

**DULAS Solar Direct Drive
VC60SDD Refrigerator and Freezer
User's Manual
(WHO PQS E003/084)**

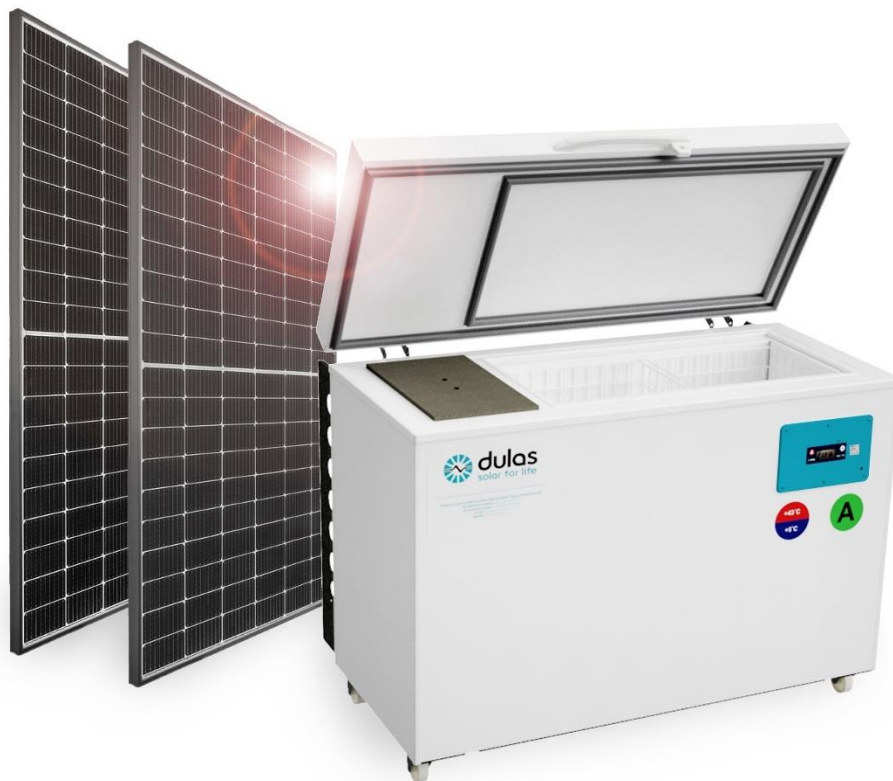


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1. Components Checklist

DESCRIPTION	QUANTITY
REFRIGERATOR	
VC60SDD Refrigerator Cabinet	1
Refrigerator Baskets	4
Refrigerator Key	2
Berlinger Fridge-tag 2 E (Refer to manufacturer's documentation)	1
SOLAR ARRAY	
315 Wp minimum Solar Modules	2
20 m Pre-terminated Solar Cable (+ve & -ve)	1 pair
Solar Connector – Branch Plug	1
Solar Connector – Branch Socket	1
Earthing Kit (incl. Earth Rod, 25 m Earth Cable & Earth Clamp)	1
MOUNTING SYSTEM	
End Clamp 28-33 mm Set	4
Mid Clamp 28-42 mm Set	2
Front Fixed Foot	3
C-Rail 47-2 – 1200 mm	4
Rail Connector Set 47	2
Rear Adjustable Leg	3
Coach Screws, Rawlbolts, Washers	1 pack
Screws	1 pack
Wall Plugs	1 pack
Cable Ties	1 pack
Cable Tie Bases	1 pack
Cable Protection Conduit	1
Silicon Sealant	1

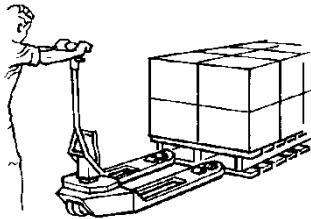
2. Safety Instructions



Read the Manual - please read all instructions completely before installing. Installation and system servicing should only be carried out by a qualified and competent engineer. Work performed by persons with insufficient technical knowledge may adversely affect the performance of the unit or cause physical injury or damage to the equipment.



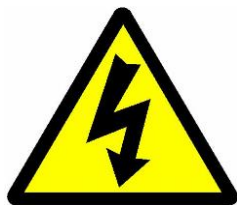
The refrigerator is not to be used by persons (including children) with reduced physical, sensory or mental capabilities, or lack of experience and knowledge, unless they have been given supervision or instruction. Children must be supervised not to play with the appliance. This refrigerator is for professional use only. It is not designed for household use.



Refrigerator and power system are heavy - please observe good manual handling procedures when moving the refrigerator and solar power system. Only use suitable transport equipment.



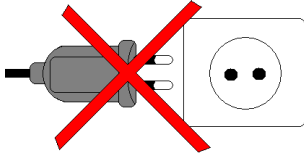
Safe working - Please observe safe working at height practices when installing the solar array.



Live electrical components – solar modules are live when exposed to sunlight. Isolate the array (using the PV isolator on the back of the refrigerator) before disconnecting any components.



Electrical danger – under fault conditions high electrical currents can occur. Never bypass a circuit breaker and always replace with the same type and rating.



