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Solarius-500 Optimum

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White Paper Release for Solarius-500 Optimum

This document outlines the technical details and engineering data for the Solar Research Technologies **Solarius-500 Optimum**.

The Solarius-500 Optimum is one of the company's intelligent line of products that allows the user to interact with the system via Internet from anywhere in the world with an active Wi-Fi or LAN internet connection. It supports a wide variety of applications and areas of specific use.

System Function Synopsis:

Solarius-500 Optimum is a solar energy harvesting system that provides up to 500VA of AC power, and up to 35Amps of 12VDC power for use. It stores harvested solar energy in an onboard 100AH, 12 Volt LiFePO4 battery. The system is completely self-contained including lightning surge protection, energy harvesting and production management system, AC inverter, MPPT Solar Charge controller. We also offer an optional 5-inch color Touch Screen display for local visualization of data and systems behavior.

System Requirements:

Solarius-500 Optimum requires only a 24volt, 200-watt solar panel to be connected to it via the solar panel connectors on the side of the unit to provide the solar energy input. It is completely sealed against weather and is environmentally protected to NEMA-4 classification. The enclosure is fan cooled for temperature control and condensation prevention.

System Physical Mounting:

The system is intended to be securely bolted to a cement, brick, or wood structure. It has four 5/16" diameter mounting holes for attaching with lag screws, or Tapcon fasteners for masonry and concrete.

System Physical Size:

Solarius-500 Optimum measures 23.6 x 19.7 x 9.1 inches and weighs approximately 45Lbs. not including the Lithium storage battery. (The lithium storage battery adds an additional 37lbs. to the total weight of the system when installed.)

System Applications:

The Solarius-500 Optimum is specifically engineered to allow the homeowner to remove the gas fired Tankless Water Heater, Home Internet Router/Modem and endless automation products from grid power. Power capacity of 350W/500VA is adequate for all gas-powered tankless water heaters and many other propane/natural gas appliances It also can supply a 12VDC power source for emergency lighting inside a garage, or the optional charging station for laptops, cell phones and lighting when grid power has failed.

There are hundreds of other practical uses for the system including providing a stable source of pure Sine Wave AC power for lower current applications that must remain functional even if the grid power becomes unavailable. Examples are fire/smoke detection systems, security alarms and LED security lighting, security cameras, Home Automation systems and controllers and much more.

The system can operate indefinitely if power consumption remains within the budget of the production and energy harvesting parameters.

Optimum powering a gas fired Tankless Water Heater.

Solarius-500 Optimum can join Wi-Fi or ethernet networks and includes a weather-proof CAT45 port on the exterior of the cabinet for user connection to their Ethernet network if desired. The user can also communicate directly with the system using Blue Tooth.

System Inverter Information:

Optimum has a sophisticated 12VDC – 120VAC Pure Sinewave Inverter system. The nominal power output is 500VA, or about 350watts continuous power. The inverter has a maximum efficiency rating of 92%. Peak momentary power rating is 900watts.

Zero load power consumption is approximately 6Watts. (In ECO MODE default zero load power consumption is 1 watt)

A remote ON/OFF port is available on the front of the inverter which can be controlled via relay or other type of switch.

Output is rated at 120VAC+/- 3% and frequency is rated at +/-0,1% nominal.

The inverter features its own fan cooling and can safely operate in ambient temperatures from -40 to 60 degrees Celsius. Maximum Humidity is 95% non-condensing.

Environmental controlled conditions are provided by the Optimum NEMA 4X Rated enclosure which is fan cooled to preclude formation of condensation and circulate cooling air.

NEVER CONNECT THE OUTPUT OF THE OPTIMUM TO HOUSEHOLD OR AC DISTRIBUTION GRID! Severe damage and electrical malfunction can occur if this is done.

To provide maximum power efficiency and consumption, the Optimum inverter can operate in **ECO MODE** which significantly reduces the amount of current drawn from the storage battery. It is always advisable when the load permits to use this function if possible.

LOW BATTERY VOLTAGE:

The inverter will shut down when the Low Battery Voltage Threshold is detected. This value is adjusted at the factory but can be changed by connecting the optional USB-VE Direct cable to the inverter and entering the main menu settings. After a delay of 30 seconds, the inverter will attempt to restart. After three restarts, the inverter will stop trying. To remediate the condition, manually charge the battery or wait until the solar system has recharged and switch the inverter OFF, and back ON to restore normal operations.

