Operation of the SBP-1100e with MF15-3600 60-Watt Solar Panels

The SBP-1100e Smart Battery Pack may be re-charged using various power conversion devices which are available as standard accessory items from Eleven Hundred Energy Corp. One re-charging option is the use of Model MF15-3600 60-Watt portable solar power panels. A Solar Cable is required to connect the solar panels to the battery pack.

MF15-3600 60-Watt Portable Solar Power Panels

The MF15-3600 60-Watt Foldable Solar Chargers are rugged, weather-resistant and are moderately flexible to resist breakage, unlike conventional rigid solar panels which are difficult to transport and subject to breakage. The panels are compact when folded for storage or transport (11″ x 9.5″ x 2″), and lightweight (3.2 lbs). Unfolded, one panel is 59″ long by 43″ wide, and 1/16″ thick, and it is equipped with four ¼ inch grommet holes, one in each corner. The available color is gray camo. In full direct sun (atmospheric model AM 1.5), striking perpendicular to the surface of the panel, and loaded for maximum power, the DC power output is rated at 55 watts at about 15.4 volts and 3.6 amps. Output power may vary ± 10% due to temperature and spectral variation, and other effects. 60 watts is the nominal maximum power. New panels may exhibit up to 20% reduced power output and may require several days of sun exposure to reach their full operating power. Maximum output power is reduced by about 1% for each 3° F of temperature rise above a panel temperature of 77° F, and is similarly increased for temperatures below 77° F.

Weather and Seasonal Considerations

In most regions of the Earth, solar power is not 100% reliable from day to day, under changing weather conditions. By using the SBP-1100e Smart Battery Pack to store the energy produced by solar panels, power can be available continuously, for as long as sufficient energy remains stored in the battery pack. Continuous power demands of up to about 200 watts can be supplied by the battery pack, and intermittent power can be supplied up to about 300 watts.

Under ideal sunny conditions, a full set of eight MF15-3600 60-Watt solar panels, always perfectly aimed at the sun, could yield in excess of 2000 watt-hours per day. In practice, with eight panels angled to face the mid-day sun, and assuming 5 hours of sun per day, a daily energy supply of up to 1600 watt-hours may be supported in sunny weather, and up to 800 watt-hours in partly sunny weather (direct sun 50% of the time). 800 watt-hours per day is equivalent to a 33 watt average load, powered 24 hours per day.

It is not practical to use solar panels during persistently cloudy seasons or in cloudy climates, nor generally in winter in arctic or sub-arctic latitudes, where there is little sun. Winter itself is no barrier to using solar panels, provided there are a few hours of mostly clear sunny skies most days, and provided the panels are held at the correct angle to fully face the mid-day sun.

Determining the Number of Solar Panels Needed

The minimum number of MF15-3600 60-Watt solar panels recommended for charging the SBP-1100e is two, and four panels are recommended for light-duty applications. More demanding applications will require up to eight panels. Generally, more sun implies that a smaller number of panels would be needed, and a larger daily energy demand or sustained power demand implies that a larger number of panels would be needed. Using more than eight panels would provide little benefit because the SBP-1100e will not accept sustained input power from solar panels in excess of about 360 watts. To obtain maximum solar performance with one SBP-1100e Smart Battery Pack, a full set of eight solar panels is recommended.

To estimate the number of solar panels needed for a given application, first consider the expected weather conditions for the location and season. If there is full sun nearly every day, the weather conditions would be classified as “full sun”, but if one or two days per week are overcast (and the others mostly sunny), or if two or more days per week are partly cloudy with broken clouds, then the weather should be classified as “partly sunny”, for purposes of the calculation. If the sky is completely overcast during most of the day-time, or if heavy broken cloud cover allows for direct sun to strike the panels for only a very small percentage of time during the day, solar power applications may not be practical under such conditions.

To estimate the number of panels needed, determine the number of watt-hours needed by the application, per 24 hours. Then divide by 200 watt-hours for full sun conditions, or 100 watt-hours for partly sunny conditions. Add one, and then round up any fraction. If the result of the calculation calls for using more than eight panels, then that indicates that one battery pack with one full set of eight solar panels may be insufficient to provide adequate performance in the application. In that case, consider combining two or more battery packs—see “Combining Battery Packs”. Two battery packs can accommodate up to 16 solar panels, and can store up to 2200 watt-hours of energy.