DC power only - this refrigerator is designed for operation with the solar power system supplied. Do not connect the refrigerator to other power supplies.



Dangerous substances - this refrigerator contains substances that are not biodegradable and can cause harm, please ensure that all components of the refrigerator are disposed of correctly, see Section 6 for more information. Do not damage the internal side panels of the compartment.



Keep Dry - This refrigerator is for indoor use only. Do not expose it to rain.

WARNING: This unit's cooling system contains flammable refrigerant. Due to this fact, the following information is particularly important:



Warning: Do not damage the refrigeration circuit. Ensure that sharp or pointed objects do not come into contact with the refrigeration circuit.

Warning: Do not use mechanical devices or other means to accelerate the defrosting process, other than those recommended by the manufacturer.



Warning: Keep ventilation openings, in the appliance enclosure or in the built-in structure, clear of obstruction.

Warning: Do not use electrical equipment inside the appliance.

Warning: Do not store explosive substances such as aerosol cans with a flammable propellant inside this appliance.

3. Your Dulas Solar Direct Drive Refrigerator

Congratulations on choosing the Dulas VC60SDD vaccine refrigerator and water pack freezer. With over 40 years of engineering experience in the production of solar powered vaccine refrigerators, Dulas is considered one of the market leaders in this field.

The VC60SDD is Dulas' latest innovation in solar refrigeration. Using our new solar direct drive technology we have replaced the traditional battery energy store with a ground breaking phase change solution. With this new technology we can offer the same renowned Dulas quality and reliability that have always kept your vaccines safe, but in a simpler and more efficient package.

How does solar direct drive work?

When the sun shines the solar panels generate electricity which directly drives the refrigerator's compressor, cooling down the refrigerator and its contents. As a result the compressor only operates during the day. To maintain the temperature at night or when the sun is not shining the refrigerator has a phase change lining. This interior lining holds the exact temperatures required for safe vaccine storage and acts as a "cold store", storing energy that keeps the temperatures stable all day and night.

