



Solar Powered Refrigerator

Valid till September 30, 1999

Solar Powered Refrigerators for Cold Chain Applications The RR-2 marks it's 20th Anniversary

The RR-2 maintains precision refrigeration and freezer temperatures, and can freeze large quantities of ice packs as required for the storage and transportation of vaccine, medical, and veterinary supplies. The RR-2 is prescribed for clinics that are located off the electric utility grid or their source of utility power is unreliable.

The RR-2 is preferred over kerosene and gas fueled absorption refrigerators because of its lower maintenance, higher reliability, and its independence from fuel sources. The RR-2 is safer because there are no burning flames or hot surfaces as required by absorption systems. Poor fuel quality, burner and wick maintenance, and keeping the refrigerator fueled are the reliability problems associated with absorption type refrigerators. RR-2 is safe from fire and explosion.

Using the sun's free source of unlimited energy along with our ultra-reliable RR-2 refrigerator is the solution for providing cold chain service of medical supplies in rural and remote areas. Even with little sunlight the RR-2 is the most cost-effective and reliable means for medical refrigeration. For areas connected to the grid but experience frequent power blackouts, the solution is our RR-2 with our Model 9650AC battery charger and a battery bank. In this application, we charge the battery from the utility power and the battery can run the refrigerator for a week or longer with no utility power.

RR-2 is unique in both its design and engineering concept. Unlike other refrigerators RR-2 was created specifically for the storage of vaccines and medical supplies in remote areas. The RR-2 is: low in cost, easily maintained in remote areas (where there are no service centers) and provides continuous effective refrigeration.



Qualification by NASA in 1981.

Solavolt International (a defunct partnership of Motorola and Shell Oil Company) had extensively tested RR-2 under contract with the National Aeronautics and Space Administration, Lewis Research Center (NASA LeRC), contract DEN3-240.

The tests have been conducted in accordance with rigorous test procedures established by NASA LeRC in conjunction with the World Health Organization, the Center for Disease Control, the Agency for International Development, and the American National Standards Institute. The performance of RR-2 has exceeded all testing parameters.

22520 Avalon Blvd • Carson, CA 90745 • Tel (310) 830-9153 • Fax (310) 830-9825 • www.polarpowerinc.com



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Polar Model RR-2

To lower the life cycle cost we have engineered the RR-2 to outlast other refrigerators by a 4-to-1 margin. The cabinet and fixtures are virtually unbreakable. Refrigeration lines and condensing coils are constructed of 100% copper for corrosion resistance in marine and tropical environments. The other materials (stainless steel, aluminum, and plastic) used throughout the system are also resistant to corrosion providing long service life. The cabinet itself is a single one-piece structure with a hollow core, which is filled with foam. There are no welded, fastened, or glued joints to come apart. Rotationally molding is the process of cabinet construction.

To provide dependable continuous refrigeration we designed RR-2 with two separate compressors and two independent refrigeration circuits and controls for reliability through redundancy. RR-2 is designed to not require servicing, but should one compressor or other component fail; the other circuit can maintain the temperatures in both the freezer and refrigerator compartments. Manual readjustment of thermostats required.

The dual compressor feature allows the RR-2 to produce large quantities of ice even in ambient temperatures up to 52° C (125° F). With the proper sized PV array, up to 6 kg. of ice can be produced per 24 hours.

The dual refrigeration circuit and controls allow accurate and independent control of refrigerator and freezer sections. Product will not freeze unless desired.

The RR-2 comes complete with the charge controller is built into the refrigerator. The PV array and battery plugs directly into the RR-2. The RR-2 charge controller will recycle the surplus energy produced by the PV array and divert this energy to a secondary battery to power other electrical systems such as: radios, televisions, cooling fans, communications, lighting, medical equipment, water pumps, tools, etc.

The photovoltaic package comes complete with roof and ground mounting array structure and hardware along with all necessary electrical wiring.

RR-2 Features

The refrigerator compartment is frost-free thereby lowering energy consumption and maintenance. Our frost-free feature is the result of a very large evaporator surface area and is not dependent on energy consuming heating elements or hot gas bypass. With the dual evaporator design defrosting freezer is not required as frequent as other products.

