Fridge optimizer – User Manual V1.1

Introduction

Thank you for purchasing a Fridge Optimizer!

The Stainless Lobster Fridge Optimizer is a palm-sized controller unit with cables and a custom connector that connects to your boat's refrigerator or freezer. It reduces energy consumption, improves the cooling capabilities and performs automatic defrost cycles.

The Fridge Optimizer is made by Stainless Lobster, a Seattle company, owned and operated by a couple of cruising engineers (Arvid and Annika Elias).

Contents

History

The Fridge Optimizer started as a project in 2012 to increase the efficiency and remove the need for manual defrosting of a built in refrigerator onboard a cruising sailboat in the Sea of Cortez, Mexico.

The project was a great success and was duplicated on several other cruiser boats. Since then the product has gone through a number of iterations. The earliest version didn't have a way for the user to change the temperatures without connecting it to a computer. The next version had a 4x4 keypad with 0-9, A-D, * and # symbols. This allowed the changing of values with the 0-9 keys, moving between values was done using the * and # keys and A-D took the user through different pages.

The next generation had a PlayStation controller joystick interface and this allowed the unit to be much smaller but the navigation took some getting used to.

The current product

The final version is what you see before you. It is compatible with both 12v and 24 systems and has a custom designed membrane switch panel and a 1.8" color display. The software in the head unit can be upgraded via a mini USB connector, hidden under a dust cover on the left side of the unit.

The brain and memory in the head unit is contained within an ARM processor called 328p.

The manufacturing of the Fridge Optimizer is done in Bellevue, WA, United States. The box, insert and manuals are all sourced locally.

All the solder material in the unit is RoHS compliant and contains silver instead of lead.

The product enclosures and all "plastic" pieces are made of biodegradable PLA, made from American corn starch.

Different versions

There are currently three different models of the Fridge Optimizer. They all share the same head unit and software but come with different compressor interfaces.

The majority of refrigerators, freezers and fridge-freezer combinations made for pleasure boats since 1998 and forward utilizes compatible Danfoss, Secop or Cubigel compressors. These include built in or standalone systems from manufactures such as:

- Adler / Barbour
- Isotherm
- Dometic
- Norcold
- Sea Freeze
- Fridgonautica
- Vitrifrigo

DC only model:

This model interfaces with the most commonly used Dafoss/Secop compressor used in Sailboats and icebox conversion kits from 1998 and newer.
sIf the power cables to your fridge or freezer goes into a box that looks like this then this is the unit for you:

ACDC model:

This model interfaces with the most commonly used built-in newer fridges and freezers on both sail- and power-boats. The ACDC controllers were introduced later than the DC model.
If the power cables to your fridge or freezer goes into a box that looks like this then this is the unit for you:

Technautics model:

This model interfaces with the Cubigel compressors used in Cool Blue fridges and freezers. It's used in built-in newer fridges and freezers on both sail- and power-boats. If the power cables to your fridge or freezer goes into a box that looks like this then this is the unit for you:

Compatibility with known refrigerator models (In Progress)

Waeco Coolmatic -

Adler Barbour ACU200 – replaces the AB metal controller box.

Display Pages and Navigation

The pages in the Fridge Optimizer are meant to separate important information into purpose focused views.

The Fridge Optimizer has 5 buttons that allows the user to switch views and changes settings.

The  'Page' button in the lower left corner is used to switch between the 5 different data views /pages:

- Overview page
- Energy page: Runtime & Compressor use
- Humidity page
- Temperature details page
- Settings page

The unit can be left in any of the views/pages. The data is refreshed every 20 seconds. If no buttons are pressed in the last 2 min the screens backlight dims down to reduce power usage and illuminate the cabin less.

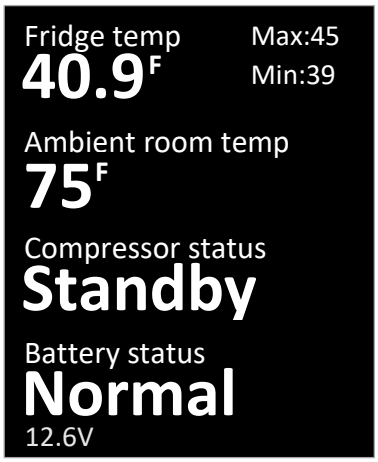
The  'left' and  'right' buttons lets the user move between values in the settings page.

