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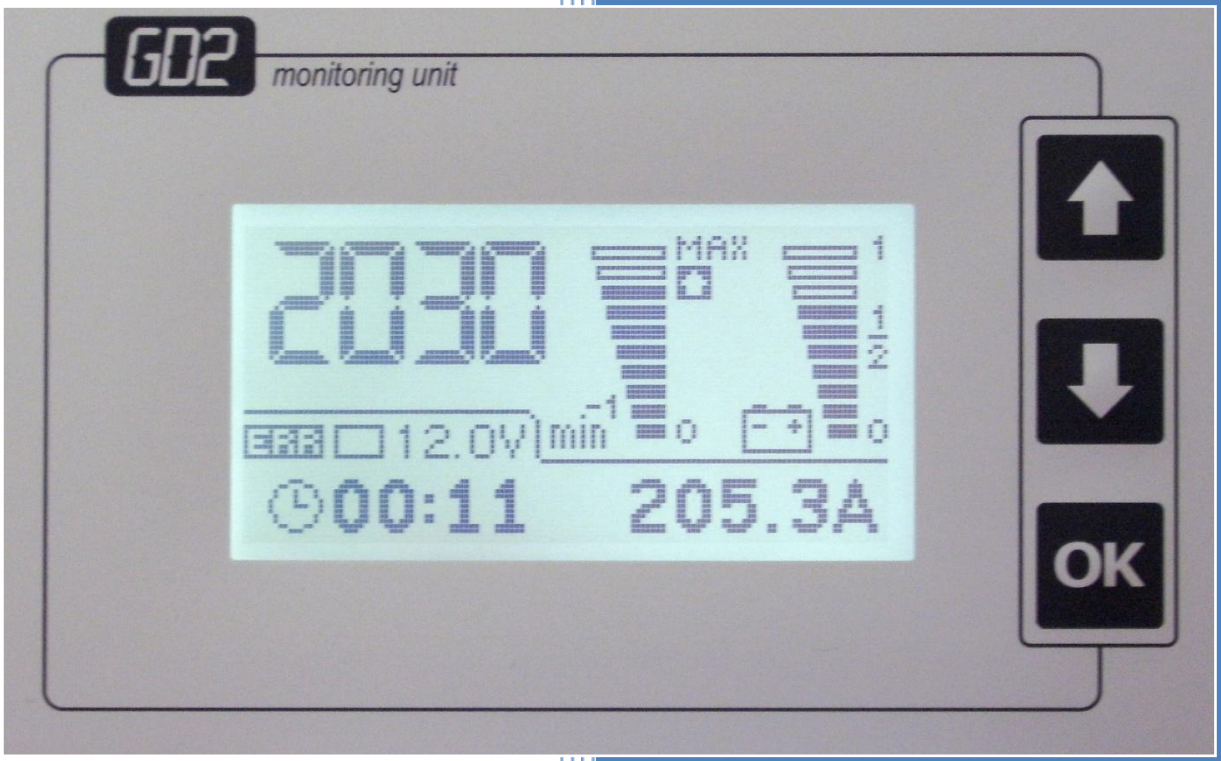
GD2/HV2 Short Guide



Display, control and battery monitoring unit

Issue: 2(2)

General Information

The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation or adjustment of the optional operating parameters of the equipment or from mismatching the variable speed drive with the motor.

The contents of this guide are believed to be correct at the time of printing. In the interests of a commitment to the policy of continuous development and improvement, the manufacturer reserves the right to change the specification of the product or its performance, or the contents of the guide, without notice.

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Display and drive software version

This product is supplied with the latest version of software. If this product is to be used in a new or existing system with other drives, there may be some differences between their software and the software in this product. These differences may cause this product to function differently.

The software version of the display can be checked by looking at the user menu by pressing [OK] button while turning on the display. SAC drive software version can be checked by connecting the drive to the PC and using SACTERM software. Please consult your SAC documentation for more information.

If there is any doubt, contact your dealer.

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Display software: 2.1.5 onwards
SAC software: 1.39 onwards

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Introduction

GD2 is a display, control and battery monitoring unit. It is intended to be used in electrically propelled vehicles and boats as an add-on to one of Piktronik's CAN enabled AC motor controllers.