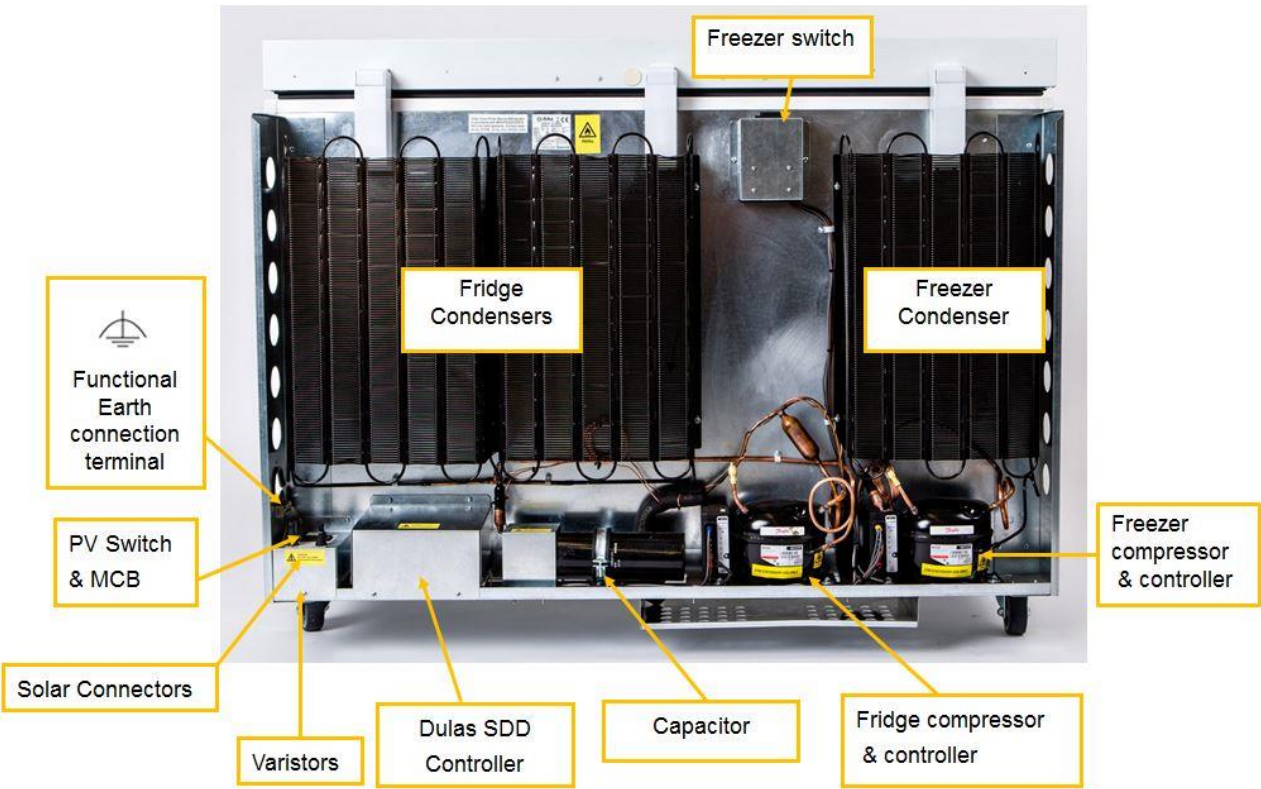
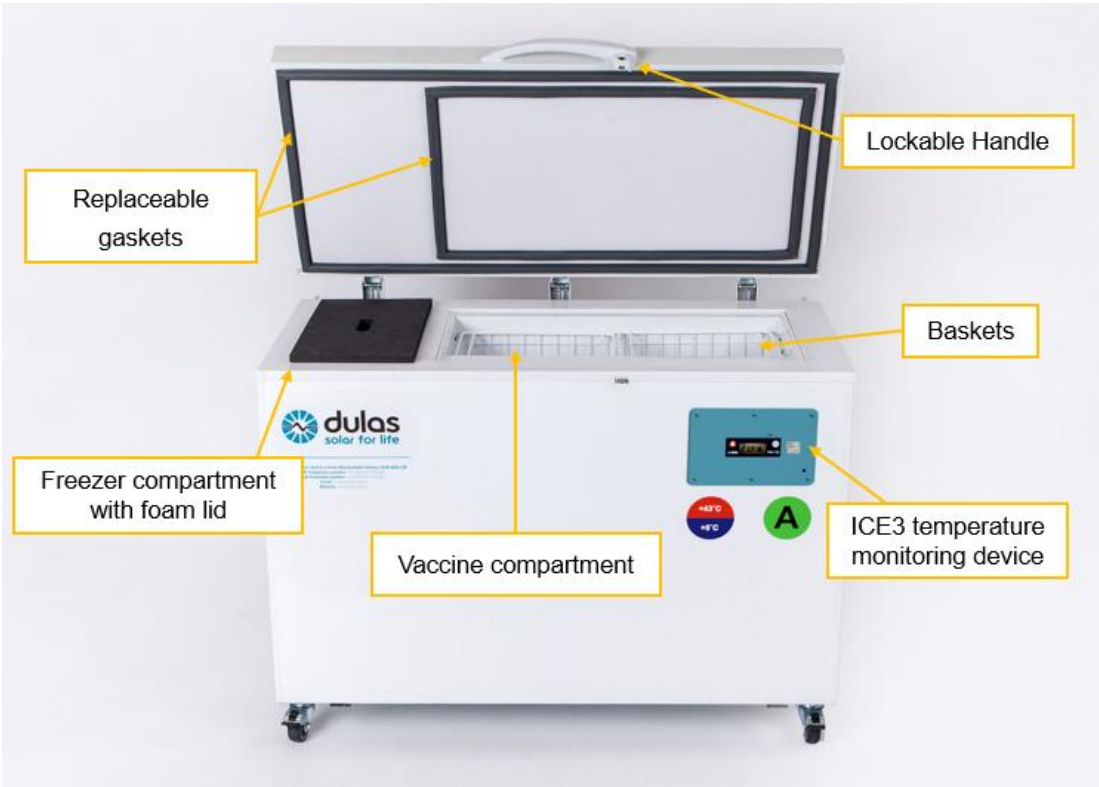
In order to store sufficient energy to keep vaccines safe for prolonged periods without any sunshine, the refrigerator must be allowed time to charge its cold store. Under normal sunlight conditions (8 hours/day of solar irradiance $>200 \text{ W/m}^2$) the refrigerator will take approximately 7 days to fully charge the cold store and be ready for vaccine storage.

In the VC60SDD the freezer compartment is secondary to the vaccine compartment. It has its own separate refrigeration circuit and we prioritise the operation of the vaccine compartment. The freezer only runs when there is enough solar energy to power first the fridge compressor and then the freezer. This means that in periods of very low sunshine it may not be possible to freeze water packs.

Recommended solar array

The VC60SDD has been designed to meet the World Health Organisation's Performance, Quality & Safety (PQS) standards. The refrigerator has been independently tested to the PQS standard WHO/PQS/E03/RF05 and is a Hot Zone rated appliance with an ambient operating temperature range of between $+5 \text{ }^{\circ}\text{C}$ and $+43 \text{ }^{\circ}\text{C}$. For use in such Hot Zone environments it should be powered by a solar array with a minimum peak power of 600 Wp and an open circuit voltage not exceeding 45 Voc.

4. Refrigerator Components



5. Material Safety Information

THE REFRIGERATOR

The Dulas VC60SDD conforms to the European Directive 2002/95/EC on hazardous substances and does not contain the following elements: lead, cadmium, mercury, hexavalent chrome, PBB or PBDE.

The absence of ozone destroying materials is in accordance with EC 1005/2009 (CFC-free).

It is compliant with European Standards (CE) EN60335-1:2010 & EN60335-2-24:2010.

R600a refrigerant – Isobutane, is highly flammable when mixed with air. Do not inhale, ingest, and avoid contact to skin. Ensure that any work carried out on the refrigeration circuit is done by a competent refrigeration engineer.