The  'plus' and  'minus' buttons increases and decreases the currently selected values on the settings page.

How to read the information on each page

Overview page

This pages shows an overview of the battery and compressor status.



The **"Fridge temp"** section shows the currently allowed maximum and minimum temperatures as well the current fridge/freezer temp. The current temperature in this view is truncated to the closest 0.1 degree. The temperature value is shown in red if the temp is more than 10F degrees over the set max value. (this indicates that the system isn't performing as expected and user action is required)

The Max and Min values are the user configured high and low values that guides when the compressor is turned on and off.
The Max and Min values are shown in blue when a reduced temperature compressor cycle is in effect (from FW version 4.2 and later)

The **"Ambient room temp"** is read from the temperature sensor inside the head unit. Note that if you're holding the head unit in your hand then the temperature reading may be higher than ambient temperature.
The ambient temperature is rounded up to the closest full degree.

The ambient room temperature is used to decide when to turn on and off power to the additional fan connector meant for an optional compressor compartment fan. It is useful in tropical climates when compressor could use a little more cooling during the days. This fan is not included in the package. Any 12V computer fan can be used for this.

"Compressor status" indicates the operation of the compressor. It has 3 different states:

- "Off" means the current battery voltage is lower than the pre-set low voltage cut off and the compressor is not running. This is not a normal state and you should check the battery bank.
- "Defrost" means the Fridge Optimizer is currently performing a defrost cycle and the compressor is during this period not permitted to run, but the fan on the thermostat will be on.
- "Standby" means that the temperature has reached the lower setting and the compressor is turned off until the temperature passes the pre-set high value.
- "ON" means the compressor is running at 2000rpm until the temperature has reached the pre-set low value.
- "Boost" means that the compressor is running at 3500rpm until the temperature has reached the pre-set low value. The boost mode is an optional mode that can be selected in the settings.

"Battery status" indicates if the system is:

- "Low" in red letters, meaning below the low voltage cut-off level. (default level is 10.5V). This protects the batteries from being drained by the fridge if the charging system is not working.

- "Normal" means the voltage level is above "Low" but below "Charging" threshold.
- "Charging" means the voltage level is above the user set threshold for when the system is under charge. (default level is 13.5V)

The voltage indicated at the bottom of the screen is measured at the head unit. It may differ slightly from what you see in a volt meter connected directly to the batteries. For this reason, you can configure the thresholds in the settings page to match your setup.

Optimization hint: If the voltage at the bottom of the page fluctuates greatly (more than 2-3 volt) between when the compressor is running and when it's not running. Then it's likely that the cable supplying power to the fridge or freezer is too thin for the load it's carrying or that there's a faulty terminal somewhere between the battery and the head unit. A fluctuation of around 1 volt is normal.

Optimization hint: The temperature may continue to rise after the compressor has turned on, due to the momentum of the temperature increase. This is normal. After the compressor has cooled down the cold plate again you will see the temperature begin to fall.

Energy page

The energy page shows information about the system's runtime and the runtime statistics of the compressor.

The **"System runtime"** (called system runtime prior to FW4.2) shows the time that has passed since the power was turned on. This timer rolls over (resets) after 30 days.

The **"24h Comp.statistics"** (replaces "Compressor runtime" in FW versions 4.1 and earlier) shows how long the compressor has been active during the most recent 24 hours. The percentage indicates compressor runtime divided by system uptime, if the uptime is less than 24 hours. (Runtime is dived by 24h if the uptime is longer than 24h)

A normal compressor runtime can be anywhere between 15 and 75 percent depending on the size and insulation of the system. Use this to compare changes you make to your system such as adding insulation, and when changing the temperature settings.
sometimes just covering the fridge with a blanket can save a significant amount of power.

The **"Realtime draw"** (called "Current Draw" in FW4.1 and earlier) shows the current power consumption measured in watts. This is a calculated value that is generated from a database of how much the system should consume during different situations.
To get the correct values it's important to check that the correct compressor model is selected in the settings.