It serves as a graphical user interface between the user and the controller. User can set the speed or torque of the motor and see the current speed as well as a range of other quantities such as battery voltage, battery current, motor current, remaining time of driving at the current consumption etc. At the same time GD2 unit observes the state of charge of the battery, that is, how much charge there is left, how much was charged and how much discharged. It detects when the battery is being charged, sounds an alarm when the battery is low etc. GD2 is linked to one of Piktronik's motor controllers over the CAN bus. In addition of sending reference for motor RPM or torque to the controller, it also receives various data from CAN enabled controller. This data is then displayed on screen. GD2 also has extensive built-in safety systems that inform the user of an error in the form of an on-screen message. It also improves energy conservation on board with configurable sleep mode.

GD2 is available in two configurations; GD2-48 for low voltage (up to 75V maximum battery voltage) systems as shown in Figure 1 or GD2-12 for high voltage systems as shown in Figure 2.

GD2-48 can be directly powered from the main batteries but the maximum battery voltage must not exceed 75V. Battery voltage and current are measured directly. Optionally a backlight control input and an economy mode switch for motor speed limitation can be connected to the device.

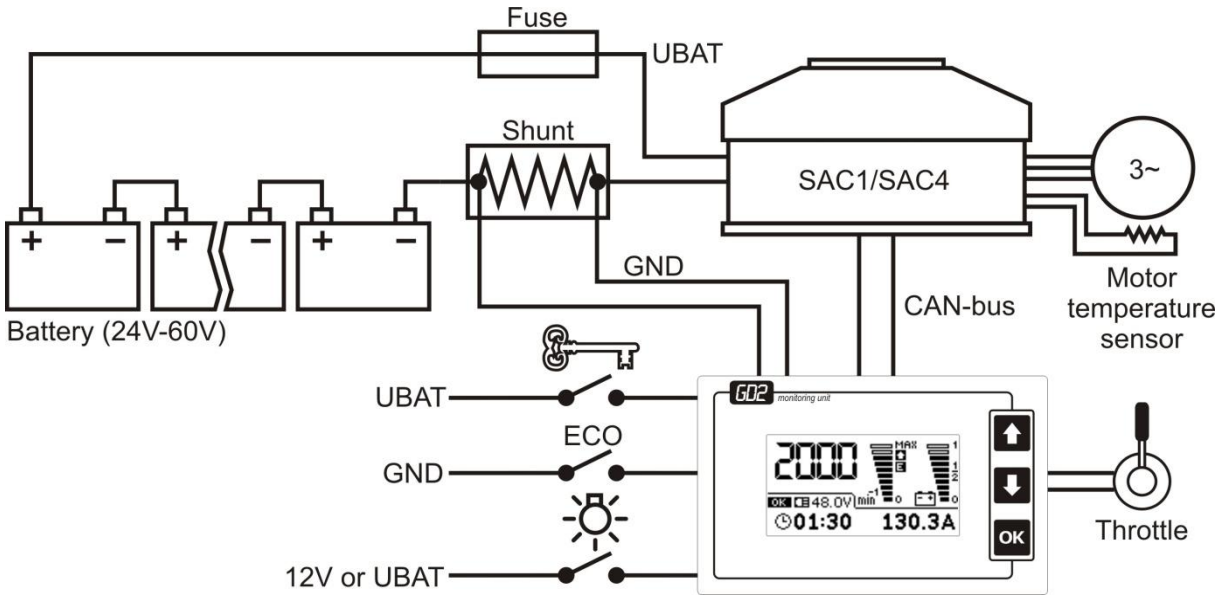


Figure 1: Integration of the GD2-48 unit in 24V - 60V systems (SAC1 or SAC4)

The GD2-12 version is intended for use with 96V - 300V batteries or battery systems.

The display unit (as well as the power supply of the AC motor controller) is usually supplied by a DC/DC converter with 12V output (such as KOP96-300). Maximum supply voltage is limited to 27V with the GD2-12 version. Battery voltage and current are measured indirectly through HV2 high-voltage galvanically isolated measurement adapter. The additions are direct motor temperature measurement, economy mode switch, and a controller power-on relay.