THE PHASE CHANGE MATERIAL (PCM)

The refrigerator contains an organic phase change material (PCM) that provides the energy store for the refrigerator. This PCM material is a paraffin wax that is liquid at room temperature and is stored in large tanks secured inside the walls of the refrigerator. In normal use the user will never be aware of its presence. This PCM is classified under regulation (EC) No 1272/2008 as a category 1 aspiration hazard and is classified under regulation 67/548/EWG, 1999/45/EG as having the potential to cause physical harm (R65 & R66). At normal ambient temperatures this product will be unlikely to present an inhalation hazard because of its low volatility. At high temperature aerosol/mist can cause an irritation of the respiratory tract.



H304 May be fatal if swallowed and enters airways.

P301 + P310 IF SWALLOWED: Immediately call a POISON CENTRE or physician.



P331 DO NOT induce vomiting.

R65: Harmful: may cause lung damage if swallowed.

R65: Repeated exposure may cause skin dryness or cracking.

In the event of a PCM spillage:

- Wear suitable protective clothing, gloves and safety glasses when clearing up spillages.
- Use an absorbent substance such as sand to contain any escaping material.
- Do not allow to enter drains / surface waters / groundwater. In the case of leakage of a large amount inform the responsible authorities.

6. End of Life & Product Recycling

PACKAGING

The packaging is made from recyclable / reusable materials and should be brought to an official recycling centre. The materials used are:

- Heat treated (HT) timber, certified by UK Forestry Commission (ISPM No. 15 Mark)
- Corrugated cardboard / Cardboard
- Polyethylene plastic
- Moulded polystyrene parts
- Steel reinforcing straps

WARNING – Keep packaging away from children - danger of suffocation from plastic!

WORN OUT REFRIGERATOR

The refrigerator still contains valuable materials and is not to be disposed of in the normal household waste.

- Ensure that the cooling circuit of the worn out device is not damaged when being transported.
- Information on the coolant used is on the type plate on the back of the refrigerator.
- The walls of the refrigerator contain an organic phase change material that can be harmful and must be disposed of safely. Please contact Dulas for advice.
- Worn out devices must be professionally disposed of in accordance with local regulations and legislation.

Potentially hazardous components / materials are:

- Refrigerant gas (R600a)
- Phase change material (PCM) - paraffin, normal C5-20
- Electrolytic capacitor
- Electronic components:
 - SDD controller
 - Compressor controller
 - ICE3 temperature monitoring device
- Battery: The ICE3 contains a LiFePO₄ (Lithium Iron Phosphate) battery. Please pay strict attention to the following points:
 - Never dispose of batteries or devices in a fire. Follow all local regulations when disposing of used batteries or devices.
 - Never place batteries or devices on or in heating devices, such as microwave ovens, stoves, or radiators. Batteries may explode when overheated.
 - Never crush or puncture the battery. Avoid exposing the battery to high external pressure, which can lead to an internal short circuit and overheating
 - Dispose or recycle the ICE3 in accordance with the WEEE 2012/19/EU guidelines or your local regulations. The device may also be returned to the manufacturer for proper recycling.

Disposal of Phase Change Material (PCM)

The PCM used in the Dulas refrigerator has a very long life and does not degrade through use. At the end of the refrigerator's useful life the PCM should be either recycled or disposed of in accordance with applicable regional, national and local laws and regulations. Contact your local waste disposal authority for advice. The product can be incinerated in accordance with local regulations. In the EU it has a Waste Disposal Code (EWC): *13 08 99 oil waste not otherwise specified*.

SOLAR POWER SUPPLY

Do not dispose of this equipment with normal domestic waste!

To comply with the European Directive 2002/96/EC on Waste Electrical and Electronic Equipment and its implementation as national law, electrical equipment that has reached the end of its life must be collected separately and returned to an approved recycling facility. Any device that you no longer require must be returned to our agent, or find out about the approved collection and recycling facilities in your area.

Ignoring this European Directive may have potentially adverse effects on the environment and your health!

Solar modules contain materials that can be recovered and reused in either new PV modules or other new products. Industrial recycling processes exist for both thin-film and silicon modules. Materials such as glass, aluminium, as well as a variety of semiconductor materials, are valuable when recovered.

7. Refrigerator Transportation

To reduce the risk of bodily injury, or damage to the refrigerator, the following precautions **must** be observed:

- Properly secure the refrigerator when in transit to prevent it moving or falling within the vehicle.
- Plan any lifting or moving of the refrigerator in advance, paying particular attention to steps, gradients and doorways.
- Ensure suitable moving and lifting equipment is used as required.
- Make sure there is sufficient assistance to safely carry out any lifting and moving of the refrigerator.
- Keep the refrigerator in its original packaging for as long as is practical to prevent damage during transit and unloading.
- Do not drop the refrigerator or allow it to topple over.

8. Refrigerator Installation

DO NOT position the refrigerator in direct sunlight or next to any heat sources. Make sure the refrigerator is positioned to provide good ventilation and ease of access for maintenance. Ventilation is particularly important for the condensers and compressors.