Here is an example of a calculation to estimate the number of solar panels needed for a particular application. If a radio transceiver is in use 24 hours per day, 99% of the time in receive mode drawing 20 watts, and 1% of the time in transmit mode drawing 100 watts, 500 watt-hours is the 24 hour energy demand. The SBP-1100e can deliver about 1000 watt-hours from a full charge, so a single fully-charged SBP-1100e will power the transceiver for 48 hours without sun. To keep the transceiver powered without interruption, at least 500 watt-hours of charging energy must be available per day, on average over each period of two or three successive days. After making allowances for less than optimal aiming of the panels and for power losses in charging and discharging, assume for estimation purposes that one panel yields an average of 40 watts in full sun during mid-day hours. Assume that “full sun” is 5 hours of full sun per day, and that “partly sunny” weather is the equivalent of half as much “full sun” time per day. So, each panel yields 200 watt-hours per day in full sun, and 100 watt-hours per day in partly sunny weather. Therefore in this example we would calculate a need for 2.5 panels for “full sun” operation, and five panels for partly sunny conditions, purely for watt-hours. Add one additional panel to assure adequate operating margin. Then, round up any fraction. The final result, in this example, is that four panels are needed for full sun, and six panels are needed in partly sunny conditions. If there is full sun nearly every day, four panels should be sufficient, but if one or two days per week are overcast, or if two or more days per week are partly cloudy, then six panels would be recommended.

The following table summarizes the potential daily watt-hours versus the number of panels for “full sun” and “partly sunny” weather, and provides the estimated charging time for charging a completely discharged SBP-1100e battery pack to a 95% state of charge, using MF15-3600 60-Watt solar panels, with no load on the battery pack during charging. The table is calculated on the assumption that one panel produces 40 watts in full sun, and 20 watts in part sun, averaged over five mid-day hours. If, during charging, power is also being supplied by the battery pack, estimate the time required for charging by considering a 40 watt load to be equivalent to taking away one panel in full sun, or taking away two panels in partly sunny conditions. Other loads would have a proportionate effect.

Number of Solar Panels	Full Sun Daily Watt-Hours	Full Sun Charging Time	Partial Sun Daily Watt-Hours	Partial Sun Charging Time
2	400 watt-hours	15 hours	200 watt-hours	30 hours
3	600 watt-hours	10 hours	300 watt-hours	20 hours
4	800 watt-hours	8 hours	400 watt-hours	16 hours
5	1000 watt-hours	6 hours	500 watt-hours	12 hours
6	1200 watt-hours	5 hours	600 watt-hours	10 hours
7	1400 watt-hours	4 hours	700 watt-hours	8 hours
8	1600 watt-hours	3.5 hours	800 watt-hours	7 hours

Combining Battery Packs

Two or three battery packs, each with its own set of solar panels, may be combined to meet a greater daily energy requirement than can be provided by one battery pack, or to meet greater sustained output power levels than can be provided by one battery pack. When using multiple combined battery packs, each pack should have the same number of solar panels, as nearly as possible. For example, 13 solar panels would be divided between two battery packs with seven for one, and six for the other.

Battery packs may be combined by using a special output combiner cable which connects the outputs together to form one power source. At 77° F, one battery pack can supply up to about 200 watts continuous power at 13.8 volts, two packs can supply up to 400 watts, and three packs can supply up to 600 watts.

Similarly, the daily energy (daily watt-hours) available from two or three combined battery packs, each with its own full set of eight solar panels, is proportionately greater than the daily energy available from one pack and one full set of solar panels.

Multiple battery packs may also be combined purely to increase the system energy storage capacity. This might be done when a light load needs to be powered for a very long time between charges. For example, a 10 watt load connected to three fully charged battery packs with a combined capacity of 3000 watt-hours could run for about 300 hours between charges.

The following standard ten-foot combiner cables, terminated with #10 stud size ring terminals, are available:

SBP 2-Way Output Combiner Cable

Model № SBP-COMBO-2-RT-10FT

Application: Use this cable to combine two SBP-1100 Smart Battery Packs to form one power output

SBP 3-Way Output Combiner Cable

Model № SBP-COMBO-3-RT-10FT

Application: Use this cable to combine three SBP-1100 Smart Battery Packs to form one power output

Custom-made Combiner Cables can be supplied to meet specific requirements. Contact Eleven Hundred Energy for details.

