
Integrel
solutions
USER GUIDE

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INTRODUCTION

Using an Integrel system is an easy and carefree way of generating, distributing and using power on board any yacht or recreational boat. The system operates autonomously with minimal user input.

Integrel produces power without the need for an additional genset. It operates seamlessly, quietly and efficiently, producing a massive amount of useable power to make living onboard and off-grid as comfortable as living at home, albeit with much better views!

STEP ABOARD AND GO

When you step aboard, ensure the Integrel System and 48V battery banks are turned on.

Use your vessel as normal and check the battery state from time to time. If you notice the batteries are low, or if a battery low warning sounds, charge the batteries using one of the following methods.

- Run your engine(s), either in-gear or out-of-gear
- Connect a shore power supply
- Turn on your solar power or wind generator

Finally, if the Integrel System goes to sleep to save power, simply tap the screen to wake it up.

THE INTEGREL SCREEN

The Integrel screen provides a convenient way to view the state of the electrical power on your boat. It shows information about the main storage batteries, as well as other battery systems that are connected to the Integrel System including house banks and engine start batteries (if configured).

Various pages indicate how much power the Integrel generator is producing, together with engine speed, energy usage by other systems as well as energy cycled into and out of the batteries. This information can be used to understand how much you are using the battery banks.

In addition, the screen advises when it is time to recharge your main batteries by sounding an alarm and showing a warning icon. When the warning appears, connect to shore power or start your main engine(s) to charge the batteries.

MENU SYSTEM

The Integrel user interface is designed to be simple and easy to understand. Menu buttons are available to the right of the screen to provide access to each page of information. The menu button associated with a page is greyed out when the page corresponding to the button is displayed. Each menu button, together with a description of the corresponding page is shown below.

Generator Status and Information

Battery Status and Information

Engine Status and Information

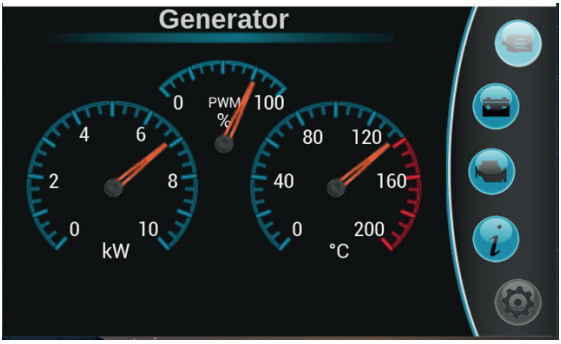
System Summary

System Settings

GENERATOR STATUS

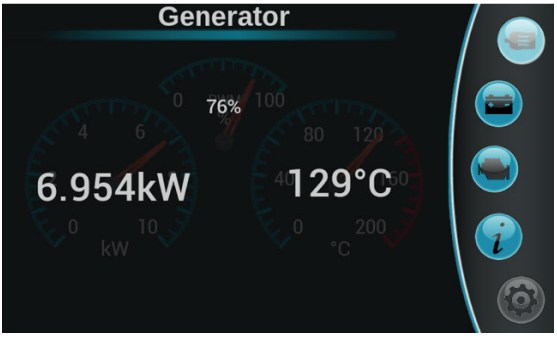
Pressing the Generator button displays the Generator Status and Information page. This page shows:

- Power output in kilowatts (kW)
- Generator temperature in degrees Celsius
- Generator load.



Tap the centre of the screen to show a digital version of the same information; tap again to return to the analogue display.

For a dual system, touch the arrows at the bottom of the screen to jump between each Integrel generator information page.

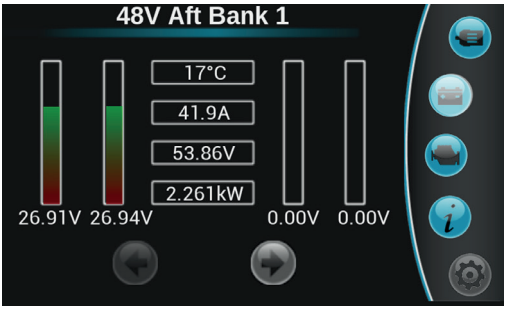


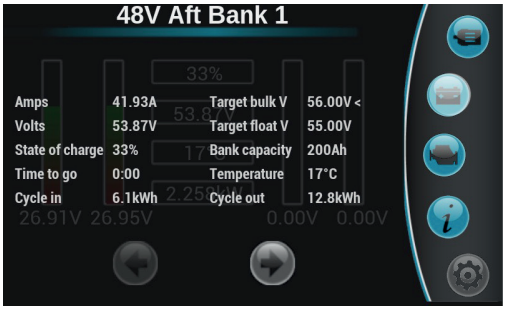
BATTERY STATUS

The Battery Status page provides information about each of the battery banks in the system. A separate page is available for each Integrel battery bank sensor installed. Depending on your battery configuration, the Battery Status page shows:

- Overall battery bank temperature
- Total bank voltage and individual battery voltage
- Instantaneous current flowing into/out of the battery bank
- Instantaneous power flowing into/out of the battery bank

The arrows at the bottom of the page allow you to scroll between each of the installed battery banks monitored with an Integrel battery bank sensor, including 48V / 24V / 12V banks.