Accessory terminal. A secondary battery bank can be connected to the RR-2 to power accessories as lighting, communications, medical instruments, educational programs, etc. A green light on the front control panel will signal that power has been switched to the accessory battery bank. This is accordance with WHO specifications.

RR-2's base is constructed of aluminum with a durable powder coat finish. This design offers the maximum in corrosion resistance and lightweight.

The double gasket seal between the lid and the cabinet increases systems efficiency.

The movable dividers allow you to adjust the size of the refrigerator or freezer compartments. The divider may be removed entirely creating either a total refrigerator or freezer. Dividers measure 5cm wide.

The dual refrigeration circuit design allow the user to switch off the freezer section and continue refrigeration section in order to save energy or have more energy available to operate other appliances.

Molded polyethylene cabinet. The seamless one-piece base and lid is stress free, nonporous, and able to withstand great abuse. Since there are no internal seams inside the refrigerator, water can not leak into the insulation causing the materials to swell and crack over time (typical of many refrigerators).

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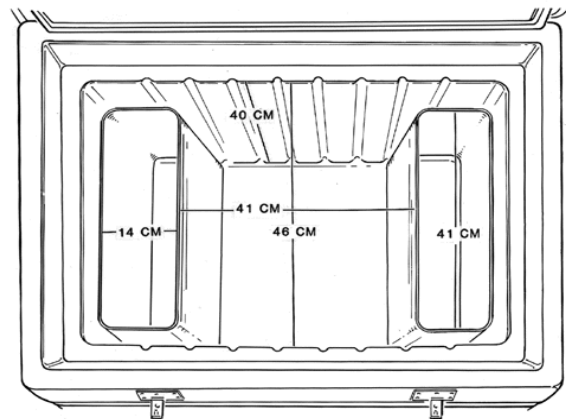
A brushless DC fan cools each condensing coil. The fan cooled condenser offers superior performance with the R134a CFC free refrigerants in warmer climates.

Simple LED indication of system status:

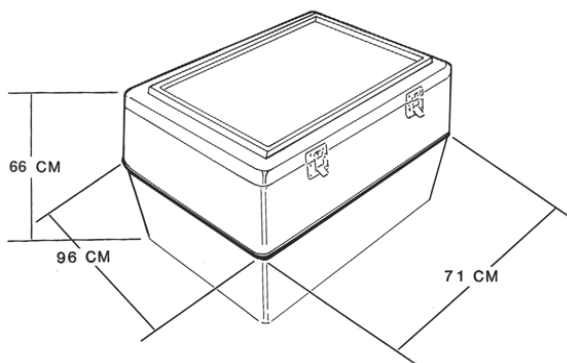
The red led light indicates low battery voltage and that the refrigeration has shut down. Our simple diagnostics routine quickly locates the problem.

The green light indicates a full battery charge and a no refrigeration load requirement. The green light gives operator the knowledge that the system can produce more ice.

The yellow LED light warns the operator to stop ice production.



Dimensions:



(NOTE: Dimensions shown are at the widest points.)

Capacities: Total usable volume is 127 liters either all refrigerator or freezer. Minimum volume for either the freezer refrigerator in combination is 23 liters. Shipping volume 823 liters, 115 cm x 98 cm X 73 cm.

Weights: Net weight 72 Kg, Export shipping weight 85 Kg.

Materials: Molded polyethylene cabinet, all stainless latches and hinge, aluminum base with baked epoxy finish, all copper condensing coils, steel casters, foamed in place polyurethane insulation.