Should the Battery become fully discharged, the solar charge controller can recover it within 2-3 hours of full sun normally.

ECO MODE SETTING:

When the ECO setting is selected on the front panel switch, the GREEN LED will flash as a slow single Pulse. A solid GREEN LED indicates the inverter is in the ON mode, the RED LED should be OFF.

> **Tech Note: When the inverter is in ECO Mode, it will require a minimum load of 15 watts AC current to activate the output and drive the load.**

In **ECO MODE**, the inverter will automatically switch off as soon as it detects that there is no load connected, (<15watts). It will switch on every 2.5 seconds to detect a load. If the output power requires more than the 15watt setpoint level, the inverter will output.

Storage Battery:

Optimum uses a 100AMP/HR LiFEPO4 storage battery. Solar Research Technologies offers an option for doubling storage capacity. Your Sales Engineer can provide details.

- Storage Capacity is rated at 1.28KW/HR and is 100% useable. **Grade A Cells** provides 4000+ deep cycles (a 10-year lifetime) & extends the battery lifespan by 8× more than the lead-acid batteries.
  100% Protection | Using without Risk: The lithium battery contains a 100A BMS to protect from overcharging & discharging, over current, short circuit, and over temp.

Lightning/Surge Protection:

Optimum has a robust and advanced protection circuit expressly designed for solar PV systems applications. Incoming power from attached PV panels and arrays go directly to the protective device and any excessive voltages that may arise from a direct or indirect lightning strike are passed safely to earth ground. The protection device has integral relay outputs that are coupled to indicator LEDs on the front panel of Optimum to alert if any surge conditions have been encountered. The protective device is a two-pole, V configuration 600VDC rated system.

Digital Inputs and connecting sensors:

Optimum has 8 Digital I/O points that can be interfaced with external sensors, data collection systems, temperature sensors and more. The inputs are non-isolated. They operate at 3V3

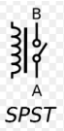
levels and can withstand up to 5V input. Each input has an internal 10k pull-up resistor to 3V3. We recommend wiring it to a potential free relay or otherwise open collector/optocoupler output. NPN or PNP sensors can be used on the digital inputs. An open collector signal provides and open and ground connection. This type of signal represents a switch connected to a ground point.

Each of the digital inputs can be configured as one of several predefined sensors that can also be configured as alarms.

Door Alarm	Open/Closed
Bilge Pump	On/Off
Bilge Alarm	OK/Alarm
Burglar Alarm	OK/Alarm
Smoke Alarm	OK/Alarm
Fire Alarm	OK/Alarm
CO2 Alarm	OK/Alarm
Generator	Running/Stopped

Other parameters related to that function can be configured by entering the device menu and selecting Setup. For sensors and alarms, you can decide whether the input should be treated as an alarm condition, whether the labels should be inverted, and whether the logical levels should be inverted.

Relays:



Optimum has two internal, programmable Relays that can be activated for external control and signaling. Each relay has a NO/NC contact that can be tied to specific functionality or sensor inputs. 12VDC is already present on the DC rail that can be connected to the common on each relay to send a 12VDC signal upon relay activation.

System Wiring:

All system components are protected by an individual circuit fuse of the appropriate rating including the solar panel input. Optional UL Listed circuit breakers can be ordered with the system as well if desired instead of standard DC fuses. All internal power handling wiring is constructed using Ancor, 10gauge pre-tinned Marine Grade stranded copper wire and is UL certified. Low current conductors are also Ancor pre-tinned Marine grade stranded copper wire and is 18Gauge. All connection points are labelled and properly identified.

GPS Location Detection and Mapping Functionality:

Optimum is fully compatible with specific USB GPS sensors. We have tested with the Globalsat device sold as an option on our website. It is possible to establish and configure Geofencing as well which will send an email should the Optimum travel outside the geofence.

Connect the USB GPS antenna to either of the USB sockets on the central unit. It can communicate at both 4800 and 38400 baud rates. Connection may take a few minutes normally, but the device will be automatically recognized. The unit's location will automatically be sent to the VRM online portal, and its position shown on the map.

Internet Connectivity

Optimum is an intelligent system and connects gracefully to any internet access point via Wi-Fi, or a wired CAT-6 network cable. There is a dedicated external weatherproof connection for wired networks

on the outside of the Optimum cabinet for this purpose. Optimum is also to connect to Wi-Fi and wired networks simultaneously and will automatically fail safe to the working network connection should one of the interfaces go down.