Tap the center of the screen to see a text version of the page showing additional information.

Amps is the instantaneous current flowing into/out of the bank; a negative number means current is flowing out of the bank.

Volts is the battery bank voltage.

Time to go is the time remaining until the battery bank is empty or charged; see the *System Summary* page for more information.

Cycle in / Cycle out is the amount of energy the battery bank has received (Cycle in) or provided (Cycle out).

Target Bulk / Target Float is the target bulk voltage and target float voltage, see *How Does Integrel Work?*

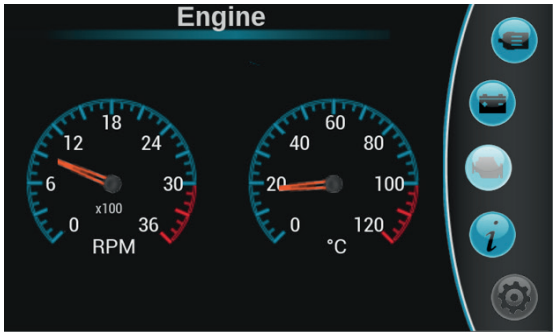
Bank Capacity is the battery bank capacity in Amp hours (Ah).
Temperature is the temperature of the battery bank.

ENGINE STATUS

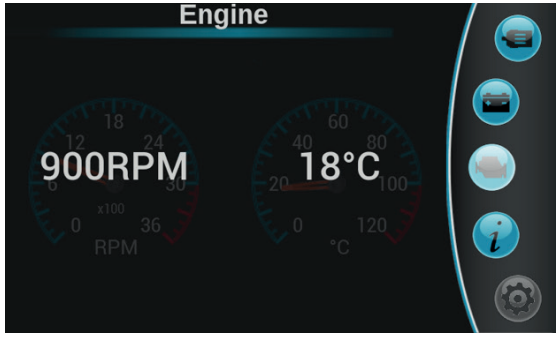
The Engine Status page shows the speed of the engine in RPM (revolutions per minute) and the temperature of the engine.

On modern, electronically controlled engines, RPM is read directly from the engine electronics. On older engines, RPM is estimated using electronics connected to the Integrel generator.

Engine temperature is measured using a temperature sensor installed on the engine.



Tap the centre of the screen to show a digital version of the same information; tap again to return to the analogue display.



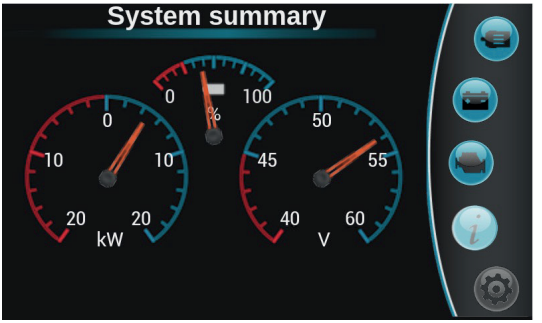
SYSTEM SUMMARY

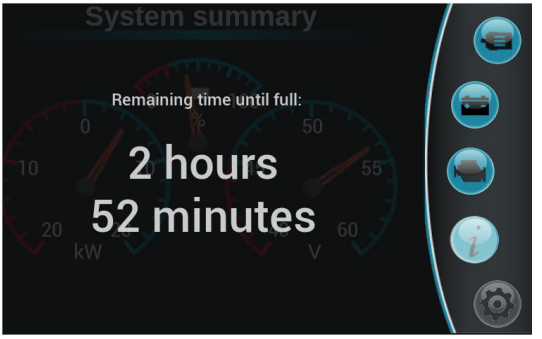
When the system powers up, the System Summary page is displayed by default, however the System Summary page can be accessed at any time by pressing the 'Info' menu button.

The System Summary page shows:

- Power being produced (or used) in kW
- Voltage of the 48V battery banks.
- Estimate of battery State of Charge

Tap the screen to show 'Remaining time until full', which is an estimate of how long the batteries will take to reach 'full charge' if charging, or to reach the 'disconnect voltage' if discharging. The estimate is calculated based on the level of power flowing into or out of the battery banks; tap again to return to the analogue display.





SETTINGS

Press the Cog menu item to open the Settings page. When the Settings page is displayed, the menu items are hidden to provide additional space to show settings. To return to the main menu, press the 'Back' button in the top right-hand corner of the page.

The information on the Settings page varies to match the hardware installed on your boat.