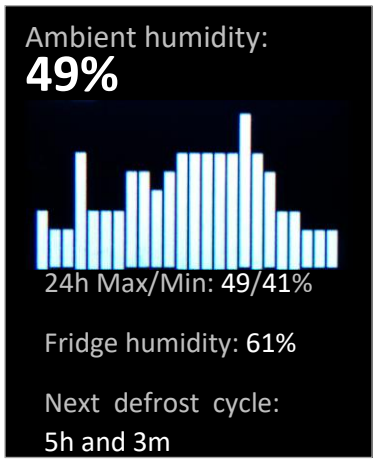
The **"24h Comp.statistics:"** is a sliding window value that shows how many ampere hours the system has consumed and how long the compressor has been actively running in the most recent 24h.

"Compressor min/hour"
Each bar in the graph represents 1 hour in the most recent 24 hours. The current hour bar is rightmost bar.

Optimization hint: If you put fresh food in the fridge you can come back some hours later and see how long it took the fridge / freezer to cool down the food to the desired temperature. It's normal to see 'full' bars for 2-3 hours after you put warm food in a fridge.

Optimization hint: If you see that the bars are high during the day and low during the night, without the fridge freezer having been opened it could be an indication of poor insulation or a bad door seal.

Humidity page

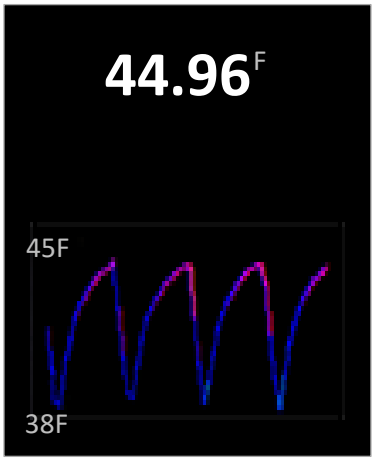


This page informs the user of the current and the past 24-hour ambient humidity as well as the current humidity level inside the fridge/freezer.

This page also shows when the next defrost cycle is due to start.

It is normal for the fridge relative humidity to be higher than the ambient relative humidity. This is because the humidity is relative to the temperature and colder air can't carry as much moisture as warmer air.

Temperature details page



This page can be used to determine how well the refrigeration system performs.

The current fridge/freezer temperature (detected at the thermostat) is shown with a 0.01 degrees' accuracy.

The graph indicates the temperature changes over the most recent 2 hours. The X axel is representing the time and the Y axel is representing the temperature at each point in time. The Y axel scales dynamically to the minimum and maximum time measured during that time.

The upward part of the graph represents the when the compressor is turned off and the temperature increases. The downward part represents when the compressor is working to cool the fridge/freezer.

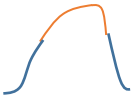
The temperature line is drawn in red/purple closer to max temp and blue closer to the min temp.

The start of the upward slope is normally steep. The slope of the topmost part of the upward slope indicates how well insulated the area is. If the insulation is insufficient, the line will continue upward at a steep angle until the compressor is turned on and the temperature starts to drop. If the fridge/freezer is well insulated the line will slope more towards the horizontal plane before the top is reached. Thus extending the warm-up period before the compressor needs to starts working again (this is good).

Fully understanding the temperature graph can be difficult and is often unique to a specific fridge/freezer.

Here are some examples of patterns to look out for:

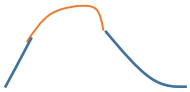
Below is a graph from a fridge that working efficiently.



In this example the line starts at a steep angle but slopes of before reaching the top. This indicates **good** insulation and a sufficient gap between the high and low temperature settings.

Once the high temperature is reached and the compressor turns on the temperature drops at a rapid and even rate. This indicates that the refrigerant level is balanced and that compressor speed is sufficient for the fridge/freezer.

Below is a graph from a fridge that has an issue with the cooling phase.



The compressor is struggling to reach the low setting and remains turned on for a long time. The long upward slope may at a first glance indicate that the system is well insulated but is actually the result of the system being cooled down over a long period. The long (or sometime endless) downward slope (compressor cycle) is a sign that the system can't reach the lower temperature set point.

This could be an indication of several things. Four examples that could cause this are:

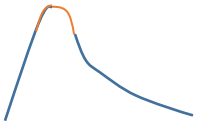
1. The air flow past the cold plate of holding plate is obstructed.
2. Compressor is not running at a high enough speed for the fridge/freezer. Boost setting is needed.
3. The refrigerant is running low **or** has been overfilled. (Frosting on the return line from the compressor is usually an indicator of an overfilled system)
4. The compressor can't get rid of the excessive heat. This is often caused by a dusty condenser, a blocked ventilation compartment or a disconnected condenser cooling fan.
5. The fridge/freezer isn't built to achieve the low temperature that the user set. This is often the case with larger boat fridges and freezers with insufficient insulation set at low temperatures.

