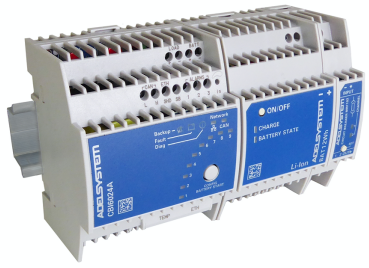
DC Ups CBI60 "AllinOne"

CBI6012A, CBI6024A, CI6048A

Instruction Manual

1Sommario

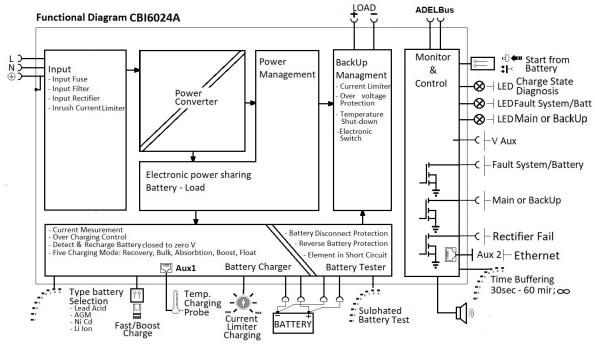


2 DC Ups CBI60 “AllinOne”

Thank you for having chosen one of our products for your work.
We are certain that it will give the utmost satisfaction and be a notable help on your job and application.

3 Product Description

It’s a new revolutionary product, with an ethernet connection running diverse protocols such as HTTPS, SNMPv3, Modbus TCP. An internal webserver allows monitoring and configuring the device. A simple programming language allows extending the product functionalities by performing actions or calculations based on the value of one or more parameters. The device also features the ADELBus protocol for connecting other ADELSystem devices using a CANOpen-compatible bus and Modbus RTU Thanks to “All In One” CBI series of DC-UPS, it will be possible to optimize the power management of your system with one single, extremely compact and cost-effective device, connected directly to the mains. The available power is automatically distributed between load and battery giving priority to the load. Battery can supply the load even with mains so the output power to the load can be twice the nominal power if required (Power Boost). When mains failure occurs, the load continues to be supplied by the battery in backup mode. It is also possible to switch on the device with no mains directly from battery. The “Battery Care” algorithm performs rapid and automatic charging, continuous battery charge optimization, flat batteries recovery and real time diagnosis during installation and operation. Temperature compensation is possible by connecting the temperature sensor probe. The real time auto-diagnostic system monitors battery faults such as sulphated battery, shorted cells, accidental reverse polarity connection or disconnection of the battery. Each fault is signaled by a blink code of Diagnosis Led or via a remote connection (ethernet / ADELBus / Modbus RTU) in order to be easily detected and removed during the installation and after sales. The continuous monitoring of battery efficiency reduces the risk of battery damage and allows a safe operation in a permanent connection. Predefined curves can be selected on the front panel or via remote connection to optimize the charge of different battery types: Open Lead Acid, AGM and Gel Lead Acid; Ni-Cd, Li-Ion are rechargeable using the same device. Charging curves can be customized via the mentioned remote connections. Output contacts are used to signal backup, fault conditions and charger or rectifier failure. A rugged casing with bracket for DIN rail or Wall mounting ensures reliable operation and optimum heat dissipation.



4 Main Characteristics

- Universal input voltage: single-phase 100–277 Vac
- Load output: 48 Vdc 1.5A; 24 Vdc 3 A; 12 Vdc 5 A
- Battery output: 48 Vdc 1.5A; 24 Vdc 3 A; 12 Vdc 5 A
- “All In One” solution: power supply + battery charger + backup module in one single device connected directly to the mains
- Suited for different battery types: Open Lead Acid, Sealed Lead Acid, AGM and Gel Lead Acid; Ni-Cd and Li-ion. 5-stage IUoU (Recovery, Bulk, Absorption, Float, Refresh Battery) plus Recovery stage for deeply discharged batteries
- Automatic diagnosis of battery status and battery Life Test function (Battery Care)
- Switching technology with high efficiency
- Protected against short circuit, overload and inverted polarity
- Solid state output contacts for signaling Low Battery or Battery Replacement and Fault system.
- IP20 protection degree
- Space saving on DIN rail and wall mount

5 Safety and warning notes

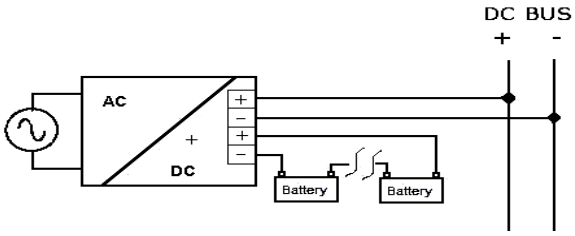
To safely operate this Device please read and follow all instructions carefully before attempting to unpack, install, or operate.
WARNING – Explosion Hazard: do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.
WARNING – Explosion Hazard. Replacement of components may impair suitability for class I, Division 2.
WARNING – Switch off the system before connecting the module. Never work on the machine when it is live. The device must be installed according to EN50178 or EN60364. The device must have a suitable isolating facility outside the power supply unit, via which it can be switched to idle. Danger of fatal injury!
WARNING – The device is equipped whit an internal fuse. If the internal fuse blows up (fails opens), it is most probable that there is a fault in the device. If this failure occurs, the device must be returned to the factory.