Generator. Turns the Generator ON or OFF

Time to Sleep. Activity timeout until the screen sleeps

Brightness. Adjusts the screen brightness

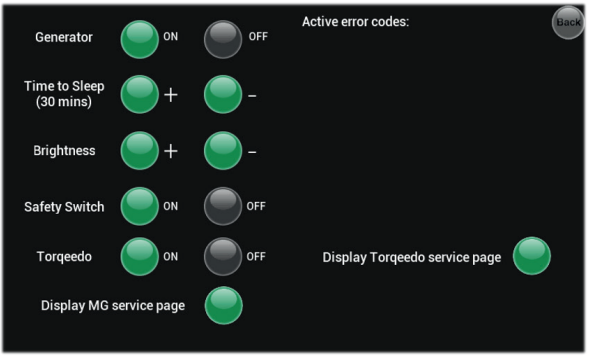
Safety Switch (& 24V Safety Switch). Controls the Integrel Smart Switch

- ON = Switch Closed (batteries connected)
- OFF = Switch Open (batteries disconnected)

Display MG service page. Displays information from the MG Battery Management System

Display Torqeedo Service page. Displays information about Torqeedo batteries.

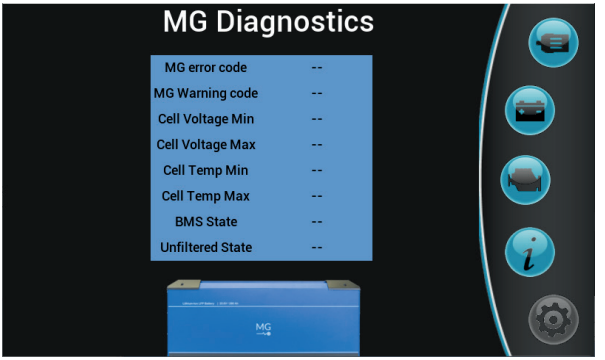
Torqeedo: Switches Torqeedo batteries ON or OFF



MG ENERGY SERVICE PAGE

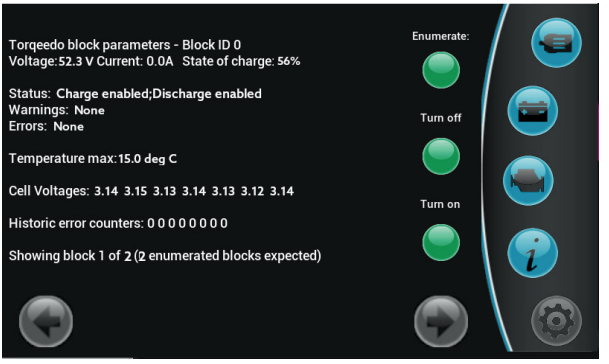
The MG Diagnostics page displays diagnostic information about MG Batteries (if installed). This information is read directly from the MG Battery Management System (BMS) via the NMEA2K bus.

- MG Error & Warning Codes. If an error or warning is reported by the MG BMS, you can provide the error information to Integrel Support to assist with diagnosing the issue
- Cell Voltage minimum (2.6V) and maximum (3.6V)
- Cell temperature minimum (0 °C) and maximum (43 °C)
- The current state of the Battery Management System
- Unfiltered state is the battery State of Charge reported by the MG Battery Management System.



TORQEEDO SERVICE PAGE

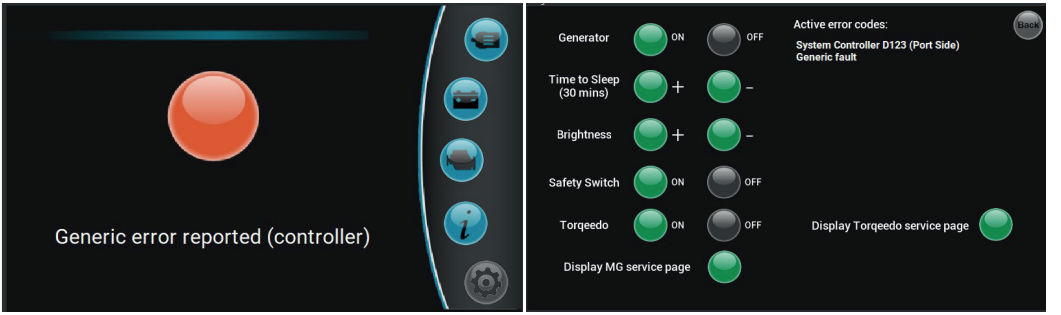
The Torqeedo service page shows information about individual Torqeedo batteries. *Note that Integrel no longer offers support for new installations with Torqeedo batteries*.



ALERTS & WARNINGS

If an alert or warning occurs, the screen changes to show a large dot with a description of the alert. Alerts are colour-coded (red, amber, green) depending on the severity. The alert can be dismissed by selecting any menu item, however a dot remains in the top left hand corner of the System Summary page until the alert has been rectified.

The alert can be viewed at any time by pressing the dot on the System Summary page, or by looking at the Active Error Codes section of the Settings page.