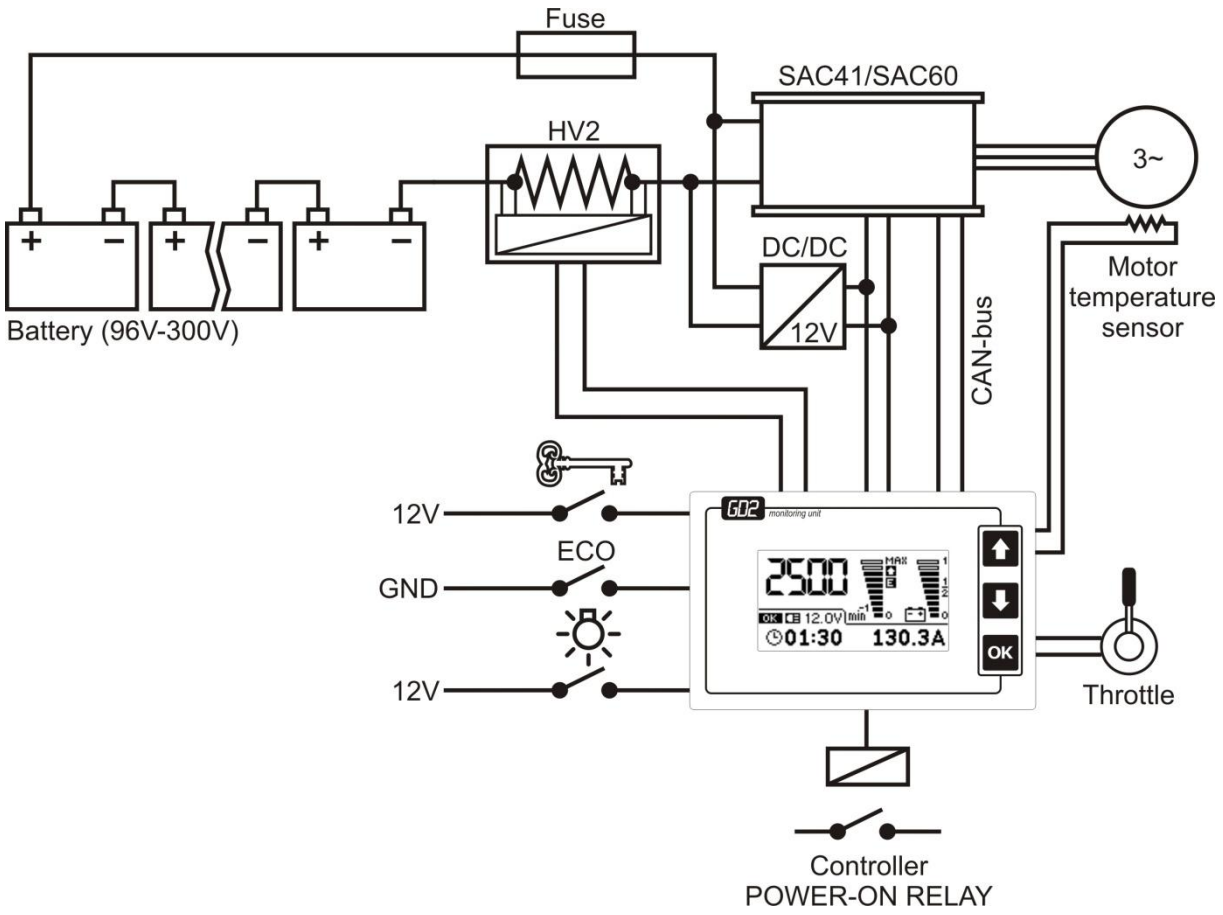


Figure 2: Integration of the GD2-12 unit in 96V - 300V systems (SAC41 or SAC60)