Below is an example of a fridge that's working well but may be optimized to reduce power consumption.

The steep upward slope indicates that the insulation is lacking or that the low and high temperature setting gap isn't big enough. When the compressor starts to run it efficiently cools the fridge/freezer all the way down to the lowest setting.

Adding more insulation or re-sealing the door to the fridge freezer will likely help reduce the compressor runtime.

Below is an example of a large fridge with a small compressor running at a low speed.



This fridge is performing well but the compressor is running longer than it needs to if it ran at a higher speed. If there's sufficient ventilation in the compressor compartment this runtime can be reduced by turning on the boost mode. This will increase the power usage of the system but the compressor will run sat shorter intervals and is able to cool down food faster.

A wave pattern that's not repeating itself and may be jagged up and down may be an indication of a fridge/freezer with a large quantity of newly inserted and warm items. It may take as long as 12h for a relatively small compressor to cool its content.
I can also be an indicator of when the compressor is struggling to cool down the content of the fridge/freezer. This temperature fluctuation during the 2 hour period is usually less than 2-3F if this is the case.

Settings page

This page contains all the user adjustable settings.

```
Fridge temp:
Low: +39   High: +45

Ambient room temp:
Below 80 degrees

Defrost every: 012h
Defrost Length: 10min

When charging:
Threshold (volt): 12.5
Reduce temp: 0 degrees
Boost compress. RPM: N

Fahrenheit / Celsius: F

Compressor mod: BD35F
Low volt. cutoff: 10.5

Factory reset: 0
```

Fridge temp

The old style thermostats had a knob that could be adjusted to change the temperature and a (somewhat) fixed gap/range in which the compressor would remain turned off.

The Fridge Optimizer lets the user decide the gap between the **"High"** temperature the system can reach before the compressor is turned on and the **"Low"** temperature that the compressor should run the system down to before turning off.

Optimization hint: Stainless Lobster recommends at least 5F gap between the low and high temperature. This will allow the compressor to rest and cool down between cycles.

The default values are:

Low=39F

High=45F

You may need to change these values depending on how close to the cold plate holding plate your thermostat is placed and the size of the fridge/freezer.

A separate thermometer can be used to measure the temperature in different spots inside the fridge/freezer during setup and calibration. Advanced options such as remote thermometers (grill thermometer) and thermal cameras are also very useful tools if you happen to have them.

Ambient room temp to control additional 12V fan

This setting controls an optional additional fan that can be installed to cool the compartment that the compressor is located in. This can in warmer climates both increase the expected life of the compressor and increase the capacity of the system.

Defrost

The defrost feature runs a preset interval and for a preset length of time. During the defrost cycle the advanced thermostat fan is running while the compressor remains turned off. This circulates the 'warm' air inside the fridge or fridge compartment past the cold plate or holding plate and forces the frost build up on the plate to melt. Note: because above freezing temperatures are required to perform the defrost function, only fridges will be frost free. Freezers will not.

The default values are to defrost every 10h for a period of 40min.

If ice is building up it's recommended to decrease the interval and increase the length of the defrost cycle.

Please allow for at least 24 hours between adjusting the values as it generally takes that long for the fridge to stabilize.

Larger fridges and fridge freezer combinations tends to require a more frequent defrost (every 6h or so) and up to 60min of length.

If the Fridge Optimizer is installed in a freezer it may sometimes be desirable to de-activate the Advanced thermostat fan all together. This can easily be done by setting the period to '999h' and the length to '00m'. Please note that this disables the fan completely even during normal compressor cycles. The temperature sensor will continue to operate. If you want the fan to be running, you can set the interval to 998h to get the maximum interval without turning off the fan.

When charging

Threshold (volt)

This setting determines at what input voltage the Fridge Optimizer will assume the system is under charge (from solar, generator, shore power).

If the incoming voltage is below the value set here the system will run using normal values and the batter status will be shown as “Normal”

If the incoming voltage is above the set value, the system will assume that the batteries are being charged and the battery status will be shown as “Charging”. The system will when in this state use the “Reduce temp” and “Boost comp.” values to override the normal parameters.

The voltage is measured at the head unit, and thus depends on the size and length of cables from the battery. If you see a lower value than at the battery, adjust the threshold accordingly to match the battery charging state.