Battery Low Warning

If the battery voltage level drops below the ‘disconnect voltage’, a battery low warning shows and an alert sounds.

NOTE

For additional troubleshooting information, see the Installation Guide.

CHARGING THE BATTERIES

The Integrel system charges the main 48V bank of storage batteries whenever the propulsion engine(s) are running, charging occurs automatically. Assuming 48-12V DC-DC converter(s) were installed with your system, the main battery bank also charges other batteries connected to the system such as 12V house batteries, again completely automatically.

The only time you need to take any action is if the system notifies you that the storage batteries are running low, at which time the engine needs to be started, or another source of power must be supplied (such as shore power, solar or wind).

CHARGING AT ANCHOR

After being at anchor for 1-2 days, the charge in your batteries may start to get low, the Integrel screen shows a battery low warning and sounds an alert. Simply start your engine(s) to charge the batteries.

If you do not plan to leave anchor, leave the engine(s) in neutral and adjust the revs to a fast idle between 1200 - 1400 RPM. This engine speed typically generates between 6.0 - 7.5 kW of power. Dual systems generate twice this amount of power assuming that both engines are run simultaneously.

Charging Time

A 10 kWh Lithium battery bank charges from below 20% to above 90% in about an hour from a single Integrel system.

A 30 kWh Lithium battery bank charges from below 20% to above 90% in about two and a half hours from a dual Integrel system.

Quite apart from a large rate of charge (up to 18kW), a dual system has the advantage of redundancy in case of a single engine failure or a system fault.

CHARGING WHILE MOTORING

When you are ready to move to the next anchorage, motoring for around two hours will typically charge the battery bank to above 80% depending on the size of your battery bank.

Lithium Battery Life

To extend the life of Lithium-based batteries, Integrel recommends avoiding fully-charging the batteries to 100% on every charge-cycle.

If you need to run the engine(s) to charge the batteries with the propeller disengaged, we recommend charging the batteries until the combined power being produced by the Integrel system drops to around 1-2 kW, at this point the battery State of Charge is typically above 80%. Fuel usage is less efficient at this point because the system is unable to fully utilize the power being produced by the engine.

Lead Acid Batteries

Integrel does not recommend allowing the state of charge of lead acid batteries to drop below 30%. Additionally, lead acid batteries do not like being left in a partial state of charge for an extended period of time. Integrel recommends lead acid batteries are fully recharged to 100% at least once each week to maintain full capacity.

HOW DOES INTEGREL WORK?

THEORY OF OPERATION

Your Integrel System operates automatically and needs minimal input, however it is useful to understand what to expect from the system so you can run it as efficiently as possible. The system operates in a carefully controlled manner and is constantly monitoring sensors, voltages, current and engine state to produce efficient power generation suited to the conditions. The following text provides a brief description of how the Integrel system operates.

Power Control with PWM

Pulse Width Modulation (PWM) is the function that controls power (in kW) to charge the batteries. Typically, as the engine speed (measured in RPM) increases, the PWM percentage increases; although PWM also depends on various other factors including temperature, battery charge state, in-gear transitions and rapid changes to engine speed.

Power Generation vs. Engine Speed

As the engine speed (in RPM) increases, the amount of charging power also increases. Under ideal conditions (low battery state of charge and cool temperatures) charging power peaks around 9 kW. At peak power output, the Integrel Generator starts to get hot.

Power Generation vs. Temperature

When the maximum generator temperature is reached, the system reduces charging power to reduce the amount of heat produced. When the generator cools down, the charging power increases again. This cycle repeats until the batteries are fully charged. However, if your engine bay is well ventilated, the generator may never reach the maximum configured temperature and the system may operate continuously at peak charging power.

Understanding Battery Charge

The graph on the facing page provides an example of the measured battery voltage (V) vs. charging power (kW) by the system over time. While the batteries have a State of Charge (SoC[1]) less than ~90%, the system attempts to produce the maximum power possible.