Technical specification

Electrical

	GD2-12	GD2-48
Operating voltage range	8.0 to 27.0 VDC	18.0 to 75.0 VDC
Maximum operating current	52 mA @ 12 V	26.5 mA @ 48 V
Standby current	4.5 mA @ 12 V	2.9 mA @ 48 V
Current measurement method	Shunt	HV2
Current measurement range	±20.0 to ±600.0 A (configurable)	

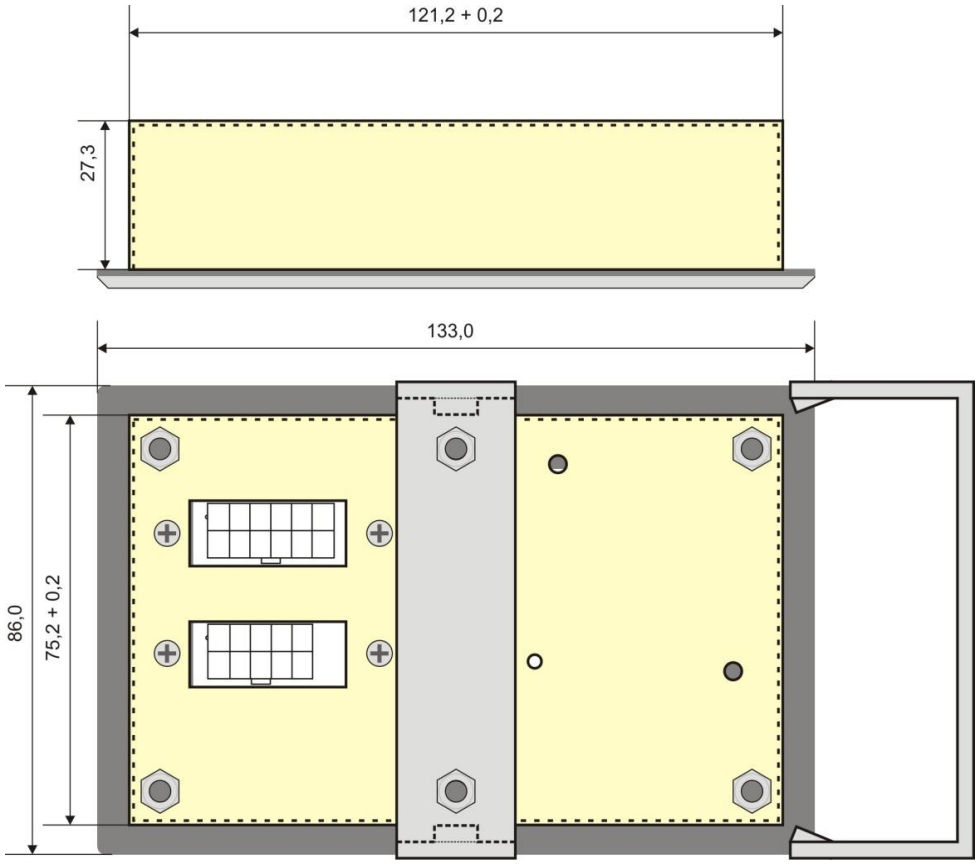
Mechanical

Display	Graphical LCD monochrome 128 x 64 pixels
Backlight	Low power white LED
Panel cutout	122mm x 76mm
Mating connector	Molex Mini Fit 12 pin, Female Crimp Terminals
	Molex Mini Fit 10 pin, Female Crimp Terminals

Environmental

Temperature range	-25°C to 60°C
Relative humidity	9% to 95% (vapor)
Enclosure protection	IP65 (face), IP40 (rear)

Dimensions



Accessories and Add-ons for GD2

Throttle (Single lever control)

Two throttle versions for side mounting in boats are available as shown in Figure 3. Figure 4 shows internal throttle wiring.

Figure 3: Throttle versions

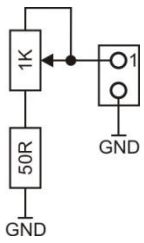


Figure 4: Internal throttle wiring

High voltage measurements module HV1/HV2[1]

HV1/HV2 provides galvanic isolation for high-voltage and current measurement. It is compatible with the GD2-12V version. Module with the accompanying shunt resistor is shown below:

Figure 5: HV1/HV2 with shunt resistors

GD2-J2 12-pin to J2 4-pin Adapter cable

Adapter is required when directly replacing GD1 with GD2 or when using 4-pin CAN connection.