5.1 Working Note

- This equipment is not suitable for use in locations where children are present.
- This equipment is intended for installation in restricted access area.
- This equipment requires a connection to the PROTECTIVE EARTHING CONDUCTOR.
- An all-pole MAINS switch in accordance with Annex L of UL 62368-1 is required.
- Proper bonding to the end-product main protective earthing termination is required.
- The following end-product enclosures are required: Fire, Electrical, Mechanical

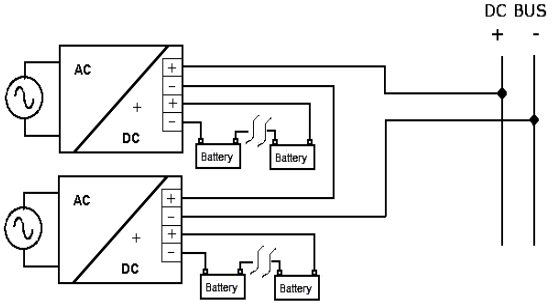
6 Diagram Configurations

6.1 Normal Configuration



Typical application for All In One device, one output for Load “DC Bus”, one Input / Output for connection to the battery.
One 12-V battery for CBI 6012;
Two 12-V batteries connected in Series for CBI 6024;
Four 12-V batteries connected in Series for CBI 6048;

6.2 Series Configuration:



It is possible to connect as many units in series as needed, provided the sum of the output voltages does not exceed 150VDC. Please notice that: a) Voltages above 60VDC are not SELV anymore and can be dangerous. Such voltages must be installed with a protection against touching. b) For series operation use power supplies of the same type. c) Earthing of the output is required when the sum of the output voltage is above 60VDC. d) Keep an installation clearance of 10 mm (left/right) between two power supplies and avoid installing the power supplies on top of each other.

Note: Avoid applying a backfeed voltage (e.g. from a decelerating motor or battery) to the output terminals.

7 How to Install

7.1 Mounting

7.2 Din Rail or Panel Mounting

Fig. 1 shows how to install the CBI60. It is possible to mount the device on DIN rail or on a panel and fix it by 2 screws suggested 2.9x8-16. There is no limit for the panel thickness.

7.3 Device Connection (Fig.2)

7.4 Connection terminal and wiring

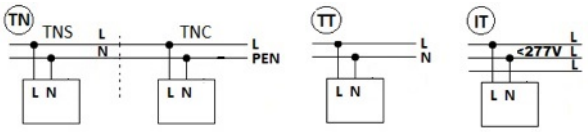
The following cable cross-sections may be used:

	Solid (mm2)	Stranded (mm2)	AWG	Torque (Nm)	Stripping Length
In:	0.2–2.5	0.2–2.5	24 – 14	0.5–0.6	7 mm
Out:	0.2–2.5	0.2–2.5	24–14	0.5–0.6	7 mm
Signal:	0.2–2.5	0.2–2.5	24–14	0.5–0.6	7 mm

Screw type terminals, 2.5 mm2. Wiring shall be marked to indicate the proper connection for the power supply. Use copper cables only; for power connections use wires suitable for at least 75°C

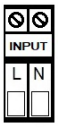
7.5 Input Line System

Primary switch mode power supply for connection to 1-phase AC and DC line systems. For AC line systems (TN, TT and IT system in according to IEC 60364-1) whit rated voltage 110 -240, 50 – 60Hz. Output voltage 12 -24 Vdc, isolated and no-load proof.



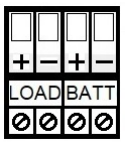
7.5.1 Input AC Port L – N: No.10

Single phase Switching Power Supplies L, N



7.5.2 Battery Connection and Load Connection

7.5.2.1 Battery Connection Port: No.1

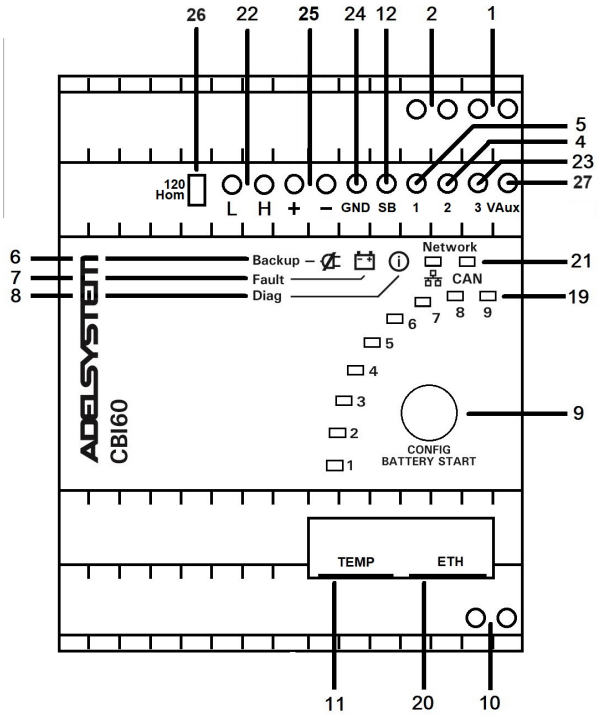


-Connect the battery between: terminal (–) and (+)
-One battery (12 Vdc) for CBI6012A
-Two battery (12 Vdc) connected in Series for CBI6024A

7.5.2.2 Output Load: No.2

Connect this output to the load, terminal (–) and (+).