A screw terminal block is available to be used with any standard SBP Combiner Cable as a power collection and distribution point. The following double-row 2-position Terminal Block (barrier terminal strip) has two double connections for #10 ring terminals:

2-position #10 Terminal Block

Model № T-BLOCK-10-2

Application: Use with any SBP Output Combiner Cable with #10 ring terminals

Choosing a Solar Cable

After determining the number of solar panels required for the application, select a Solar Cable which will accommodate at least the required number of panels, and which will be long enough to accommodate panel placement. The standard Solar Cable consists of a MIL circular connector which plugs into the power input receptacle on the SBP-1100e Smart Battery Pack, a “trunk” portion 10′ long, which joins the MIL connector to the main splice, and four 10′ long cable arms splitting off from the main splice. Each arm can accommodate one solar panel directly connected, or, one arm can connect two solar panels, by adding a Solar Y-Adapter model SOLAR-Y-PF-2FT. The connection to a solar panel may be conveniently extended 15 feet, by adding a Solar Extension Cable model SOLAR-EXT-PF-15FT.

There are trade-offs involving the overall length, number of arms, weight, and cost of solar cables, so the anticipated placement of the panels relative to the battery pack should be considered, as well as the means of propping up or aiming the panels to most accurately face the mid-day sun—see “Deployment”.

The four-arm standard Solar Cables from Eleven Hundred Energy are constructed of rugged UL type SOOW and type SJOOW black rubber-jacketed 16 AWG 4-conductor and 2-conductor water and oil-resistant, and sunlight-resistant cable. Solar cables are equipped with a tethered protective/safety cap at each panel connector, for covering the connector while it is not otherwise connected. The MIL connector back-shell is splash-proofed by being covered with adhesive-lined shrink tubing, and the main splice is epoxy-potted.

The following Solar cabling and connection accessories are available:

Name: SBP Solar Cable, 4 arms, 20 ft.
Model № SBP-CBL-SOLAR-4PF-20FT
Construction: MS3116F14-5S MIL circular connector, trunk 10 ft. 16 AWG 4-cond. UL type SOOW cord, epoxy-potted main splice, four arms, 10 ft. each, 16 AWG 2-cond. UL type SJOOW cord, four weather-resistant connectors, four tethered protective/safety caps
Transport: Weight, 5 lbs. May be coiled in a space 15 x 15 x 2.5 inches

Name: Solar Y-Adapter
Model № SOLAR-Y-PF-2FT
Construction: 18 AWG 2-cond. UL type SPT-2 cord, two arms, 1 ft. and 2 ft., total length approx. 3 ft., weather-resistant connectors
Transport: Weight, 0.2 lbs.

Name: Solar Extension Cable, 15 ft.
Model № SOLAR-EXT-PF-15FT
Construction: 18 AWG 2-cond. UL type SPT-2 cord, total length 15 ft., with weather-resistant connectors
Transport: Weight, 0.5 lbs.

Custom-made Solar Cables can be supplied to meet specific requirements. Contact Eleven Hundred Energy for details.

Deployment

To deploy a MF15-3600 solar panel, unfold the panel and place it in a sunny location. The dark-colored side of the panel should directly face the sun, with the sun's rays striking the panel perpendicular to its surface. Secure the panel against wind using cordage and the grommet holes in the corners of the panel. The grommet holes will accommodate cord or rope up to 1/4 inch diameter, as well as some bungee cord hooks. As the sun moves through the sky during the day, the panels may be re-aimed from time to time to maintain optimum power performance, or, as a compromise, the panel may be set up to catch the mid-day sun, and left in that position all day. For example, the battery pack might be placed inside a tent, and the solar panels might be draped over a south-facing sloping roof of the same tent. Panels might be draped over a parked vehicle to face in the general direction of the sun, or the panels may be laid out or propped up on sloped terrain facing the sun.

Note: Avoid blocking the sun's rays from hitting any part of the active solar cell areas of the panel, and avoid having any part of the panel in shade or in a shadow. If even a small part of a panel is shaded, that will result in a significantly decreased power output.

Connect each deployed panel to one panel connector on the SBP Solar Cable, and connect the trunk of the Solar Cable to the SBP-1100e Smart Battery Pack. A Solar Y-Adapter model SOLAR-Y-PF-2FT may be used to connect two panels to one arm of the Solar Cable. A 15 ft. Solar Extension Cable, model SOLAR-EXT-PF-15FT, may be used to extend the connection to a solar panel.

Check that any un-terminated panel connectors on the Solar Cable are firmly covered with the provided tethered protective cap, to prevent accumulation of dirt or moisture in the connector, and thus inhibit corrosion or deterioration of the connectors.

Safety Precautions and Lightning Protection

The highest voltage which would normally be present in the Solar Cable is about 30 volts, which is no more than a mild shock hazard. Power levels of several hundred watts may potentially be flowing in the solar cable, and protective caps are provided to cover any open panel connectors.