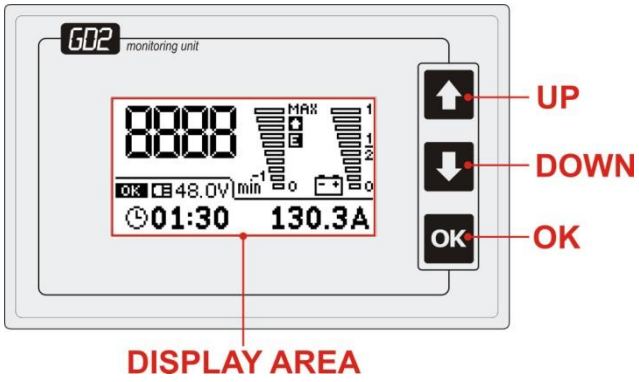
Figure 6: GD2-J2 Adapter

[1] The GD2-12V is compatible with both HV1 and HV2 module. The HV2 has better measurement accuracy than the HV1 and is therefore preffered over the HV1.

Handling and operation

GD2 is turned on with the START switch. User interface of the GD2 has the following elements:

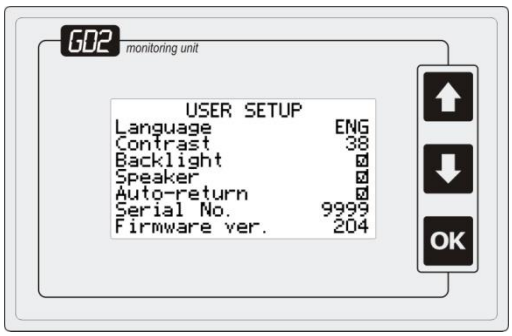
- Display area, showing relevant data, device setup and error messages
- [UP], [DOWN] and [OK] keys for direct interaction with the GD2.



Device Setup

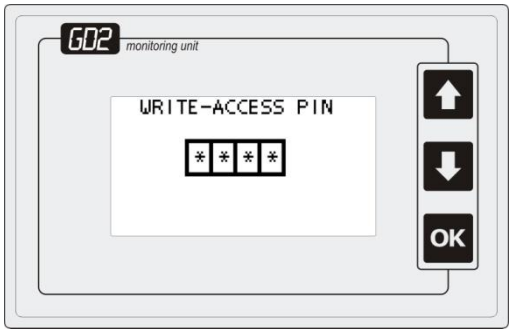
Before the GD2 unit can be used, it must be properly configured. To enter setup, while the GD2 is connected to the battery, hold [OK] while you restart GD2 with the [START] switch.

You will enter the first page of setup, which requires no PIN code to change parameters.



Without the PIN code you can still browse through the parameters on the following pages. However, you cannot change them. The navigation is done by using the [UP] and [DOWN] button. Press [UP] or [DOWN] to select the next parameter. The parameter with focus will have a browse sign (>) in front of the value. When you reach the last parameter on the page, press the [DOWN] button again to go to the next page. Or if you have reached the first parameter on the page, press [UP] to go to the previous screen. Holding [UP] or [DOWN] longer will let you jump to the next page directly without skipping through parameters.

To edit the parameters you have to enter Write-access PIN code on the second page:



When entering a PIN code, press [OK] to enter edit mode. Then select the first digit with [UP] / [DOWN] and press [OK] to proceed to the next digit. Repeat the procedure until all digits are entered. If you have entered a valid PIN code, you will be granted permission to change all parameters. If not, you will have to wait 30 seconds to try again. Once a valid PIN is entered, the field will show OK.