7.6 Lay Out



Reference	Description
1	Battery
2	Load
4	Battery or System fault Alarm (or reconfigurable by Web Server)
5	Mains – Backup (or reconfigurable by Web Server)
6	Mains – Backup LED
7	Battery fault – System fault LED
8	Diagnosis LED
9	Configuration – Start from Battery
10	Input Vac
11	Aux1: RJtemp – DPY353
12	Start from Battery or UPS Disabling: close to negative GND N°24
19	Battery Config - Life test – Fast Charge – UPS Disabling- Time Buffering – UPS Enabling
20	ETH: Ethernet
21	Network Communication LED
22	ADELBus (CAN)
23	Charger / Rectifier Fail Alarm (or reconfigurable by Web Server)
24	GND: Ground reference for terminal N°12
25	Battery Sense: Connect to battery terminals + and – for SoH detection.
26	120 Hom LT CAN. Insert Jumper for Enabling
27	V Auxiliary: Auxiliary Output 12, 24 or 48 Vdc depending on the device voltage. Max 100mA.

8 Charge & Testing

8.1 Battery Care

Battery Care is a philosophy of charging and testing based on algorithms that implement rapid and automatic charging, battery charging optimization over time, flat batteries recovery and real time diagnostic during installation and operation. Batteries elements in short circuit, accidental reverse polarity connection, disconnection of the battery, high internal resistance, can easily be detected and identified by means of unique blink codes of the Diagnosis LED, during the installation and normal operations. Each device is suited for all battery types, it is possible setting predefined curves for Open Lead Acid, Sealed Lead Acid, Gel, Ni-Cd, Li-Ion. All devices guarantee battery reliability in time by continuously testing the internal impedance status, avoiding any possible risk of damage and granting a permanent, reliable and safe connection of the battery to the power supply. The system is able, through an internal battery stimulation circuit, to recognize sulphated batteries or batteries with one or more short-circuited elements. The battery testing is carried out automatically every 60 sec. for all basic battery checks and every 220 minutes in Float charge for the battery efficiency test. Battery Faults can be monitored by means of relays, led blinking and via remote connection (ethernet, ADELBus, Modbus RTU).

8.2 Charger

8.2.1 Battery Management Configurations

Completely automatic, all devices are suitable to charge most batteries types thank to User Selectable charging curves. They can charge open lead acid, sealed lead acid, Gel, Ni-Cd and Li-Ion. It is possible to change or add other charging curves connecting the web server device to a PC. The battery must be disconnected during the program operations, otherwise it is not possible the choice of the Battery type.

Note: the device can also be configured by Web Server.

8.2.2 Device Configurations by Push-Button (9)

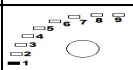
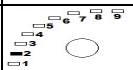
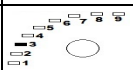
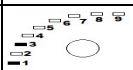
To display the current device configuration, press the Config/Start button briefly (< 1 sec). The LEDs will show the configurations listed in the table at the end of this section. By pressing the button again, the sequence stops and the display returns to normal operation.

To change the device configuration, complete the procedure below (note: if the procedure is not completed no settings are saved; the procedure is aborted if no command is given for 60s).

Note: the device can also be configured by Web Server.

With battery disconnected:

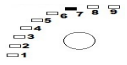
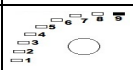
- press the Config/Start button (No.9) for more than 2 seconds, until the first led starts blinking
- press briefly the button to cycle through the battery types as shown by LEDs 1,2,3 (please refer to the pictures at the end of this section) then confirm with a long press until the 5th LED starts blinking
- LED 5: Option: not used: continue with a short-press
- LED 6: Life Test; long press to enable the function (Led ON), short press to disable
- LED 7: Fast Charge; long press to enable the function (Led ON), short press to disable
- LED 8: UPS Disable; long press to disable the UPS function (Led ON), short press to keep it enabled
- LED 9: Buffering time: press briefly the button to select the max backup duration, then confirm with a long press. The current selection is shown with other LEDs blinking together with LED 9 as follows:
- Led 1: 30 sec; Led 2: 120 sec; Led 3: 300 sec; Led 4: 10 min; Led 5: 15 min; Led 6: 20 min; Led 7: 30 min; Led 8: 45 min; All leds: Infinite time
- Note: the last selection (infinite time) is confirmed automatically also with a short press
- More values can be selected by Web Server, Modbus or SNMP
- End Programming: the device shows the selected configuration for 10 seconds then resumes normal operation,

Battery Type chemistry Selection			
	LED Config	**Float charge (Volt/Cell)**	**Fast charge (Volt/Cell)**
Open Lead		2.23 (12V:6 cells) (24V:12 cells) (48V:24 cells)	2.40 (12V:6 cells) (24V:12 cells) (48V:24 cells)
(AGM) Low		2.25 (12V:6 cells) (24V:12 cells) (48V:24 cells)	2.40 (12V:6 cells) (24V:12 cells) (48V:24 cells)
Gel Battery		2.30 (12V:6 cells) (24V:12 cells) (48V:24 cells)	2.40 (12V:6 cells) (24V:12 cells) (48V:24 cells)
Ni-Cd		1.4V/cell (12V:10 cells) (24V:20 cells) (48V:40 cells)	1.45V/cell (12V:10 cells) (24V:20 cells) (48V:40 cells)
Li-Ion LiFePo4		3.45V/cell 12Vfield: 13.8V 24Vfield: 27.6V 48Vfield: 55.2V	3.65V/cell 12Vfield: 14.6V 24Vfield: 29.2V 48Vfield: 58.4V

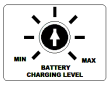
With battery connected:

- press the Config/Start button (No.9 in sect.4.3) for more than 2 seconds, until the 5th led starts blinking

follow the procedure above from step "LED 5: Option" (Battery Type can be changed only when the battery is not connected).