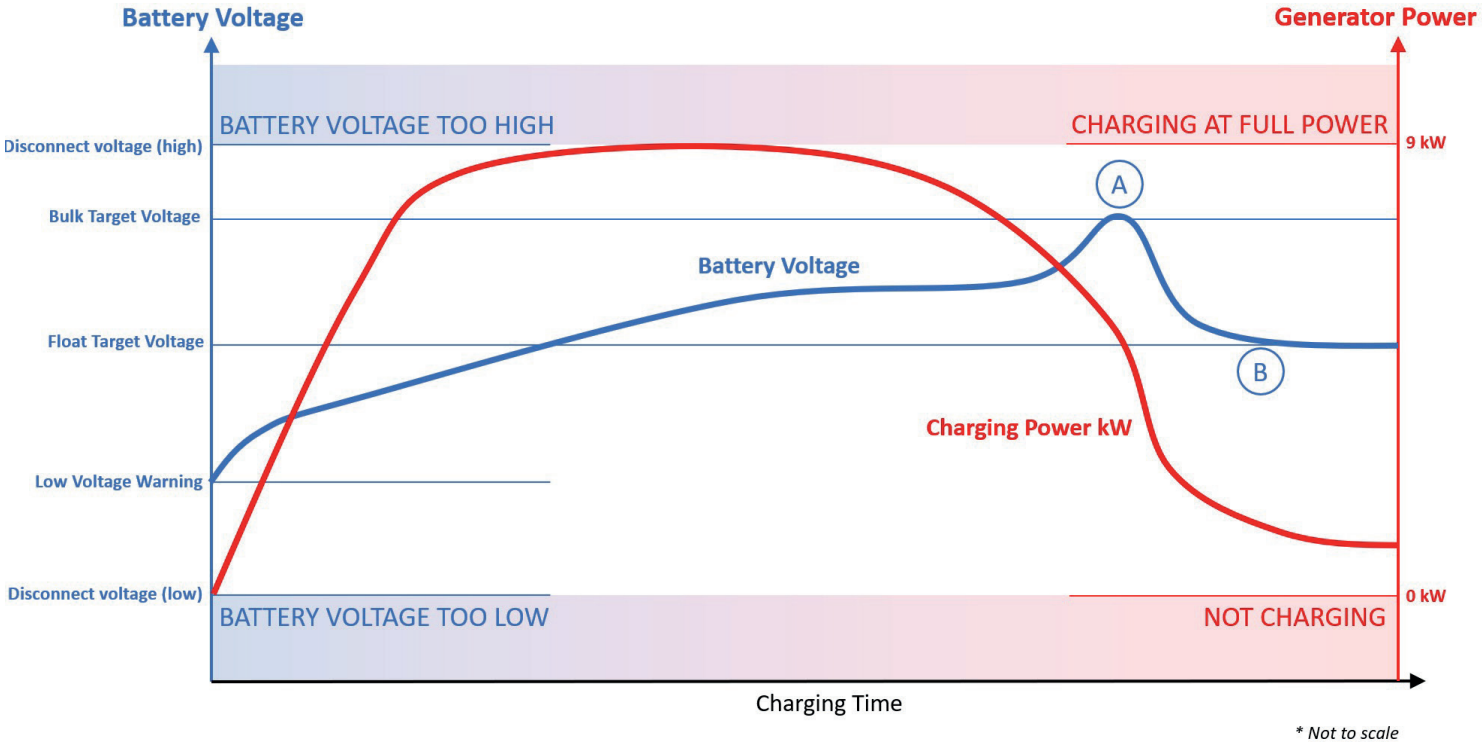
As the batteries reach or exceed 90%[2] charge, the system reduces power generation until the battery bank voltage reaches the Bulk Target (A). Once the Bulk Target is reached, the battery is considered 'full' and the system drops back to the float level (B) and only produces a small amount of charging power to maintain the float voltage.

Warnings and Cut-offs

As power is used from the batteries, the battery voltage begins to drop. It is CRITICAL that the terminal voltage of lithium-based batteries does not drop below the specified minimum voltage and does not exceed the specified maximum voltage. To prevent this occurrence, the Integrel system includes a Smart Switch[3] as a safeguard to protect the batteries.

If the battery voltage drops too low, a warning is shown on the Integrel display and an alert sounds. The alert indicates that the batteries need to be charged. If the warning is missed or ignored, the voltage continues to drop until it reaches the low disconnection voltage. When this occurs, the Smart Switch disconnects the batteries from any charging devices or loads to safeguard against potential battery damage.

1. State of Charge is an estimation only and is used to monitor how much the battery has been charged or depleted.
2. Typically <90%. Depending on the brand of battery, the charge may drop before or after 90%.
3. Some systems may use other protection devices. An Integrel System may not always be installed with a smart switch


Battery Voltage
Generator Power
BATTERY VOLTAGE TOO HIGH
CHARGING AT FULL POWER
9 kW
Disconnect voltage (high)
Bulk Target Voltage
A
Battery Voltage
Float Target Voltage
B
Charging Power kW
Low Voltage Warning
Disconnect voltage (low)
0 kW
BATTERY VOLTAGE TOO LOW
NOT CHARGING
Charging Time
* Not to scale

PRIORITIZING PROPULSION

The Integrel Generator is limited to a maximum 9kW electrical power output, and typically produces a continuous 7-8kW at cruising speed provided the engine space is well-ventilated. This substantial amount of power must be carefully managed to ensure the engine is correctly loaded and that propulsion is always prioritized.

The Integrel Controller handles all of the load management automatically. As the controller adjusts the amount of power the generator takes from the engine, you may notice a slight change in the sound of the engine. The generator load makes no difference to the boat speed on a modern engine with electronic governing. On older engines with a mechanical governor, the engine revs may drop slightly.