Reduce temp

This value is used to drop the systems temperature while the batteries are being charged. This will cool the content of the fridge/freezer down lower than normal, thus storing extra energy and reduce the initial power drain from the batteries when the batteries are no longer under charge.

Note: choose a value that doesn’t lower the temperature below freezing, especially if you have sensitive food or medication.

Boost comp.

Similar to the “reduce temp” feature this value is only taken into account while the batteries are under charge. If active (”Y”) the feature increases the RPMs of the Danfoss/Secop compressor to 3500 (normal is 2000 RPM) while the batteries are under charge.

This feature helps reduce the time it takes to cool new content in the fridge/freezer and also reduces the compressor cycle time.

The increased speed of the compressor uses a significantly larger amount of power so it’s not effective to run the compressor in this mode while the batteries are not under charge, unless the fridge/freezer was designed to run at higher speed (more about this below)

The increased speed also generates more heat so it’s strongly recommended to only use this feature if your compressor is located in a well ventilated area.

The option ‘A’ (introduced in firmware version 4.2) changes the compressor to run at 3500 RPM independently of boost charging conditions. This option is for larger fridges/freezers that requires the system to run at a higher RPM.

An optional compressor room fan is recommended if using this feature (this fan can be controlled by the Fridge Optimizer’s compressor room fan feature)

Fahrenheit /Celsius

This setting determines what temperature measuring standard should be used by the Fridge Optimizer.

Switching from one to the other will change the system preference and reported temperature but will leave the settings unchanged. For instance, if the system is set up to turn on at 45 degrees (Fahrenheit) and the user changes to Celsius. The system will now be set to turn on at 45C.

It's recommended to step through all the settings after switching from F to C or C to F.

Compressor mod

The compressor model setting affects the displayed energy consumption estimates. The most common Secop/Danfoss model used is the BD35F and that's also the Fridge Optimizer's default option.

The option "Demo" is meant for demonstrating capabilities of the Fridge Optimizer. Changing to and from demo requires a restart (disconnect and re-connect power) to clear the fake statistics data from the system.

The way the Fridge Optimizer estimates power consumption is by measuring how long the system is run in different modes (Off, Standby, Defrost, Normal, Boost) and looking up the average power consumption for that mode of operation with the specified compressor model.

Low volt. cutoff

Modern Danfoss/Secop compressor controllers has a built in battery cut off feature that can be changed by connecting an external resistor between two of the controller's pins.

The Fridge Optimizer's advanced voltage monitor replaces this feature with a software controlled system that detects three different ranges of voltage:

- **Charging** is when the voltage is higher than the preset "Threshold (volt)". This is used by the boost features described in an earlier section of this manual.
- **Normal** is when the voltage is between the "Threshold (volt)" and the "Low volt. cutoff". When this level is detected the system will use the parameters set in "settings" without any overrides.
- **Low** is when the voltage is below the "Low volt. cutoff" level.
  When the system detects this level the compressor and advanced thermostat fan is turned off and the head unit shows the compressor status as "Off" (in red letters) and the battery status as "Low" (also in bold red letters).
  The effective level can be set to any value but the Danfoss/Secop compressor will not operate below 10.5V (the Fridge Optimizer's default cut off value) so setting a value below 10.5 is not recommended as it will make the Fridge Optimizer think it can control the compressor when it can't and will therefore present misleading power consumption and runtime information.

Factory Reset

Switching this value from 0 to 1 will trigger the system to ask if you're sure. Pressing the  (select) button at that time will reset all the settings to their default values.
It's recommended (but not required) to restart the system after a factory restore to ensure that all historical power usage data is restarted after the values have been changed.

More detailed installation instructions

Thermostat placement

It's recommended that the thermostat is placed within 10inch/25cm of the cold/holding plate. This ensures that the air from the fan can melt the frost from the cold/holding plate before ice forms.

If you have a "shoe box" type of evaporator, and you are not using it as a freezer, you can remove the lid and place the thermostat inside the gap so air is blowing directly into the box.

If the thermostat, for whatever reason, can't be placed close to the cold/holding plate due to a drip plate or other object is placed between the thermostat fan and the holding plate then it's recommended to increase the defrost period to a longer period (40-60min).

It's important that the fan is placed so that condensation isn't dripping into the fan motor or the thermostat sensor.