- 1) Position the refrigerator on a level surface; wipe all internal and external surfaces with a clean cloth.
- 2) Check the PV isolator at the back of the cabinet is in the "0" position.
- 3) Check the freezer switch on the back left of the cabinet is in the "0" position.
- 4) Plug the solar connectors into the refrigerator. Check that there is sufficient slack in the cable to allow access to the back of the refrigerator.
- 5) Turn the PV isolator on by switching it to "1". Within 1 minute the compressor will start if there is sufficient sunlight (solar irradiance of $>125 \text{ W/m}^2$). You will be able to hear the compressor operating and feel the condensers getting warm.



- 6) Turn the freezer switch to "1". Within 1 minute the second compressor will start if there is sufficient sunlight (solar irradiance of $>250 \text{ W/m}^2$). You will be able to hear the compressor operating and feel the condensers getting warm.

- 7) Activate the ICE3 temperature monitoring device: Press and hold both buttons for 10 seconds. Please refer to Section 9 for further information.

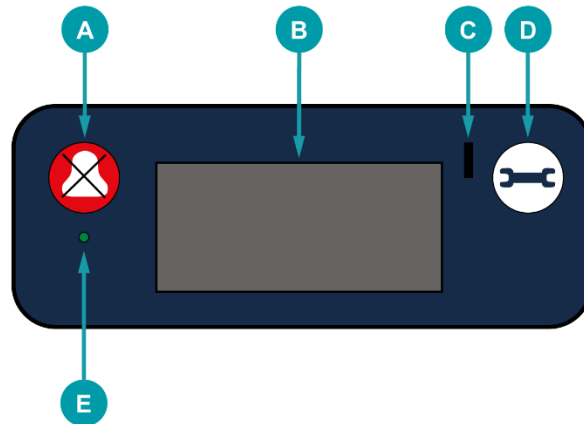
- 8) Ensure that all baskets are in position and the refrigerator lid is firmly closed.

- 9) Check that all cables are securely supported so that they will not be pulled loose if the refrigerator is moved for cleaning.

- 10) Roll the refrigerator into its final position and apply the brakes on the castors to secure it.

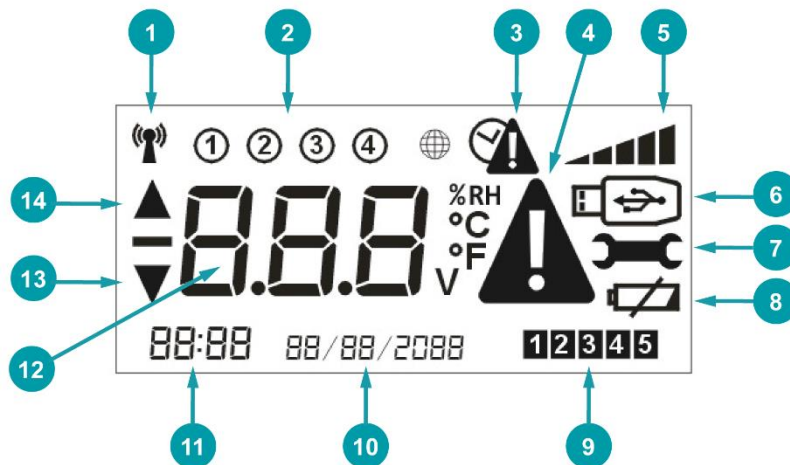
9.ICE3 Temperature Monitoring Device

This refrigerator is fitted with a Beyond Wireless ICE3 temperature monitoring device. The ICE3 is prequalified as a 'Remote Temperature Monitoring Device' (RTMD) in the World Health Organisation's Performance Quality Safety catalogue, WHO PQS ref E006/036.



Key to Front Panel

- A. 'Mute' Button
- B. LCD Display
- C. Data Connection Point, USB 2.0 Type-B Mini
- D. 'Test Mode / Force Connect' Button
- E. LED Indicator

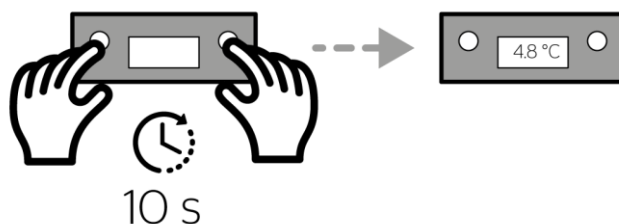


Key To LCD Display

- | | |
|--|----------------------------------|
| 1. 'GSM Modem On' Indicator | 8. 'Battery Low' Indicator |
| 2. 'Channel' Indicator(s) | 9. 'Connection Status' Indicator |
| 3. 'Historic Alarm' Indicator | 10. Date |
| 4. 'Active Alarm' Indicator | 11. Time |
| 5. 'Signal Strength' Indicator | 12. Temperature/Humidity Reading |
| 6. 'USB' Indicator | 13. 'Low Alarm' Indicator |
| 7. 'Test Mode / Force Connect' Indicator | 14. 'High Alarm' Indicator |

COMMISSIONING

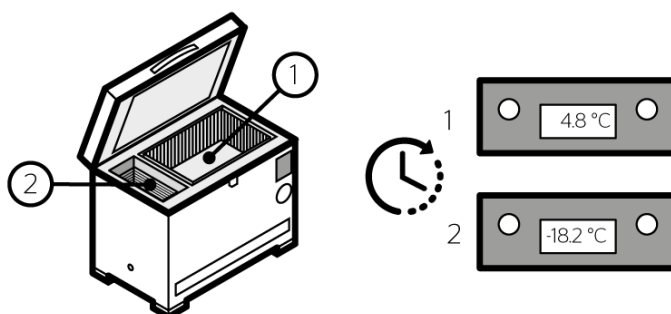
The ICE3 is not active during shipping. Once the refrigerator has been installed, the ICE3 device must be activated by pressing and holding both buttons on the front panel for 10 seconds. The display will turn on and the device will begin recording.



