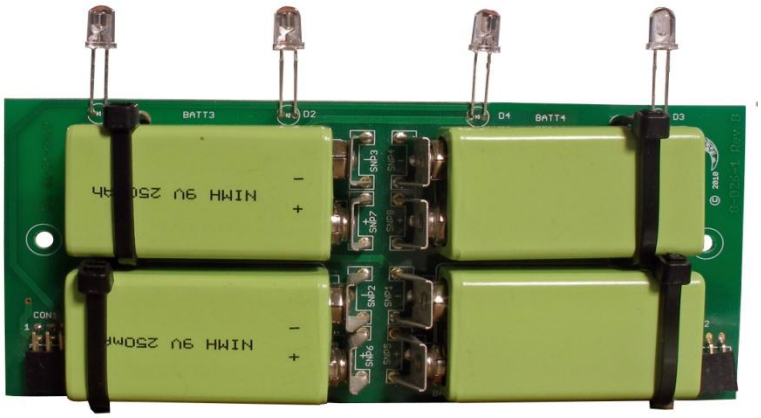
BATTERY REPLACEMENT PROCEDURE

CAUTION!

Nickel-Metal Hydride batteries produce high currents when short circuited.

Follow the procedure carefully to avoid damage to the unit.

Battery – LED Board detail.



1. **IMPORTANT!** All batteries should be replaced at the same time including the lithium coin-cell battery, B1.
2. **IMPORTANT!** Batteries should be replaced at night or with the combiner disconnect switch OPEN because power is supplied by the combiner during daylight. Otherwise you must disconnect the CAT-5 cables going to the combiner and any other MNBH panels.
3. **IMPORTANT!** Do NOT place the Battery-LED board on any electrically conductive surface or article such as a tool while there are batteries installed on it. High SHORT CIRCUIT currents will flow!
4. **IMPORTANT!** Before proceeding, shut off AC power at the circuit breaker panel.
5. Open the MNBH panel's large door and remove the six #8 flat head screws holding the case on. Carefully remove the case and place it in a safe location so it will not be damaged.
6. **IMPORTANT!** Remove the shunt on JP1. See photo in the Installation section.
7. Allow the power supply time to discharge (all LEDs go off) and remove the two screws holding the Battery-LED board to the top of the unit. Remove the board being careful not to damage the LEDs.
8. Carefully slice through the silicone sealant holding the batteries to the circuit board or Cut the tie-wraps and remove the old batteries. Dispose of the used batteries properly.

9. Replace all four 9-volt batteries with new, fully charged NiMH batteries. Since the battery connectors cannot be conformal coated they are a potential point of corrosion. Using a small amount of silicone grease on the battery terminals is recommended.
10. Secure the batteries to the board. Tie-wraps are provided but electrical tape also works well.
11. Replace the 3-volt lithium coin-cell battery, B1, before reinstalling the Battery-LED board. There's more room to work around the area of the battery with the Battery - LED board removed.
12. Re-install the Battery - LED board.
13. Re-install the shunt on JP1. After about ten seconds the voice annunciator should say, "The system is ready." And the LEDs should reflect the current state of the combiner disconnect switch.
14. Restore AC power. The AC ON LED should come on.
15. Re-install the case.
16. Restore solar power and test the system. Reseal the case to wall interface with caulk as shown in the detail on page 12.

PERIODIC INSPECTION

While leakage and terminal corrosion is extremely rare with modern batteries, it is not impossible and may be exacerbated by environmental conditions such as extreme heat, dust, moisture, or salty ocean air. Of course, the main cause of battery leakage and corrosion is leaving them in a discharged state for a long time as well as repeated overcharging, neither of which should ever happen if the unit is functioning properly. The red BATTERY LOW LED will come on if the batteries are undercharged.

However, for security and peace of mind it is recommended that the MNBH panel cover be removed once every 2 years for inspection especially the batteries and connectors on the Battery-LED board, particularly if units are exposed to the elements.

WARRANTY

The MidNite Solar MNBH Disconnect Panel comes with a 5 year warranty on the electronics (excluding batteries). We will repair or replace a defective MNBH Disconnect Panel at no charge during this 5 year period.

PREPARING FOR RETURN SHIPMENT

Prior to returning any product to the factory please contact MidNite Solar to obtain an RMA number and receive shipping instructions.

IMPORTANT! To avoid any possibility of damage due to battery leakage or corrosion it is recommended that used batteries be removed from the MNBH Disconnect Panel and not returned to MidNite Solar unless you are instructed to do so by Customer Service. If you are instructed to do so, it is very important that you REMOVE the battery shunt, JP1, on the main board. See JP1 detail photograph in Step 2 of the Installation Procedure, on page 8.

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