Make sure the air can also circulate inside the rest of the fridge, so avoid placing large bottles or packages just next to the fan.

We provide zip ties to tie to a shelf or other suitable bracket, but feel free to use what you have onboard to ensure a placement that doesn't create noise from vibrations when the fan is running.

Installing an additional 12 V fan to cool the compressor compartment

Any common 12V computer fan can be connected to the ambient fan output on the connector block. We recommend using a 250mA (2-3W) fan but up to a 500mA fan (or two 25mA fans connected in parallel) can be used.

12V fans can be used even if the system is powered with 24V.

The fan output voltage is set to 10.5V. The reason for this is that the fan will run quieter and use less power.

The fan output pins will be powered when the ambient room temperature is above the set value AND the compressor is running. The temperature is measured where the head unit is located.

The default value is 80F.

DC Only connector

Ambient fan blade connectors:

Postive (+) is the top connector and **negative** (-) is the lower connector

AC/DC connector

Cables

The Fridge Optimizer is delivered with cables to connect the thermostat and the head unit to the connector block. For many systems, the length is sufficient to connect all the pieces, but no boat is built the same. If you need longer cables, look for these characteristics of the cables:

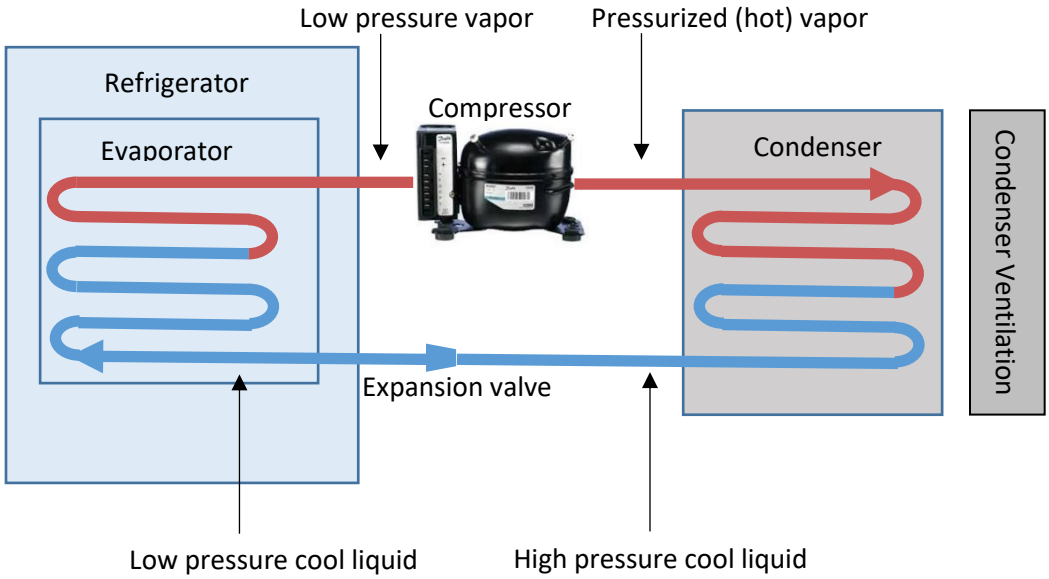
1. Head unit cable: This is a straight Ethernet cable. Not to be mixed up with a twisted cable that can be used between routers in a wifi network. You can substitute up to 40 ft of straight Ethernet cable of Cat 5 quality.
2. Thermostat cable: This is a 4-pole 3.5mm plug cable with gold plated ends. We sell a longer version of the this cable via Stainlesslobster.com. You may also be able to find a local replacement in audio stores or RadioShack. We recommend gold plated plugs as they resist oxidation better in a marine environment. You can also get a cable extension for the same type of cable to extend the cable you have. If you do, make sure the extension is outside of the fridge and in as dry environment as possible to further prevent oxidation issues.

We sell some cables on the website: http://stainlesslobster.com/product-category/accessories/.

You can also find them in stores across the world. Using standard cables was a specific choice we made as we have experience of being stuck in port in Mexico waiting for a specific Raymarine cable to arrive!