Optimum can also be supplied with an option to allow connection to cellular GSM networks. Finally, it is compatible with some cell phones via USB tethering but not all phones are supported.

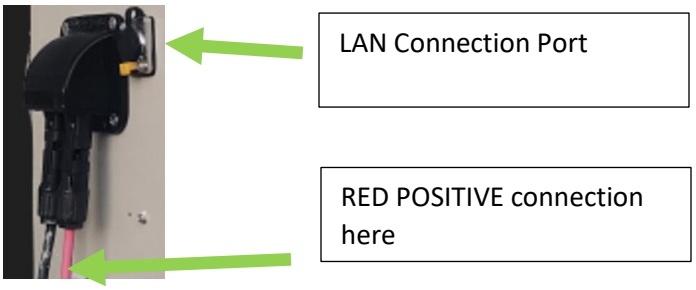
When Optimum finds multiple Wi-Fi networks of which the password is known, the strongest network is selected automatically. When the signal of the connected network becomes too weak, it will automatically switch to a stronger network - if it knows the password of that network. Wi-Fi is an inherently less reliable connection than a hardwired ethernet cable. It should always be a preference to connect via ethernet when possible. Signal strength should always be at least 50%.

To connect the Optimum to a mobile (cellular) network, such as a 3G or 4G network, use a cellular router. Connect Optimum to that router with either a LAN cable or the router's Wi-Fi network.

Solar Panel Connection:

We recommend a single, 24-volt DC 200-Watt solar panel be connected to the MC-4 connectors on the Optimum. You can also connect an array of solar panels provided the combined input does not exceed 100VDC at the input connections to Optimum.

Observe color coded polarity connections as shown:



VRM Live Data Portal:

Optimum is highly intelligent and will allow you to view and interact with the system from anywhere in the world via a live internet connection.

You will set up your account credentials, password and connect to the app with your cell phone, laptop, computer, or smart tablet to get started.

Once you have successfully connected to your installation, you will see the following view and be able to know exactly what Optimum is doing live.

This is the menu homepage data showing full detailed view. Here you can see your solar harvesting and production, battery voltage and charge state, charging mode, inverter state, inverter power draw, and DC rail voltages along with other important information.

In other menus, you can select detailed graphs, energy information and a plethora of data to collect.

In the upper right-hand corner, you can directly control a relay that has been wired to perform a task as well if desired.

If the optional GPS sensor is attached, you can also see the current physical location of the Optimum and set geo-fencing to alert when the device has moved out of the geo-fence parameters you configured.

Product Comparison: Hugo vs. Solarius-500 Optimum

Feature	Hugo	Solarius-500 Optimum
Backup Power Time	**5-7 days**	**Indefinite within power budget w/solar panel**
Pure Sine Wave AC Power	**Yes**	**Yes**
Solar Ready	**Yes ***	**Yes**
Indoor/Outdoor Install	**Yes**	**Yes**
Internet Communications	**NO**	**Yes**
Storage Battery Type	**38 AH AGM**	**100 AH Lithium**
Output	**500 VA/ 350 Watt**	**500 VA/ 350 Watt**
Touchscreen Display	**NO**	**Yes**
Lightning/Surge Protec.	**NO**	**Yes**
Enclosure Rating	**IP 54**	**NEMA 4****
Sound/Visual Alarms	**Yes**	**Yes**
LED Indicators	**Yes**	**Yes**
Energy Management	**NO**	**Yes**
Programmable Output Relays	**NO**	**Yes**
Blue Tooth Accessible	**NO**	**Yes**
Warranty Period, System	**1 Year**	**5 years**
Warranty Period, Battery	**3 months**	**5 years**
Maintenance Free Operation	**Yes**	**Yes**
Free Factory Monitoring	**NO**	**Yes**
Email Alerts	**NO**	**Yes**
Fan Cooled, Moisture Control	**NO**	**Yes**
12 VDC Output	**NO**	**Yes**
Alexa Compatible	**NO**	**Yes, (Optional)**

***** Hugo unit does not include any solar panel energy harvesting hardware, lightning surge protection and alarms, nor solar charge controller. Requires external equipment for these features.

** NEMA 4 Enclosure Ratings are higher in class than IP. NEMA 4 also includes protection against corrosion.