USE

Once activated, the ICE3 will measure the temperature of the refrigerator's compartment(s) using the inbuilt temperature probe(s), and will show this on its display.

The ICE3 display alternates between the temperature of the vaccine compartment ('Channel' 1) and the temperature of the freezer compartment ('Channel' 2). If there is no second compartment, only one temperature will show.



ALARMS

Alarm Thresholds

The upper and lower alarm settings are factory set into the device as follows:

'Low Alarm' setting: Exposure to a single temperature event of -0.5 °C or below for 60 minutes.

'High Alarm' setting: Exposure to a single temperature event of +8 °C or above for 10 hours.

Active Alarms

When there is an active alarm:

- The 'Active Alarm' symbol displays.
- An up or down arrow displays to show if its a 'High Alarm' or 'Low Alarm'.
- The LED flashes.
- The buzzer sounds with short beeps when *warning* of an alarm event.
- The buzzer sounds with fast beeps during an alarm event.

The ICE3 will signal a *warning* that an alarm event is pending by sounding short beeps when it detects that either of the alarm temperature thresholds have been breached. Once a temperature threshold has been breached for a given duration (see 'Alarm Thresholds' section above), the buzzer will sound with fast beeps to indicate an alarm event. The buzzer can be silenced temporarily by pressing the 'Mute' button on the front of the device, and will stop permanently once the compartment temperature has returned to within threshold.

Historical Alarms

Historical alarms are indicated by the 'Historical Alarm' indicator. When displayed, this indicates that there has been an alarm which resolved, but that the user did not "acknowledge" by pushing one of the buttons. The indicator can be cleared by pushing the 'Mute' button, signalling that the alarm has been acknowledged.

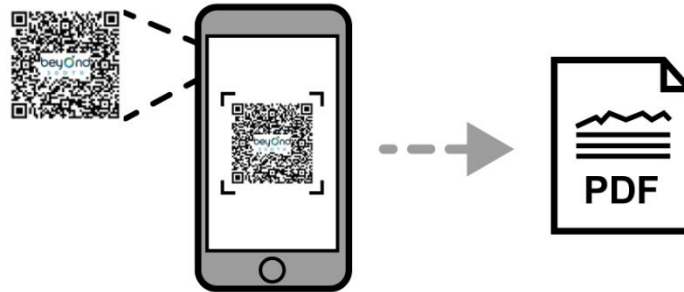
The 'Historical Alarm' is designed to act as a prompt for the user to download or access the temperature data via any of the methods described below. The temperature excursion can then be properly investigated, and corrective action taken.

DATA STORAGE

Local Data Storage

The ICE3 has the capacity to store up to 120 days of data in its on-board memory. Once this is full, the oldest data will be overwritten. The 120-day record can be accessed via the USB port on the device (using a USB 2.0 Type-B Mini connector cable) connected to a PC laptop.

Alternatively, a unique sharable pdf report of the last 30 days of temperature data can be generated online by scanning the QR code on the front of the ICE3 with a mobile phone (apple or android). Please refer to your mobile phone user manual for information on scanning QR codes.



Remote Data Collection - Optional

The integrated ICE3 supplied with this refrigerator has the option of enabling Beyond Wireless's industry leading remote temperature monitoring services (RTMS). The RTMS can either be configured to activate alongside the device when it is first turned on, or alternatively they can be activated remotely at any point once the ICE3 is in service.

Once the RTMS are activated the ICE3 is then visible as part of Beyond Wireless's Connected Cloud platform. This offers the full range of PQS accredited functionality of the standalone ICE3 product (WHO PQS/E006/036).

If your refrigerator does not have RTMS enabled and you would like to learn more about this option, please get in touch with Dulas for more information and pricing.

MAINTENANCE

Wipe with a dry cloth. Avoid contact with water.

The ICE3 is powered by a rechargeable lithium battery. The battery has a design life in excess of 10 years and should last for the lifetime of the refrigerator. Should replacement be required, please contact Dulas directly for a spare and technical support.

10. Refrigerator Loading

IN ORDER TO KEEP INTERNAL TEMPERATURES OPTIMISED AND MINIMISE ENERGY CONSUMPTION, ONLY OPEN THE LID WHEN STRICTLY NECESSARY.