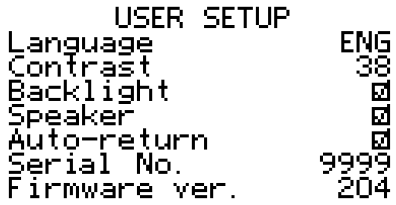
If you have permission to change the parameters, then the edit sign (➡) in front of the parameter value will be shown. To edit a parameter, press [OK]. Value to be edited will appear inverted. You can now change the value using [UP] / [DOWN] keys. If you hold the key for a longer time, you will notice that values change faster and faster - this will help you select the desired value faster. When you enter the desired value just press enter to store the value and proceed with other parameters.

Pressing the [OK] button when an ON-OFF parameter is selected will toggle the parameter value. Parameter value is [ON] when ☑ is shown.

Not all parameters can be directly edited with [UP] / [DOWN] keys. A teach in sign (⇒) in front of the parameter value indicates to teach the value in.

Parameter page 1 – User setup

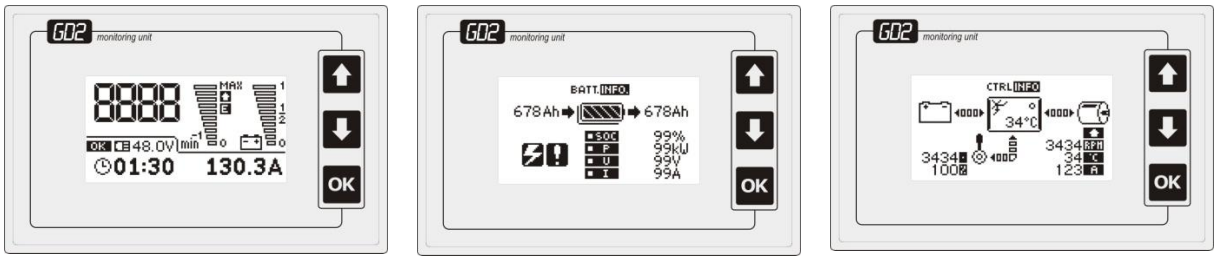
Parameters on this page can be changed by the user without entering PIN code.



P1.1	Language Select the desired language. Currently, the English and German languages are supported
P1.2	Contrast Select contrast of LCD module.
P1.3	Backlight (always on) Select this option if you want to always turn on the backlight for LCD module. When set to “off” the backlight will be controlled by using the backlight switch input (Pin J1.7).
P1.4	Speaker Turn speaker on or off.
P1.5	Auto-return Automatically return to the main screen when enabled. See chapter ‘Automatic scrolling to Screen1’ for more information.
P1.6	Serial Number Read-only. Shows serial number of GD2 unit.
P1.7	Firmware version Read-only. Shown software version in your GD2 unit.

Normal operation

When you turn the [START] switch on, you will see startup logo on the screen for a few seconds. If there are no errors, you will see the main screen (Screen 1). There is a total of 3 screens and you can scroll between them with [UP] / [DOWN] keys.



Screen 1 – Main

Screen 2 – Battery info

Screen 3 – Controller info

Figure 7: GD2 Overview of displayed information

Operating GD2

Turning off the [START] switch will put the unit into sleep mode. If the throttle is in neutral and there was no action from the user then the GD2 will go into standby mode after the set amount of time. In sleep mode the LCD display is turned off, but the GD2 still remains active and monitors the battery voltage and current. Before it goes into sleep mode, it also disables the controller and so saves energy.

Before you turn the unit on with the [START] switch, you must make sure that the throttle is in the neutral position. If not, then the unit will inform you of that with an error message. This function makes sure that the boat does not start moving if you have forgotten to move the throttle to the neutral position and turned the [START] switch on.

Notification system

The notification system informs you if there is something wrong with any part of the system. When such an error occurs, a message will appear on the screen, titled "NEW MESSAGE". When the error is related to the functionality of the GD2 unit then an error number will be displayed, as well as the message itself. For example "ERR 001: Move throttle to neutral position". When the error is related to the controller then the controller error will be displayed followed by the message.

When you have read the new message, confirm this with the [OK] button. If there are any other messages then they will also be displayed and you will have to press the [OK] button to confirm them, until you will finally return to one of the three screens. If you wish to see if errors are still present, press the [OK] button on any of the screens. You will now be able to read the message and the screen will be titled "MESSAGE LIST". Press [UP] / [DOWN] to scroll between the messages. For the list of all messages please see the chapter "Error messages and error codes".