The generator is shut down completely under the following circumstances:

- When the engine is below minimum operating temperature
- When a gear shift is detected
- When the boat is maneuvering
- If there is a rapid change in engine speed (RPM)
- At approximately 75% of wide open throttle and above

This behavior ensures that when maneuvering, or in circumstances where you need propulsion quickly, the entire engine power is available to drive the propeller.

When the system senses the engine is in a steady state, or the engine speed is changing slowly, it gradually ramps the electrical load.

The Integrel Controller never allows the electrical load to push the total engine load (propulsion and generation) above 75% of the total available power. This operation is handled automatically.

Where you need propulsion quickly, all the engine's power is available to turn the propeller.

This operation is all handled automatically and you do not need to do anything at all.

MAINTENANCE

Unlike a standalone generator, Integrel requires virtually no maintenance and the only spare part required is a drive belt. We recommend the belt is changed at every main engine service, typically every 500 hours of operation. The generator itself is a heavy duty alternator and is designed to operate for many thousands of hours without service.

The primary battery bank, whether Lithium-Ion or Lead acid batteries, are sealed units requiring no maintenance other than ensuring they are charged and powered off for storage during extended idle periods.

Under normal usage conditions, the Integrel system must remain ON to enable it to monitor all energy cycled into and out of the batteries by various charging sources and appliance loads.

PREPARING FOR STORAGE

It is CRITICAL that your batteries are placed into 'storage mode' if you do not plan to use your vessel for an extended period of time e.g. wintering the boat. When in storage mode, any device that may draw power MUST BE DISCONNECTED from the battery bank.

The following points provide a guide to managing batteries during storage, however Integrel strongly recommends that you carefully read the battery manufacturer's documentation regarding storage of your batteries during idle periods.

GUIDE FOR BATTERY STORAGE

1. Ensure the batteries are charged to at least 60% of full capacity
2. Ensure the Integrel System is switched OFF
3. Ensure the batteries are switched OFF
4. Ensure that any BMS connected to the batteries is turned off and/or disconnected
5. Set the negative disconnect to OFF at the batteries (if installed)
6. Turn the Integrel Smart Switch 90 degrees clockwise to avoid it accidentally being bumped ON

Failing to follow these instructions may result in fully discharging your batteries, and may result in **PERMANENT DAMAGE TO YOUR BATTERIES**. The Integrel Warranty statement does NOT cover replacement of batteries damaged in this manner.

If in doubt, consult a Marine Electrician or open a ticket with our support desk at https://integrelsolutions.com/support/

RETURN AFTER STORAGE

After a long period of storage, it is important to reverse the storage procedure in order to correctly start the system.

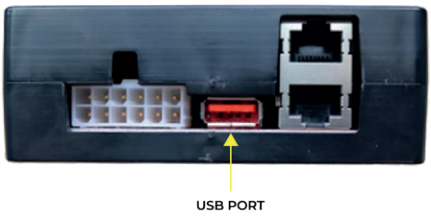
Prior to switching the system on, carefully check the voltage of each battery with a voltmeter or multimeter. Ensure the voltage of each battery in the system is greater than the minimum voltage recommended by the battery manufacturer.

If one or more batteries are below the minimum recommended voltage, do NOT turn the system on. Contact a marine electrician for advice before proceeding.

SOFTWARE UPDATE

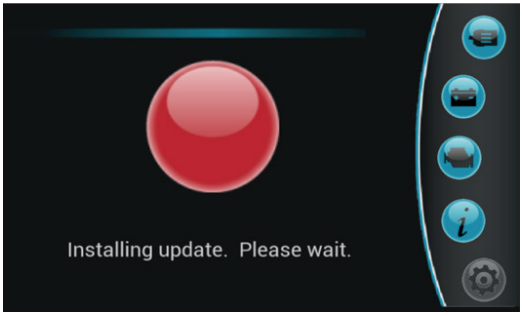
The Integrel Solutions engineering and support teams are constantly working to improve our products. We intermittently offer software updates to customers as and when required to improve system operation and provide new features such as integration with the latest battery brands.

If you have any questions or issues related to software, open a support case at https://integrelsolutions.com/support/