The VC60SDD refrigerator has two refrigerated compartments. The large one is specifically for the storage of vaccines and the smaller one with the fan is the freezer, see Section 4. The vaccine compartment is designed to maintain a stable temperature between +2 °C and +8 °C across an ambient temperature range from +5 °C to +43 °C. There are no points within the vaccine compartment that drop below freezing and thus no danger of freezing vaccines.

The refrigerator contains stacking baskets designed to make stock management easier and encourage air circulation within the compartment.

Do not remove these baskets and do not store vaccines outside of these baskets.

The wire baskets encourage the circulation of air by maintaining a small gap between the basket and the cabinet wall. Good air circulation will help the refrigerator to maintain an even temperature throughout the compartment. In order to save energy, try to keep the lid open for as short a time as possible.

Stock management

- Allocate a certain space for each different type of vaccine, so that they may be located rapidly.
- Check the vaccine labels and adhere to any special requirements.
- Always use before expiry date (store older vaccines on top).
- Store the most frequently used vaccines in the top baskets for easy access.

WARNING: ALWAYS FOLLOW THESE VACCINE STORAGE GUIDELINES

11. Freezer Operation

The VC60SDD freezer is a highly efficient freezer designed specifically for freezing water packs for vaccine distribution. It has a fan to maximise the cooling power and is able to rapidly freeze up to 2.4 kg of water each day.

The refrigeration circuit of a solar direct drive freezer only runs during the day time when there is enough sunshine. The VC60SDD is designed to prioritise keeping the vaccine compartment cold over the freezing of water packs. The freezer only turns on when there is enough solar energy to run first the fridge compressor and then the freezer. In low sunshine conditions it is normal for only the fridge to keep running.

To freeze water packs simply place the required number of water packs in the freezer at the beginning of the day and by the end of the day they will be frozen. The freezer is well enough insulated that the water packs will remain frozen overnight.

The VC60SDD can be used to build up a store of up to 23 x 0.6-litre water packs allowing multiple outreach trips to take place in a short time. Simply add 2.4 kg of water packs each day until the desired amount of ice has been accumulated.

Freezing capacity per day	
Water pack volume	Qty = 2.4 kg
0.3-litre	8
0.4-litre	6
0.6-litre	4

The VC60SDD has an intelligent controller that automatically ensures the operation of the freezer never endangers the safe storage of the vaccines in the fridge. There is also an on / off switch on the back of the cabinet.

There is no need to turn the freezer off unless for maintenance.

There is no risk of damage to the system by freezing too many water packs.

Tips to maximise the freezing power of the VC60SDD:

- Allow the freezer to run for 2 or 3 days before starting to freeze water packs.
- Use the foam lid: make sure it is always replaced securely.
- Use the basket provided in the freezer: this is designed to allow air to flow around the water packs and ensures rapid freezing.
- If there is a build-up of ice on the cabinet walls, turn the freezer off for a day until it has melted. **Keep the lid closed during defrosting!**
- If water builds up in the bottom of the freezer there is a drain plug on the side.

12. Green Compressor Status LED Light

The green LED light on the front of the refrigerator illuminates to indicate that the refrigerator compressor is operating. The refrigerator compressor will run if the refrigerator temperature is above about 4 °C and there is sufficient solar power.



Normal operation

The refrigerator warms up slightly overnight. It is usual for the compressor to start running shortly after sunrise. It will run continuously for a few hours to cool the refrigerator. After this time the compressor will begin cycling on and off to maintain the correct internal temperature. This will continue until the sun sets at the end of the day. At night there is no power to the refrigerator and so the compressor will not run nor will the LED light operate.

13. User Training

The end user of the VC60SDD should be instructed in the simple processes outlined below and also those in Section 14. It should be stressed that these tasks are essential to ensure correct and reliable operation of the refrigerator.

Caution: failure to follow these instructions may lead to system failure and vaccine wastage.

If you have a problem, please contact your appointed engineer.

Operation of the Refrigerator

Turning on:

When turning on for the first time or when the refrigerator has been turned off for more than 3 days:

- Connect the solar panels and allow the refrigerator to run for at least 7 days.
- Before loading with vaccines, ensure that the temperature display on the front of the refrigerator reads +4.5 °C or less by 4pm in the afternoon.

Daily Routine

- Keep the lid closed, open only when required and lock after use.
- Store the most frequently used vaccines in the top baskets for easy access.
- Do not keep food or drink in the refrigerator.

Vaccine Storage:

- Only store vaccines in the refrigerator.
- Use the baskets provided: Do not store vaccines outside the baskets.
- Always store vaccine in its original packaging.
- Always keep the same type of vaccine together and store your vaccine neatly.
- Always use old vaccines before new ones; before use make sure the vaccine has not expired.

Freezer operation

- Designed to make 2.4 kg of ice each day. Freezing more may be possible when very sunny.
- Use the foam lid, always replace it securely.
- Use the basket provided.
- Defrost the freezer if ice builds up on the walls (use switch on the back to turn it off).

14. Maintenance Tasks

Every morning and afternoon:

- Check the vaccine compartment temperature (the correct temperature is +2 °C to +8 °C).
- Fill in the daily record sheet.