Functional Setting		
Battery Life test ON		Life test enabled
Fast Charge Enable (3)		Fast Charge enabled.
UPS Disabling		UPS function disabling. Use terminal 12 for connection to external Contact. - Close to GND: DC Ups Enabled - Open to GND: Dc Ups Disabled
Time Buffering		1 blink => 0.5, 2 blink => 1, 3 blink => 5, 4 blink => 10, 5 blink => 15, 6 blink => 20, 7 blink => 30, 8 blink => 45 min 9 Solid => ∞ infinite" (Time = minute)

8.2.3 Charging Current limiter:



In order to protect the battery from excessive charging currents, the device allows to limit the maximum charge current by selecting the charging current limit using the user interface as described below or via remote connection (including the webserver). To determine the maximum battery charge current, refer to the battery datasheet or, if not available, consider that typically the maximum recommended charge current is 10% of Ah's rated battery current, for all the chemistries.

Double click button (9) to display the current limit of the charge current on the LED bar graph;. click the button multiple times to change the limit current in 20 steps from 5% to 100% of In.
Press for more than 2 sec. to store the selection in permanent memory.
CBI6048A: from 0 – 1.5A ; 20 step; 1 step 75mA
CBI6024A: from 0 – 3A ; 20 step; 1 step 150mA
CBI6012A: from 0 – 5A ; 20 step; 1 step 250mA
It is possible set the limiting current also by the internal Web Server, please refer to the Ethernet section.

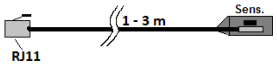
8.2.4 Displaying the ongoing charging stage

When mains is available and the battery is connected, the LED Diagnosis N°8 displays the ongoing charging stage by means of a blinking code. The same information is provided via the mentioned remote connection, also.

Charging State	LED Configuration: LED: 6 Backup, 7 Fault, 8 Diag — Network, CAN		
	6	7	8
Float	Off	Off	1 blink/2sec
Absorption	Off	Off	1 blink/sec
Bulk	Off	Off	2 Blinks/sec
Recovery	Off	Off	5 blinks/sec
Fast	Off	Off	If Enabled

8.2.5 Battery Charger in a Temperature Compensated Environment

No. 11 - Remove the window label to find the connector: Auxiliary Output "AUX 1".
It is possible to connect the Temperature sensor probe and apply it on the battery in order to adjust the battery charging voltage according to the battery temperature. This feature allows to meet the requirements of the EN54- fire certification also.



- PN: RJTEMP111N (1 m length)
- PN: RJTEMP113N (3 m length)

8.2.5.1 Battery Temperature Compensation Charge (not for Li-Ion)

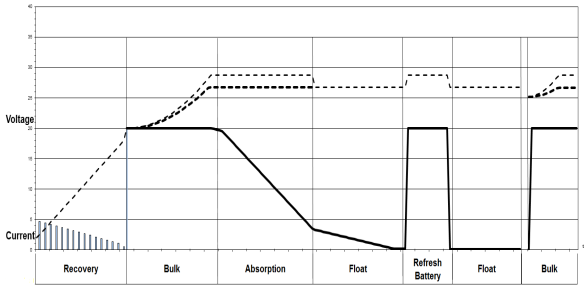
Connecting the cable RJTEMP (supplied separately) to Auxiliary Output AUX1, the CBI will adjust the battery charging voltage according to the battery temperature.

Fast Charge: Open Lead, AGM, Gel	Float charge: Open Lead, AGM, Gel
• +/- 5mV/°C x n. Cells • -8°C to +60°C • +140 ÷ -200 mV/Cell Refer: 20°C	• +/- 3mV/°C x n. Cells • -20°C to +60°C • +120 ÷ -120 mV/Cell Refer: 20°C
Fast Charge: Ni-Cd	**Float charge: Ni-Cd**
• +/- 2.5 mV/°C x n. Cells • -20°C to +60°C • +100 ÷ -100 mV/Cell Refer: 20°C	• +/- 2.5 mV/°C x n. Cells • -20°C to +60°C • +100 ÷ -100 mV/Cell Refer: 20°C

The device stops charging the battery if the temperature is below -20°C or above +60°C. The sensor placed on cable RJTEMP must be applied on the battery.

8.2.6 Charging Curve

Automatic multi-stage operation and real time diagnostic allow fast recharging and recovery of deeply discharged batteries, adding value and reliability to the system hosting the CBI device. The type of charging is voltage-stabilized and current-stabilized IUoU. Five charging phases are identified by a flashing code on a Diagnosis LED or Modbus (refer to Charging State). To keep the Output Load voltage close to the nominal voltage (12, 24, 48V) the fast charge must be disabled with the push button or on the web server. When Fast Charge is enabled the device activates the "Cyclic Refresh Charging" every 288h for 85 minutes at 2.4V/Cell.