Automatic scrolling to Screen 1

If you are viewing the Screen 2 or the Screen 3 without pressing any buttons for more than 30 seconds then you will automatically be scrolled to the Screen 1. That is the main screen and the data presented there are the most important and of most interest. If such behavior is not to your liking, it can be prevented by clearing the parameter (P1.5).

Power-on initialization

When GD2 unit is connected to the battery for the first time, the battery voltage is measured. State-of-charge (SOC, percentage of remaining charge, displayed on Screen 2) is then estimated according to the battery voltage. Therefore, if possible, try to connect the GD2 to the battery only after the battery has rested for a couple of hours without any load. Otherwise, the SOC value will be correct only after the first full charge.

Charging detection

When the conditions for charging are met then the GD2 detects charging. If enabled, two confirmation beeps will follow and the Battery monitoring screen will be displayed as shown on the Figure 8. There the arrow that symbolizes the charged Ah will start blinking. It keeps blinking until charging takes place. After that the GD2 returns to the sleep mode.

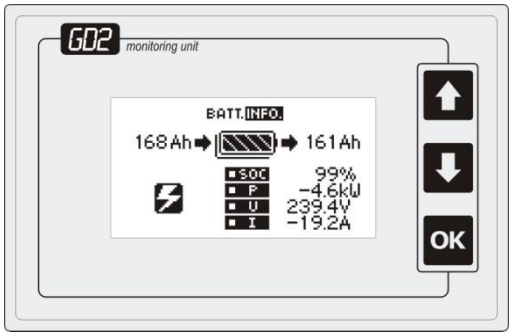


Figure 8: Battery monitoring screen during charging

Because the GD2 must detect various types of charging, regardless of whether the battery is full or empty or if different types of chargers are used, there exists a set of rules that describes charging.

Charging detection conditions:

The [START] switch is turned off. Negative (charging) current is equal to or greater than the preset current charging threshold or the battery voltage is greater than the preset voltage for more than 6 seconds. This ensures that the charging will still be detected in case the battery is already full and there flows almost no current.

Synchronisation

In order to keep your battery monitor delivering accurate status information about your battery, it is important to regularly synchronize your battery monitor with your battery.

A synchronization step means nothing more than performing a complete charge cycle on your battery. A charge cycle will be considered complete when the charging current drops below the threshold and the battery voltage is higher than the preset value. This typically means: when the battery charger switches to the float mode. By meeting these conditions, the battery is considered full, which will be indicated by the State-of-charge readout showing 100% (see description of Screen 1 - Battery monitoring screen).

Performing synchronizations regularly is also important to keep your battery healthy and to increase its lifetime.

Generator principle (REGEN)

If enabled for your system, the generator principle allows recharging the batteries from mechanical power obtained from the motor shaft. The application is suited for boats with sailing capabilities.

Enabling generator mode (REGEN mode)

In order to allow generator operation, the GD2 display must be set into the REGEN mode. REGEN mode can only be enabled with the potentiometer set to the neutral position. Successful setting of the generator mode is acknowledged with 1 beep and the status line on GD2 will indicate “REG” as shown in Figure 9.

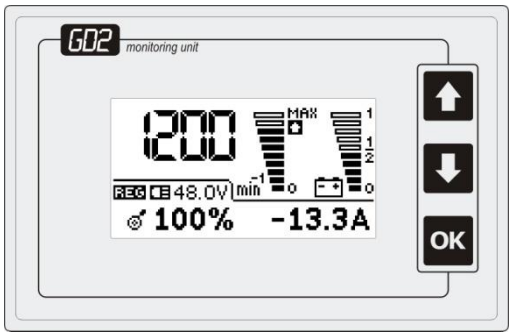


Figure 9: GD2 Main screen in REGEN mode

Operation

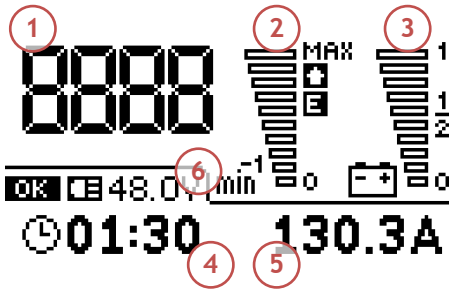
The power obtained from motor shaft is limited with motor speed / maximum power production characteristics of the propeller. The characteristics and its maximum power point depends of the boat speed. The speed of the shaft decreases with load torque in generator mode, while power increases with increasing of the speed at given torque.