Electrical:

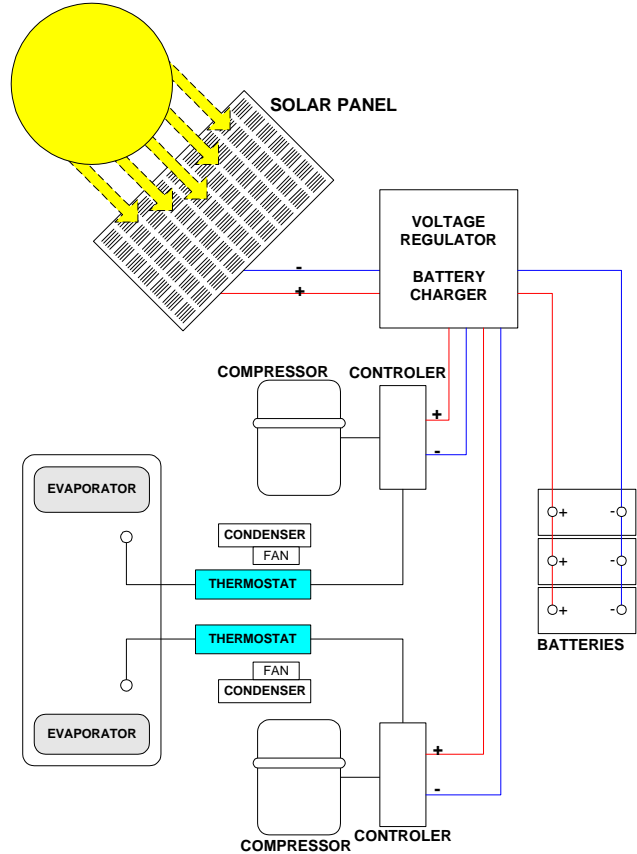
Voltage regulator/battery; charger: Factory voltage calibrations: load disconnect threshold 11.0 Vdc, Load reconnect threshold 12.0 Vdc., end of charge 14.7 Vdc, charge reconnect 13.4 Vdc, low battery or no ice production warning 11.7 Vdc, resume ice production 13.2 Vdc. Temperature compensated charging -30 MV per C per cell. Maximum power diversion to auxiliary load is 25 amps. Charging is configured for flooded type lead acid batteries, as you would find on electric cars of lift trucks. Automotive type batteries do not cycle well in this type of application and their use is discouraged. Sealed batteries do not cycle well in hot climates.

Fuse Protection: 30 amp main circuit and 8 amp for each compressor. System is reverse polarity protected.

Solid state electronic thermostats independently control freezer and refrigerator temperatures. Temperature adjustable from -25° C to +14° C with adjustable differential of 1° C to 8° C.

Refrigeration System & Performance:

- To independent refrigeration Circuit
- Minimum voltage requirement for compressor 11.0 Vdc
- Recommended system voltage input can range from 12 to 22 Vdc
- Running current, for each compressor is under 4.9 amps
- Under normal use, average Current consumption is 2 amps per hour
- Energy consumption per 24 hour at 43° C is 62 amp hours, box empty, 54 amp hours, box full
- Freezer temperatures can be adjusted to as low as -25° C in 43 C ambient Maximum ice production is 6 Kg per 24 hour at 43° C.
- Holdover time in 43 C ambient is 12 hours for +2° C temperature rise (8° to 10 C°).
- Recommended battery bank size is 300 amp hours at 20 hour rating



With our efforts of continued product improvement, we reserve the right to make any change or modification with out prior notice.

All units are thoroughly tested prior to shipment. Because of our high quality control standards and engineering excellence, we are able to offer a 5-year limited warranty. RR-2 is warranted against any defects in material or workmanship under designed use for a period of five (5) years on parts and one (1) year on labor. Warrantee is FOB Los Angeles, California and does not include transportation costs.

Rays from the sun strike the photovoltaic (PV) cells (the cells are encapsulated within a module for protection) which convert the sun's energy into electricity directly. PV should not be confused with Solar Thermal "panels" which produce heat from sun's rays. PV cells are solid state devices

that have no moving parts, liquids or gasses. During the day the electricity produced by the PV modules is used to power the refrigerator and the battery. During the night battery is used to power the refrigerator. Next day the cycle is repeated. There is sufficient energy reserve in the battery to operate the refrigerator up to 5 days without sun. Conventional home refrigerators run on alternating current (AC). Photovoltaics produce and batteries store direct current (DC). To reduce systems cost and increase reliability and efficiency we designed RR; 2 to operate on (DC) without power conversion equipment.

The RR-2 can accept power from wind generators, large and small generators, conventional. AC or any other source of power