8.2.7 Purification Charge

8.2.7.1 What is it?

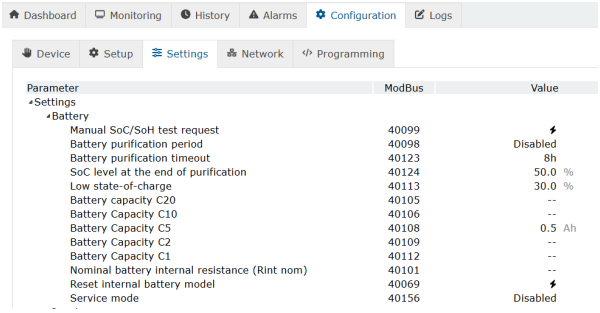
Purification charge is suggested in applications where it is necessary to refresh the electrochemical state of the battery, such as stationary applications, where batteries stay for long time in float or trickle condition without providing power to the load. In such prolonged inactivity the batteries may become less efficient thus impairing their capability of sustaining the load in the event of a mains outage. For this purpose, we have developed the following feature:

8.2.7.2 Two PURIFICATION TECHNIQUES

The Adelsystem CBI range of devices implement two different techniques to purify the battery electrolyte:

1 Battery refresh charge: done automatically every 12 days (or 288h) for 85 min at 2.4V/cell. This stirs the electrolyte by moving oxygen inside and help to remove oxide on the internal plates.
- Conditions:
  - Only if the Fast-charge is enabled
  - For Lead-acid batteries only

2 Battery purification: a controlled battery discharge that exercises the batteries and helps desulphate and rejuvenate the batteries. This is suggested in stationary applications and even recommended to be part of the standard working cycle of some chemistries such as Lead Crystal. To maximize the effectiveness of this technique, a load should be connected to the device output load terminals. The battery purification can be programmed to be done periodically and can be configured in terms of purification timeout and end-of-purification SoC level: the purification ends when either the timeout has expired or the SoC level has been attained, whichever occurs first.
- Conditions:
  - Remote connection to the CBI's ETH connector is needed, because purification is configured and activated only from remote
  - Use the internal webserver or connect to the CBI via Modbus or SNMP using a suitable application.
- Configure the battery capacity using the information provided by the battery datasheet. This is required in order for the CBI to compute the state-of-charge to be attained at the end of purification. Provide as many battery capacity parameters as possible from the battery datasheet and leave the others at 0
  - Setting:
    - Battery Capacity C20: HR40105
    - Battery Capacity C10: HR40106
    - Battery Capacity C5: HR40108
    - Battery Capacity C2: HR40109
    - Battery Capacity C1: HR40112
- Set the Battery purification period, i.e. the time interval between two subsequent battery purifications; If the period is set to zero, the device does not perform the Battery Purification
  - Battery purification period: HR40098 (the parameter is in hours, range; 120 thru 18000, default value: 0 – no purification)
- Set the Battery purification timeout, i.e. the maximum allowed duration of the purification
  - Battery purification timeout: HR40123 (the parameter is in minutes, range 5-1800 minutes, default value: 480)
- Set the SoC level at the end of purification.
  - SoC level at end of purification: HR40124 (the parameter is in units of 0.1%, range 300-900, default value: 500)
- Purification Battery Test condition
  - SoC > 95%
  - Minimum load current 0.5 A



8.2.8 Charger Fail – Rectifier Alarm

To provide the maximum reliability in the system the device, continuously and unobtrusively, monitors its internal circuits. In the case the charger circuitry is faulty or malfunctioning, the Charger Fail or Rectifier fail alarm is activated.

8.3 Battery tester

8.3.1 and Control by Blink LED

All CBI devices support the user during Diagnosis installation and operation. A Blink code of the Diagnosis Led allows to discriminate among various possible faults.
All the error conditions are signaled by means of the Fault LED that is lit and the Battery fault alarm on. The diverse errors are uniquely identified by a blink code of the Diagnosis LED. See the following table.

Auto Diagnosis System	Status	Diagnosis / Fault Batt
	Reverse polarity or high battery Voltage (over 32.5Vdc for CBI 6024A)	1 Blink/pause.
	Battery not connected	2 Blink/pause
	Battery element in Short Circuit	3 Blink/pause
	Overload or short circuit on the load	4 Blink/pause
	Bad battery; Internal impedance Bad or Bad battery wire connection	5 Blink/pause
	Life test not possible	6 Blink/pause
	Rectifier Alarm	7 Blink/pause
	Boost condition; battery discharge after 4 min. of overload.	8 Blink/pause
	Low battery (under 18.5Vdc for CBI 6024A) Only if started from battery, no mains input	10 Blink/pause
	Mains detector failure	13 Blink/pause
	Device over-temperature Alarm	15 Blink/pause
	Calibration error	16 Blink/pause

8.3.2 SoC "State of Charge"

The algorithm for the estimation of the battery State-of-Charge "SoC" implemented in the 600-W range of CBIs allows, at any time, the real-time monitoring of the actual charge available in the battery that can be provided to the load in the case of a mains outage.
Moreover, such algorithm, leveraging the Adelsystem Battery Care system, monitors highly significant battery health indicators over time to quantitatively assess the health of the battery thus allowing preventive maintenance to be implemented. This allows the early diagnosis of potential battery failure that might lead to system downtime.
Since both the state-of-charge and the state-of-health depend on the battery ratings, it is essential that the correct battery parameters be set in the CBI. Such group of parameters will be referred to as the "Battery settings"; they can be set in the CBIs using the remote connections, including the webserver.

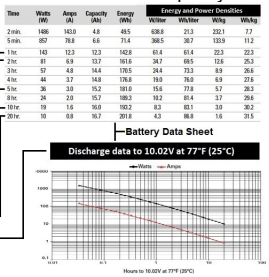
8.3.2.1 SoC: Battery settings how to configure the internal algorithm

The battery settings describe the rated capacity of the battery. All of these parameters are used by the CBI to compute a battery model which is used to determine the SoC readouts on the basis of the measured battery voltages and currents.
All of these parameters can be written to the specified holding registers, but only when the battery is not wired.