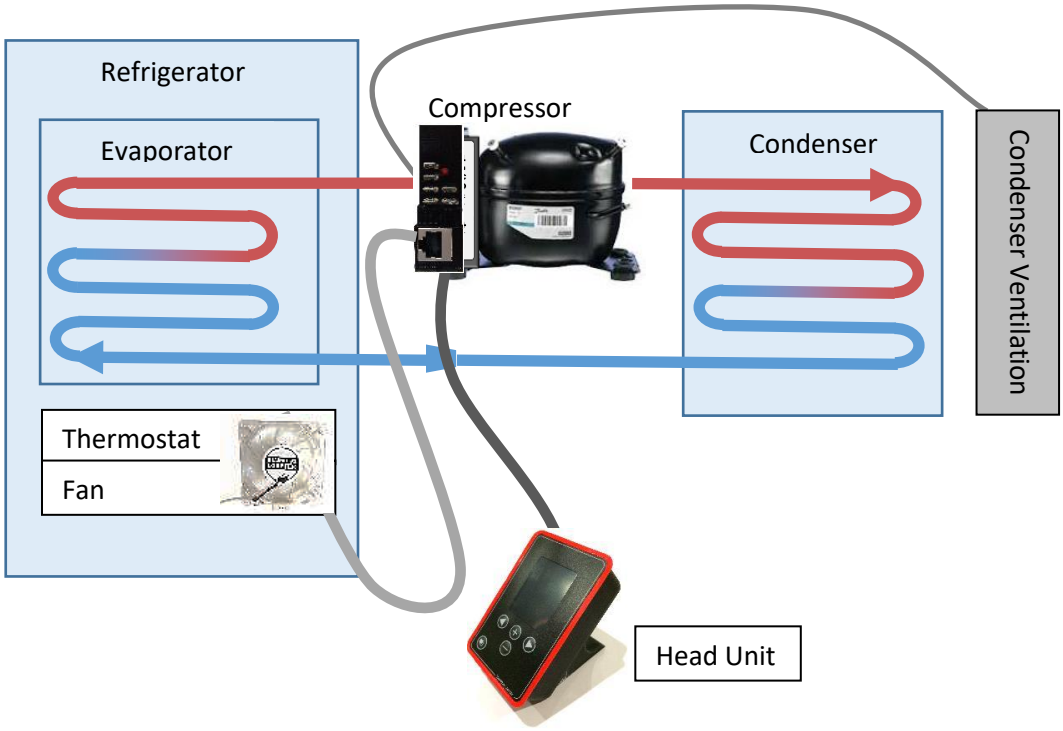
Refrigeration System Overview

An overview of how a refrigeration system works.



Evaporator	Aka “Cold Plate, aka “Holding Plate”. The cool refrigerant liquid absorbs heat from the air in the fridge, chilling the inside of the fridge. The liquid vaporizes. The evaporation can sometimes be heard inside the fridge.
Compressor	The vapor is compressed, bringing it to a higher temperature (this is part of why the compressor is warm).
Condenser	Allows the gas to cool and liquify, and to release its heat through ventilation fins that’s part of the condenser (looks like a small radiator). As the heat is removed the gas condenses to a liquid.
Expansion valve	The flow of the liquid is controlled and pressure is lowered so that some of the liquid turns into a vapor. This evaporation cools the remaining liquid.
Ventilation	Heat from the condenser is released through the ventilation in the condenser. It’s very important that there’s a source of fresh/cool air for the condenser fan and that the condenser isn’t blocked by dust (or pet hairs).

Fridge Optimizer components



Troubleshooting

The fan LED doesn't turn on and the fan is not turning

- This means the power is not getting to the fan. It may be perfectly fine, or a connector issue. The fan/LEDs should only be on if the fan should be running.
    - When the compressor is running
    - When defrost mode is on

  Otherwise it should be off.

- If you chose the defrost interval to be 999, as suggested for freezers in the Settings section, the fan will not run even if the compressor is on. This is normal. Change it to anything other than 999. When the compressor starts a new cycle (turns on again) the fan will light up.

- If it is not lighting up when it should, it is time to troubleshoot.
    - First **turn off the power** to the fridge and check all the connections. Are the plugs all the way in on both the fan and the connector block? Do you have oxidation on the plugs, or in the connection if you added an extension cable?
    - It is IMPORTANT to not jiggle the cable with power on, to avoid damaging the thermostat.
    - Once you have checked all the cables, turn the power back on and wait for the compressor to turn on.

- If it still is not lighting up, contact us.