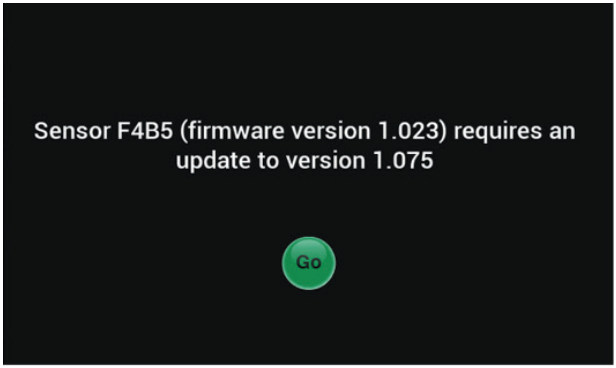


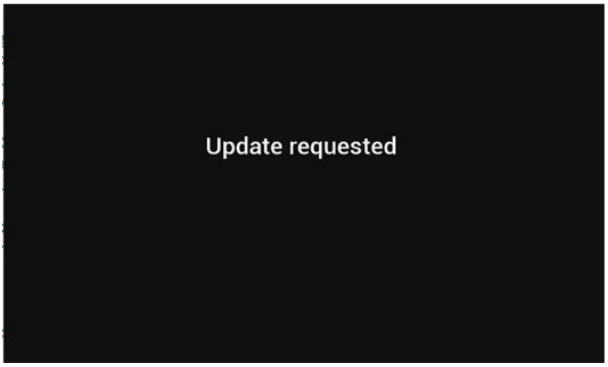
The following steps provide a guide to updating your Integrel system.

1. Ensure your engine(s) are **OFF**
2. Turn the Integrel System **ON**
3. Copy the Integrel software update to a formatted USB stick. Ensure the software filename is **factory_erase.recovery**
4. Locate the USB port on the Integrel Screen Interface box (shown above)
5. Insert the USB stick (containing the updated Integrel software) into the USB port
6. Wait for the System to read the software update from the USB stick; this may take a couple of minutes. Once the initial update begins, the screen shows a big red dot with the message 'Installing Update'.



7. After the initial screen update completes, other devices in the system may each need to be updated in turn. In this case, a page similar to the following shows requesting update of each component together with the network ID of the component.





8. Press the 'Go' button on the screen to continue the update
9. An 'Update requested' message appears as a confirmation.
10. After all system components are updated, the update completes and the USB stick can be removed.
11. The system is now up to date with the latest software.

SUPPORT

Integrel provides premium customer service and support. If you need help with your Integrel System, we are ready and waiting to help.

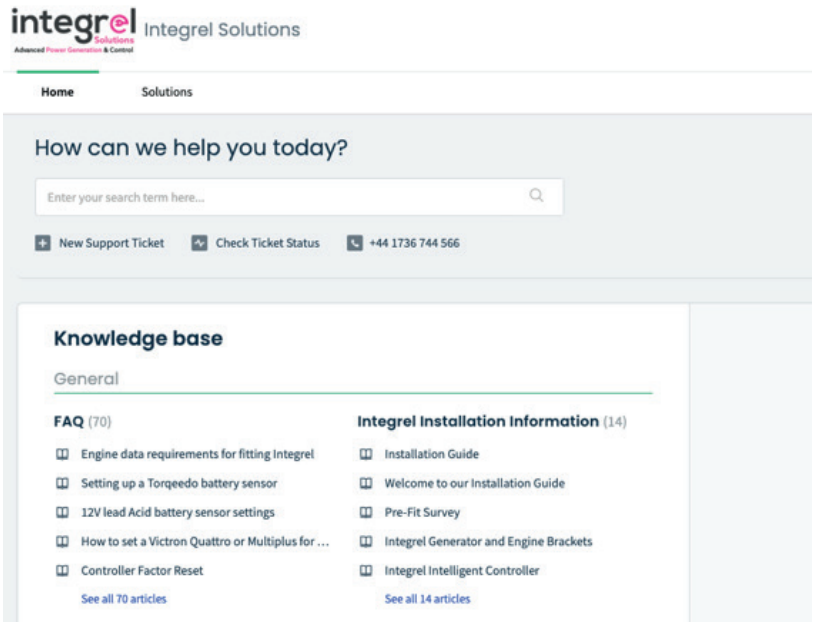
General support is available by either of the following methods:

Open a support ticket at https://integrelsolutions.com/support/

Send an email to support@integrelsolutions.com

For urgent help, please call our support number shown below. Phone support is generally limited to business hours in the United Kingdom.

Technical Support - +44 78 6529 3937



FAQS AND INSTALLATION TIPS

Our support portal also features lots of frequently asked questions and installation information articles.
Check out our Youtube channel too for how-to videos.

WARRANTY

Integrel Solutions Warranty Policy – September 2, 2020

Integrel Solutions warrants its products to be free from defects in workmanship and materials for a period of 2 years from the date of purchase by the end-user, with a maximum of 36 months from the Integrel Solutions Limited invoice date.

Integrel Product Warranty Statement

Triskel Marine trading as Integrel Solutions, have comprehensive Product Liability cover for our Integrel System. In the event of any warranty-covered issue with an engine where Integrel has been fitted Triskel Marine will cover the repair or replacement of dam- aged parts in line with your existing engine warranty. This cover is not in addition to any engine warranty but supplements where a warranty is void because of the fitting of Integrel. It has identical terms and conditions as the manufacturer's warranty and the cover is like-for-like including the requirements around servicing, length of warranty and identifies how Triskel Marine, in lieu of the engine manufacturer, will deal with an issue. In the highly unlikely event of any warranty issue arising you will need to contact Integrel Solutions who will take lead responsibility on dealing with a claim. Triskel will manage any claim directly and will liaise directly with the client to ensure a single point of contact to minimise any delays. The full policy schedule for the Product Liability cover is available upon request.