The battery capacity parameters are mapped as follows:

- HR40105: C/20 rated capacity, also known as the 20-hours capacity
- HR40106: C/10 rated capacity, also known as the 10-hours capacity
- HR40108: C/5 rated capacity, also known as the 5-hours capacity
- HR40109: C/2 rated capacity, also known as the 2-hours capacity
- HR40112: C/1 rated capacity, also known as the 1-hour capacity

Description	HR
Battery capacity "C1"	40112
Battery capacity "C2"	40109
Battery capacity "C5"	40108
Battery capacity "C10"	40106
Battery capacity "C20"	40105
Alarm level "Low SoC"	40113



When the battery settings are entered, the algorithm computes the effective battery capacity based on the available data. The more data are provided, the more accurate the SoC results will be.

In the Web Server interface, it is possible insert the nominal battery values in Ah, if the device is connected to customized Software, the values must be entered in units of tenth of Ah, e.g. the value 75 means 7.5Ah. The values should be those specified at ambient temperature: in fact the temperature compensation is implemented by the CBI provided the battery temperature probe is connected to the CBI.
The battery capacity figures are usually available from the battery datasheet, although not all the hour-ratings may be available. Note however that it is NOT necessary to provide ALL the hour-ratings in order for the algorithm to be operational: enter as many ratings as they are available and set the others to zero. The algorithm will work out the battery model based on the data provided: the more data are entered, the higher the accuracy of the model and consequently of the results obtained from it.

The SoC-low alarm threshold can be set, in units of per mille (900 = 90%) using holding register HR40113.

The State-of-Charge is measured both during charge and during discharge. Its value, expressed as the ratio of the available internal capacity to the battery internal capacity, can be read from HR40023 in per-mille units. (e.g. 1000 = 100%). The presented SoC is compensated for temperature, aging and current magnitudes.

Moreover, during discharge the SoC can be read also in terms of the remaining buffering time before the battery reaches 0% SoC with the present load. Such remaining time can be read from the HR40022 in units of seconds. Note however that this is an approximate estimation which can vary significantly with the load.

The capacity consumed (HR40016) describes the net charge that has been consumed from the battery. It can be read in units of tenth of Ah (e.g. the value 75 means 7.5Ah) from holding register HR40016.

Two history parameters aid the user in keeping track of the battery usage: it is the maximum depth-of-discharge (HR40061) and the average depth-of-discharge (HR40064). Both are updated during discharge and are reported in percentage units and are preserved through power-cycling. The information about depth-of-discharge is valuable for determining whether the battery, during discharge, often approaches low-SoC conditions. If this is the case, it may be worth using higher-capacity batteries. In fact, running batteries at conservative depth-of-discharge ratings is an effective way to prolong their useful life. Such history parameters can be reset by writing the value 0 individually or along with all of the other histories by issuing the History Clear All command (HR40065 = 1). The two histories do NOT get cleared by a Battery Reset command (HR40069 = 1). Also, changing the chemistry will not clear such histories.

8.3.3 SoH "State of Health"

The measurement of the battery internal resistance requires that the device be setup properly as well.

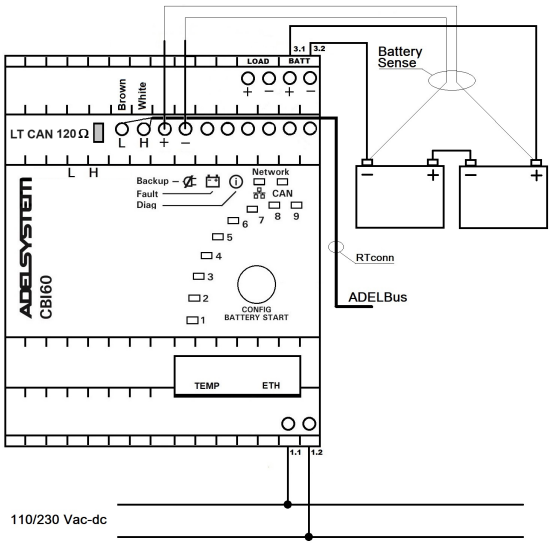
8.3.3.1 Set Up the device for SoH Measurement

First of all it is necessary to configure the device to enable the SoH calculation:

- Enable the Life test as described in section 7.2.2

8.3.3.2 Cable Configuration

To determine the battery state of health "SoH", two additional wires must be connected close to the battery poles as shown in fig. below. The device must also be configured with battery data via the web server or Modbus/SNMP.



Connect two additional wires from the Battery Sense terminal of the device, to the Battery posts + and –; HR40004 provides the Voltage measured from the battery sense. The battery sense wires allow the battery voltage to be accurately measured without the influence of any possible ohmic drop due to charging/discharging currents in the battery power cables

8.3.3.3 Internal battery Resistance Configuration

- Enter the Nominal Internal Battery Resistance from the datasheet of the battery: HR40101, units 0.1 m ohm; *Rint Nom*. The Value is used as *Rint Ref* during the first days after the onset of float charge. The value entered in HR40101 must be the nominal resistance of the entire battery pack and not that of the single battery or cell: if two batteries are wired in series, the value to be entered is twice the value found on the single battery datasheet, four-times if four batteries are wired in series.
- After the first days of initial measurement of the internal battery resistance compared against the *Rint Nom* HR40101, the device identifies the optimal value of the *Rint Ref*, the battery internal resistance reference value.
  This value will be kept as a reference for the future calculation of the SoH during all subsequent test. The *Rint Ref* Holding Register is HR40015

8.3.3.4 Control Indicators

To help in the SoH configuration and for the monitoring of the operation of the SoH algorithm, the HR40033 provides all the information about potential issues detected by the device that could impair the SoH measurements or event prevent their calculation from being carried out.
HR 40033 Battery state of charge and state of health alarm:

- bit 0: low state-of-health, internal resistance of the battery too high. It is not updated when the Manual SoH test is requested by writing 1 to HR40099
- bit 5: unexpected values in the measured *Long Term Rint. Meas*: check cables resistance. Can occur only if the battery sense cables are not used
- bit 7: low state-of-health by Manual SoH test, battery internal resistance is too high
- bit 8: low state of charge
- bit 11: SoH calculation not possible because no reference RintNom has been provided in HR40101
- bit 12: Measured internal resistance exceeding 6.5 ohms. Check battery and, if battery sense leads are not used, the battery power cables
- bit 13: Rint and SoH calculations not possible because the battery sense is not connected and no cable resistance has been provided

Finally, the device is ready to do the SoH Measurement on the Battery

8.3.4 SoH Operation: Manual Test

The Manual test can be triggered on the web server or via the Modbus or SNMP protocols using a suitable application.
The test is enabled only when the battery has been evaluated as fully charge from the CBI, consequently the conditions for the test are only when the battery charger is in Floating / Trickle charge.

Procedure for the Manual Test:

- After 150 minute from the transition to Float charge the HR40100 is =1; this means “Device Ready for the Manual SoH Test”
- When such condition is met, start the test by writing 1 in HR40099. The test takes less than 1 minute.
- The test ends when HR40099 reverts to zero. A new test is possible in 12-15 min.
- Test Result:
  - Internal Battery Resistance “*Rint Meas*” units of 0.1 m Ohm measured during Manual Test: HR40115
  - Battery Manual SoH in % "State of Health" measured during manual test: HR40116
  - =0% when *HR40115* = HR40015 x 2.5
  - =100% when *HR40115* = HR40015

The HR40117 is for monitoring the type SoH test: =0 No test; =1 Manual Test in Progress; =2 Automatic Test in Progress

The battery datasheet usually states the typical battery internal resistance at room temperature. In the case the battery temperature probe is available, the CBI will compensate the battery nominal resistance for the battery measured temperature.

8.3.5 SoH Operation: Automatic SoH Test

The Automatic test results can be retrieved on the web server or via the Modbus or SNMP protocols using a suitable application.
The test is enabled only when the battery has been evaluated as fully charge from the CBI, consequently the conditions for the test are only when the battery charger is in Floating / Trickle charge.

Procedure for the Automatic Test:

- The test is activated automatically from the device and it is repeated every 90min in Float Charge
- Test Result:
  - Average Internal Battery Resistance “Long Term Rint Meas” units of 0.1 m Ohm measured during Automatic Test: HR40028
  - Battery Long Term SoH in % "State of Health" measured during automatic test: HR40021
  - =0% when *HR40028* = HR40015 x 2.5
  - =100% when *HR40028* = HR40015

The HR40117 is for monitoring the type SoH test: =0 No test; =1 Manual Test in Progress; =2 Automatic Test in Progress

The battery datasheet usually states the typical battery internal resistance at room temperature. In the case the battery temperature probe is available, the CBI will compensate the battery nominal resistance for the battery measured temperature.

Notice that the SoH values of HR40021 and HR40116 may be different because the HR40021 value is an average value over several evaluations and better describes the time-evolution of the battery state of health. When the battery reset command is issued (HR40069 = 1), the HR40021 SoH will be reset as well as the respective internal algorithm.

8.3.6 SoH Logging

Once a day the latest sample of “Long Term Rint Meas” (HR40028) and of “Battery SoH” (HR40021) are stored in the “Lifetime log” that can be accessed and downloaded via the web server.

9 DC Ups

9.1 Monitoring status and Fault conditions

9.1.1 Mains or Backup – Fail and Low Batt – Diagnosis and Charging.

9.1.1.1 STATUS: Mains or Backup: Input Mains On/Off.

- No.5 Output Open Collector Contact: 1
- No.6: LED

9.1.1.2 Fault Battery or Fault System

- No.4 Output Open Collector Contact: 2
- No.7: LED
- No.8: Led DIAGNOSIS: Diagnosis of the system through “blinking code” light signal

9.1.1.3 Fault Internal Rectifier

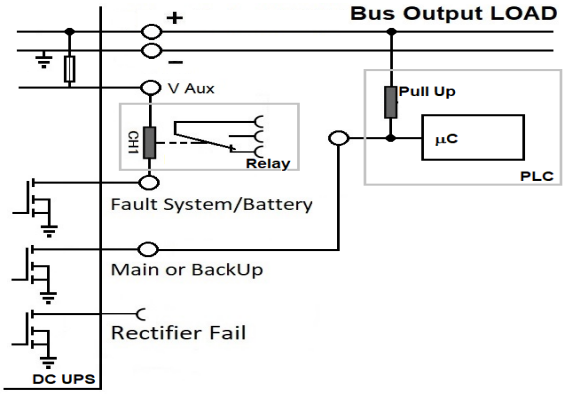
- No.23 Output Open Collector Contact: 3

9.1.1.4 Driver Contact open drain:

The devise provides 3 open drain drivers, referred to the Load negative terminal. Requires an external DC power source (max 48Vdc) or connect to V Aux (N°27) the positive pole Relay.
Drain current: 20 mA Nom ; 40 mA Max for 3 sec

Below are the Output conditions and LEDs

		Main Input Present		Fault System/Battery	
		Yes	No	Yes	No
Fail / Low Batt	LED	○	○ - ● <30%	●	○
	Relay Contact 8-10	■	■ batt < 30%	■	■
Main/ Back Up	LED	○	●	○	○
	Relay Contact 5-7	■	■	■	■
LED Diagnosis	Charging	Cyclic ●	○	○	Cyclic ●
	Diagnosis		○	Blinking ●	○