Maximum amount of torque that can be used to recharge batteries, can be adjusted with potentiometer as percentage of maximum torque at maximum speed. Torque limit is proportional with speed.

Disabling generator mode

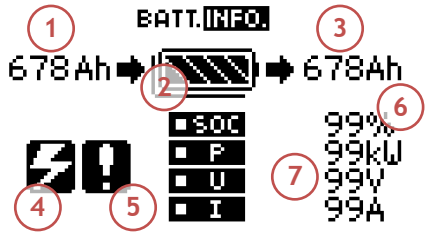
To disable generator mode [START] switch must be turned off.

Screen 0 - Main screen



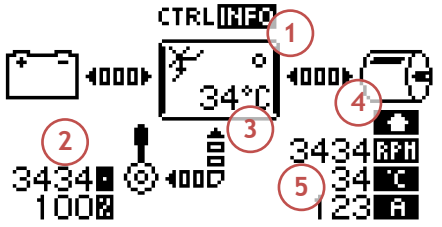
1 Speed value (RPM)
2 Speed, direction and economy mode indicator (RPM)
3 Remaining battery charge (State-of-charge)
4 Estimated remaining time of driving
5 Battery current
6 Status line

Screen 1- Battery monitoring screen



1 Charge charged
2 Remaining charge indicator
3 Charge used
4 Charging indicator
5 Low battery indicator
6 Amount of remaining charge
7 Battery measurements

Screen 2 - Controller and motor monitoring screen



1 Controller bridge-on indicator
2 Throttle position
3 Controller temperature
4 Motor direction
5 Motor measurements

Error messages and error codes

List of all messages and error codes is provided below:

ERR 001: Move throttle to neutral position
ERR 002: Throttle error/disconnected
ERR 003: CAN bus timeout
ERR 004: Battery low
ERR 005: Motor temperature high. Reducing power.
ERR 006: High Voltage PCB timeout/no link
CONTROLLER ERR 001: Over current
CONTROLLER ERR 002: Over voltage
CONTROLLER ERR 003: Under voltage
CONTROLLER ERR 004: Voltage low at start
CONTROLLER ERR 005: Potentiometer error during operation
CONTROLLER ERR 006: Potentiometer not zero at start
CONTROLLER ERR 007: Controller over-temperature
CONTROLLER ERR 008: Controller under-temperature
CONTROLLER ERR 009: Controller temperature sensor error
CONTROLLER ERR 010: Current offset error
CONTROLLER ERR 011: DC link charging error
CONTROLLER ERR 012: Relay error
CONTROLLER ERR 013: PDPINTA (shortcut or mosfet/driver error)
CONTROLLER ERR 014: Bad user parameter CRC
CONTROLLER ERR 015: Bad system parameter CRC
CONTROLLER ERR 016: Bad flash CRC
CONTROLLER ERR 017: Wrong parameter version
CONTROLLER ERR 018: Invalid motor type
CONTROLLER ERR 019: Auto tuning error
CONTROLLER ERR 020: Boost error
CONTROLLER ERR 021: Motor over-temperature
CONTROLLER ERR 022: Motor temperature sensor failure
CONTROLLER ERR 023: Internal error
BMS WARN 01: Cell voltage high
BMS WARN 02: Cell voltage low
BMS WARN 03: Temperature high
BMS WARN 04: Temperature low
BMS WARN 05: Battery warning
BMS ERR 64: Cell over voltage
BMS ERR 65: Cell under voltage
BMS ERR 66: Temperature high
BMS ERR 67: Temperature low
BMS ERR 68: Over current
BMS ERR: Battery error

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