Integrel Solutions Limited Warranty Policy

Exceptions to this are:

Warranty for 3rd party products such as Power Electronics and Batteries are the responsibility of the manufacturer. The owner is responsible for registering these products and for contacting the manufacturer in case of a warranty claim. The manufacturer is solely responsible for the repair or replacement of the faulty product unless the damage is proven to be a direct result of a fault in the Integrel System, as diagnosed by an authorised representative of the manufacturer and Integrel Solutions.

Lithium-ion batteries supplied by Integrel Solutions; These are subject to the manufacturer's warranty or 3 years from date of purchase by the end-user. In addition to this proof of correct battery, usage is required when making a battery warranty claim. During this period, the manufacturer will, at its option, repair or replace the defective product free of charge. The warranty does not include performing or reimbursing de-installation, transportation and re-installation.

Warranty Exclusions

This warranty will be considered void if the unit has suffered any physical damage or alteration, either internally or externally, and does not cover damages arising from improper use or incorrect user installation, or unauthorised modifications to an installation like:

- Reverse of battery polarity.
- Inadequate connection.
- Mechanical shock or deformation.
- Contact with liquid or oxidation by condensation.
- Use in an inappropriate environment that includes, but not limited to, dust, corrosive vapour, humidity, high temperature, biological infestation.
- Breakage or damage due to lightning.
- Connection terminals and screws destroyed or damaged due to insufficient tightening.
- For any electrical breakage except due to lightning (reverse polarity, over-voltage due to external cause), the state of the internal control diode and of the inputs/output X and Y capacitors determine the warranty.
- This warranty will not apply where the product has been misused, neglected, improperly installed, or repaired by anyone other than Integrel Solutions Engineers or one of its authorized Certified Installers. In order to qualify for the warranty, the product must not be disassembled or modified.

Warranty Remedies

Repair or replacement are our sole remedies and Integrel Solutions shall not be liable for damages, whether direct, incidental, special, or consequential, even caused by negligence or fault. Integrel Solutions owns all parts removed from repaired products. Integrel Solutions uses new or reconditioned parts made by various manufacturers in performing warranty repairs and building replacement products. If Integrel Solutions repairs or replaces a part of a product, its warranty term is not extended. In the case of replacement, the new component has a warranty of 6 months, without effect on the initial warranty period. All remedies and the measure for damages are limited to the above. Integrel Solutions shall in no event be liable for consequential, incidental, contin- gent or special damages, even if having been advised of the probability of such damages. Any and all other warranties expressed or implied arising by law, course of dealing, course of performance, usage of trade or otherwise, including but not limited to implied warranties of merchantability and fitness for a particular purpose, are limited in duration to a period of two (2) years from the date of purchase.

Severability

If a part of the terms and conditions set out above is held invalid, void or unenforceable due to any particular national or international legislation, it shall not affect other parts of the terms and conditions remaining.

Consumer Law

The relevant consumer law for the country the goods are sold in will apply. You are also entitled to have the goods repaired or replaced if the goods fail to be of acceptable quality and the failure does not amount to a major failure.

EXCLUSION OF LIABILITY

TO THE FULLEST EXTENT PERMITTED BY APPLICABLE LAWS, WE ON BEHALF OF OUR DIRECTORS, OFFICERS, EMPLOYEES, AGENTS, SUPPLIERS, LICENSOR AND SERVICE PROVIDERS EXCLUDE AND DISCLAIM LIABILITY FOR ANY LOSSES AND EXPENSES OF WHATEVER NATURE AND HOWSOEVER ARISING INCLUDING, WITHOUT LIMITATION, ANY DIRECT, INDIRECT, GENERAL, SPECIAL, PUNITIVE, INCIDENTAL OR CONSEQUENTIAL DAMAGES; LOSS OF USE; LOSS OF DATA; LOSS OF INCOME; LOSS OF PROFIT OR LOSSES OF ANY KIND OR CHARACTER, EVEN IF WE HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES OR LOSSES, ARISING OUT OF/OR IN CONNECTION WITH OUR PRODUCTS OR 3RD PARTY PRODUCTS SOLD BY US.

THIRD PARTY WARRANTIES

We partner with selected brands and have tried and tested their products to ensure they work with our system.

Each partner provide their own warranty that can be found on the web at the following links.

Victron Energy

https://www.victronenergy.com

MG Energy Systems

https://www.mgenergysystems.eu

Mastervolt

https://www.mastervolt.com

CONTACTING INTEGREL

If you have any questions regarding this warranty statement, please send them in writing to **sales@integrelsolutions.com**

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