Avoid laying the Solar Cable or the solar panels so as to cause trip hazards or be an impediment to passage.

When solar panels and the Solar Cable are deployed outdoors, there is a possibility that the panels or the cable may be struck by lightning, resulting in voltage surges which may affect user equipment and/or pose a hazard to personnel. As a precaution, user equipment which is connected to a solar-charged SBP-1100e should be properly earth-grounded via a wire clamped to a copper-clad grounding rod driven into the ground. As a further precaution, the Solar Cable should be disconnected from the SBP-1100e Smart Battery Pack whenever a storm approaches, if possible, as this will protect the battery pack and the downstream equipment.

Operation and Maintenance

Once a set of solar panels has been properly set up, slanted to face the mid-day sun, securely tied in place, and proper charging action has been observed and verified, little operator attention or intervention is necessarily required, and the installation may be left unattended for weeks or months.

If an operator is available to monitor and maintain the system, recommended action items include:

1. Several times daily (early morning, mid-day, and late afternoon) check and log the time, the state of charge of the battery pack, the weather, and the load current or power. At any time, the state of charge, and other information such as input and output current and voltage may be checked by pressing the SCROLL button on the battery pack control panel. Over time, the logged information will provide a performance baseline which may help detect problems and help in determining whether more solar panels are needed.

2. Daily, or as often as seems appropriate, check the panels for dust or debris on the active surfaces, and brush off any accumulation. If only a small part of the active surface of a panel is covered or in shadow, the output power of the panel will be substantially reduced. When needed, clean the active surfaces of the panels using a rag or a soft bristle brush wetted with plain water, or water with soap or detergent.

3. Monthly, check that the panels are securely tied in place, and check for deterioration of the tie-down cordage. Consider re-positioning or re-aiming the panels, if needed, due to seasonal changes in the position of the mid-day sun in the sky. Check the Solar Cable for damage, and un-mate the connector at each panel to check the contacts for corrosion.

Troubleshooting

If charging stops while the sun is shining on the solar panels, it might be because the battery pack is already fully charged. Press the SCROLL button to read the state of charge. Press the SCROLL button repeatedly to view other information such as input and output current and voltage, and estimated time to charge. As a battery pack nears full charge, the charging current will drop off, and the actual state-of-charge reading for a fully charged battery pack might be a few points less than a full 100%. If a battery pack shows a high state of charge, and it is not indicating ‘CHARGING’ at the control panel display while there is also no load on the battery pack output, that battery pack is considered to be fully charged. Note that some or all of the power drawn by the load which is connected to the battery pack will be drawn from the solar panels, if the solar panels are able to provide power, so power indicated at the input of the battery pack is not necessarily charging power.

If it is suspected that a solar panel is bad, disconnect the suspect panel from the cable, and use a multi-meter to measure the open-circuit voltage, with the panel in the sun. It should be about 20 to 30 volts. If the multi-meter has a 10 amp (or greater) DC current measurement capability, use that to measure the short-circuit current with the panel in strong sun, with the panel aimed directly at the sun. The short-circuit current should be about 3 to 6 amps. If the test results seem inconclusive, the measurements for the suspect panel should be compared with similar measurements made with a known good panel under the same conditions.

If strong sun is shining on the panels, but there appears to be no power available from the solar cable, as indicated by low input voltage and current readings at the battery pack control panel, check the voltage at a panel connector on the Solar Cable. If the voltage is zero or is very low, the cable may be short-circuited or overloaded. Disconnect the cable from the battery pack and measure the cable voltage again. Disconnect all the solar panels and use a multi-meter to check for a short circuit within the solar cable. Check each solar panel as described in the previous paragraph.

Warranty

- All Eleven Hundred Energy products are warranted for 90 days from the date of purchase. Any defects due to workmanship or materials will be repaired or replaced, at Eleven Hundred Energy's discretion, within the warranty period.
- ***Normal Wear and Tear*** Periodic maintenance, repair and replacement of parts due to normal wear and tear are excluded from coverage.
- ***Abuse and Misuse*** Defects or damage that result from:
    - **a.** Improper operation, storage, misuse or abuse accident or neglect, such as physical damage to the surface of the product resulting from misuse.
    - **b.** Subjecting the product to abnormal usage or conditions.
    - **c.** Other acts which are not the fault of Eleven Hundred Energy, are excluded from coverage.
- ***Unauthorized Service or Modification*** Defects or damages resulting from service, testing, adjustment, installation, maintenance, alteration, or modification in any way by someone other than Falcon, or its authorized service centers, are excluded from coverage.

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