On the first day of every week:

- Wipe away any moisture build up inside the refrigerator and around the cabinet lid.
- Drain any water from the bottom of the refrigerator (using the inbuilt drain).

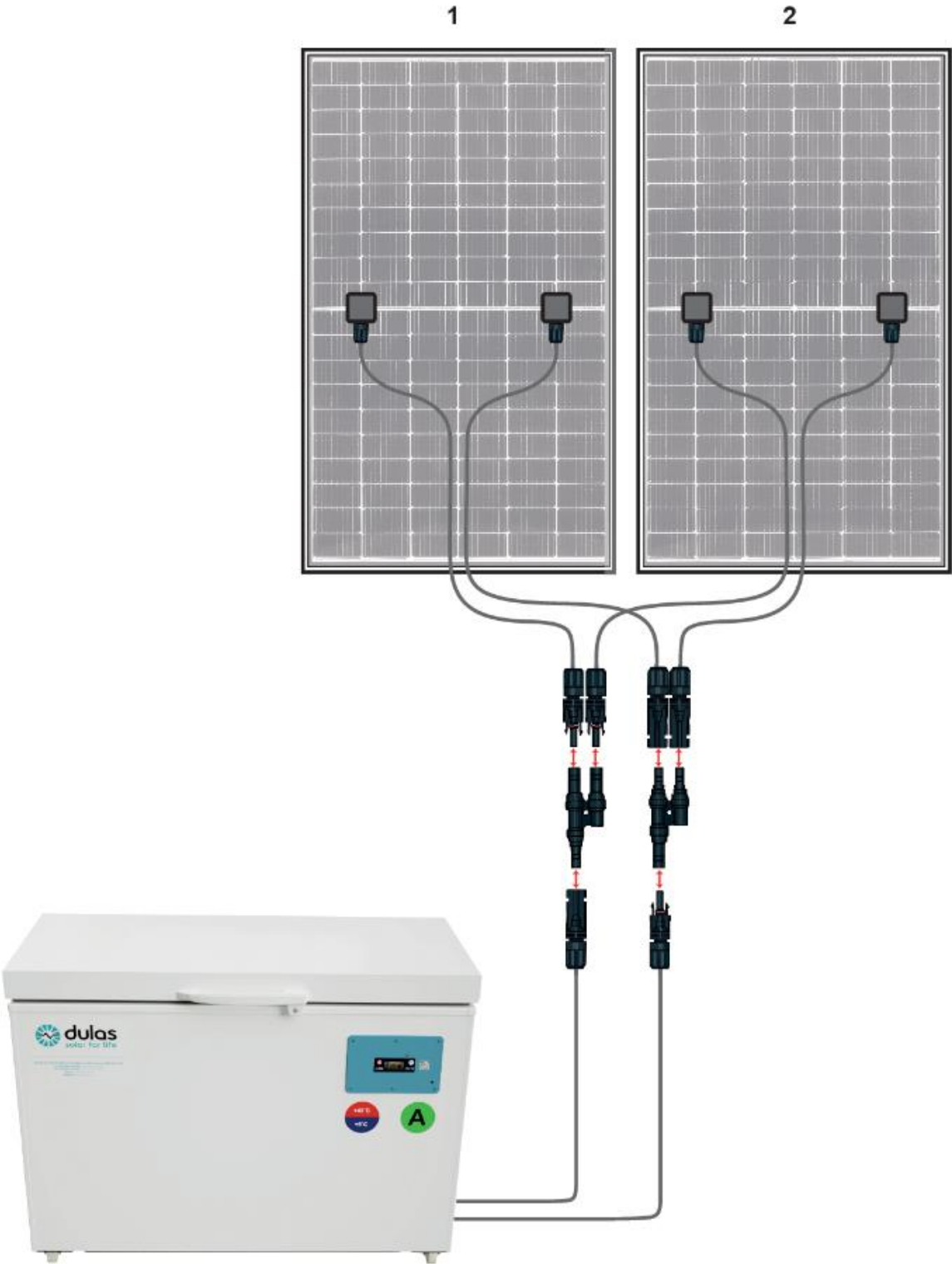
On the first day of every month:

- Clean the refrigerator with a soft damp cloth (avoid using water to the rear of the fridge).
- Clean the lid gasket and inspect for damage or gaps.
- Clean the solar panels (before 8am, use only clean water and a soft cloth or brush). In dusty conditions, solar panels should be cleaned weekly.
- Make sure that the solar panels are not shaded between 08:00 and 16:00.
- Defrost the freezer if there is a build-up of ice on the walls of the compartment.
- Check that the freezer fan is working (should be audible from inside the freezer when the sun is shining).

Every 6 months (technician only):

- Check all mechanical fixings and electrical terminals are good (solar panels, cables & refrigerator).
- Check for visual damage to PV panels, earthing fixings and cables, power cables.

15. VC60SDD System Layout





About Dulas

For over 40 years, Dulas has been a pioneer in renewable energy. Our mission is to develop and implement renewable energy solutions that improve lives, help to combat climate change, and support communities in the most rural parts of the world.

Our approach is summed up in three words: **People. Purpose. Planet.**

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