The display screen doesn't turn on

- When you turn on the power to the fridge, the head unit can take up to 15 seconds to start up and turn on the screen. This is normal as it is going through its startup sequence. Be patient.
- If it doesn't turn on after 15 seconds, check that the Ethernet cable is pushed all the way in to the ports on both sides. It should say 'click'.
- Also check if the battery + and – connectors on the connector block has power.

The Fridge Optimizer says the compressor is running but it isn't

- This can happen if the connector block is not seated properly on the fridge controller so the signals from the head unit is not reaching the compressor.
- It can also happen if the compressor is manually configured to cut off when voltage drops below 10.5 V (possible with newer Danfoss controller), and the corresponding setting in the Fridge Optimizer is not set. This functionality was added in software version 4.1.0.0. Look for an update at: http://stainlesslobster.com/downloads/. See the section on "Settings" to learn more.

The compressor is running almost all the time

- Isn't it nice that you finally get a visualization of this so you know why your batteries are getting drained all the time?
- A compressor is running if the temperature in the fridge is not at the set minimum temperature level. This can have a lot of different causes.
- Note: it is normal that the compressor runs more than usual if you have added a lot of new room temperature groceries. Give it 24 h to stabilize. Also try to use cold packs and cooling bags when you transport food from the store.
- Here are a few common environmental issues we have seen:
    - The compressor condenser and fan is blocked by dust and grime built up over the years. It doesn't cool the compressor as it should, so it has a hard time getting rid of the excess heat and therefore circulates coolant that is warmer than it should be.
    - The insulation is poor. If the box is not properly insulated the cool air will heat up faster due to leaks and radiation through the lid/walls. Check using your hands or a spot thermometer (ex: a remote grill thermometer). If you have access to a heat camera, it is very useful.
      Fridge manufacturers recommend a minimum of 4" of dense insulation in all directions. This is not always achievable, so you have to trade off run time and box size.
    - The compressor is too small for the box. When you are converting an ice box to a refrigerator, follow the manufacturer's guidance on which compressor to choose for the volume of the box.
    - Somebody (I'm not going to call out any names!) likes to stand with the door open while contemplating what food to get. On a front door system, this will drain the cool air quickly and the compressor needs to run more.
    - The cold plate has frosted up and is acting as an insulation layer instead of spreading the cool inside the fridge. When you install the Fridge Optimizer, start by defrosting the cold

plate. The system will then maintain the no-frost state, but it will not automatically defrost months' worth of built up frost. This is the last time you will do it, so take pictures for your memory album!
Check the section about "Defrost settings" on how to tune it initially to work for your system.

- You may also be able to affect runtime by properly configuring the temperature range
  - Make sure the compressor can reach the lower value. Monitor the system so you see that it turns off after it has reached the minimum value. Adjust this upwards if needed. If the minimum value the compressor can reach is higher than you desire for food quality, check if you can improve the environment (see above).
  - Set the upper region to about 5F higher than minimum, to allow the compressor to rest. You can tune this setting too by using the data page for temperature. Experiment to see if one degree warmer isn't impacting the food temperature, but lets the fridge sit idle for longer without causing the compressor to run too long. See the section for "Temperature details page" for more tips.

The temperature continues to rise after the maximum value is reached

- This is normal. The compressor will turn on, but depending on the volume of air in the fridge it may take a little while to start to affect the average temperature that is circulating.

The Fridge Optimizer shows a lower voltage than my other power meter

- Power meters such as Xantrex LinkPRO and other great brands are connected directly at the battery for a very exact reading. The Fridge Optimizer is connected at the refrigerator, and the length and size of the cables play a part in what value will be displayed. Thicker and shorter cables reduce the impact.
  It is also impacted by the power draw of the fridge, which spikes when the compressor is starting up. This is normal, and a fluctuation of 1 V during operation can be expected.
- We suggest using the power value for relative measurements. Look at the value on the display when you know batteries are charging, and set the charging threshold accordingly.

Water is accumulating at the bottom of the fridge

- This is normal. The frost on the cold plate will turn liquid during the defrost phase, and will drip downwards.
- We recommend placing a sponge underneath and squeeze it over the sink at regular intervals. This avoid the water to spread under other food that is standing at the bottom.
- If you have a drain, you can open it to drain it at regular intervals.
- Depending on the installation, you may also be able to place a bucket or a cup in a strategic place. Just note that it may tip over if you have rough seas, which is why we're a fan of the sponge method.