9.2 Input Device

For all devices the robust input range voltage is from 85 – 305 Vac, in this way all kind of environmental variations are taken into account. On the input side it is possible to measure and the record the voltage in real time and keep track of its min and max value in the history data. It is also possible to log the data

9.3 Output Load

9.3.1 Output Voltage

The output Load in normal mode, when the Mains Input Vac Voltage is available, follows the charging battery DC output voltage. The minimum and maximum range stabilized are the following:

- CBI6012: 11 – 14,4 Vdc; 15,5 Vdc for NiCd (Without battery connected out. Voltage set at 12.2Vdc)
- CBI6024: 22 – 28.8 Vdc; 30 Vdc for NiCd (Without battery connected out. Voltage set at 24.2Vdc)
- CBI 6048: 44 – 57.6 Vdc; 62 Vdc for NiCd (Without battery connected out. Voltage set at 48.4Vdc)
- The output voltage without battery connected can be changed with HR40158.

9.3.2 Output load management

By means of the remote communication interfaces it is possible to configure the management of the load output. In addition to load always ON or load always OFF, the load ON- and OFF- timings and therefore the duty-cycle can be programmed. Moreover, load activation and deactivation can be related to events such as external start button activation. This provides enhanced flexibility to the product.

9.4 Back up conditions: "Buffering Time"

The Current on the Load depend also from the Battery Size
Some example of buffering time depending on the LOAD Output as a function of the Ah of the battery.

Back Up Time	BATT 1.2 Ah	BATT 3 Ah	BATT 7.2 Ah	BATT 12 Ah	BATT 100 Ah
Load 1.5 A	20 min	60 min	200 min	400 min	/
Load 3 A	3.5 min	30 min	120 min	240 min	/
Load 5 A	1 min	15 min	55 min	100 min	/
Load 7.5 A	No	10 min	30 min	60 min	/
Load 10 A	No	7 min	20 min	45 min	20 h
Load 12 A	No	3 min	12 min	30 min	600 min
Load 15 A	No	No	9 min	20 min	400 min
Load 20 A	No	No	7 min	13 min	240 min

It is possible to set a buffering time by Web Server, Holding Register 40104

9.5 Start from Battery Only, No Input Mains Vac

The feature allows turning on the device and the load connected to it with the sole battery connected in the absence of mains.

Press the push-button for 3 sec max. (No. 9), in the front panel of the device to switch ON the system when mains is not available.
It is possible also to activate the contact from remote with an external push button mounted on the front panel or driven by a PLC. The connection is done using an RTCONN cable connected on the Start from Battery remote contacts (No.12).
Please notice that the remote Start from battery contacts also act as the UPS Enabling or Disabling control when "UPS disable" is selected in the device configuration or on the web server. Refer to sections 7.2.2. and 8.7 for further information.

9.6 Low Bat and Protection against total battery Discharge

During the Backup condition, the device continuously monitors the state of the battery.

9.6.1 Low Bat - Threshold alarm of Battery almost flat

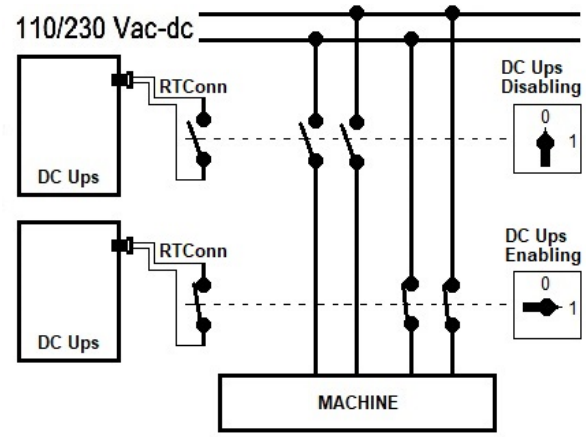
- When the battery voltage becomes lower than the threshold in **Volt**
  - The default values are on the data sheet for each product
    - the device switches the Relay and Turn ON the LED – see section 8.1.1.
  - It is also possible to use a remote communication to configure the alarm and receive it:
    - Modify the Low bat Threshold alarm by means of the Holding Register HR40097
    - Receive an Alarm on the Holding Register HR40035.1
- When the battery goes below the threshold in **SoC%**
  - It is possible to use a remote communication to configure the alarm and receive it:
    - Modify the SoC-low alarm threshold by the Holding Register HR40113
    - Receive an Alarm on the Holding Register HR40033.8

9.6.2 Low Voltage Deep Discharge battery - LVD Protections against total Battery discharge

- When the battery becomes lower than the threshold in **Volt**
  - The default values are on the data sheet for each product
    - the device automatically turns off to prevent a battery deep-discharge
  - It is possible to configure the threshold and delay time for the automatic power OFF using a remote connection as follows:
    - To modify the voltage threshold for switch off, Holding Register HR40071
    - To modify the Delay for switch off, Holding Register HR40107

9.7 UPS Disabling

This function is aimed at disabling the backup when the machine connected at the output load of the CBI is turned off. The backup function is enabled only in case the mains outage occurs when the machine is on. Please refer to the following figure



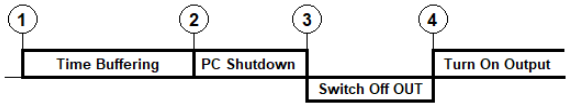
The functionality uses the Start from battery remote contacts (12) and the "UPS disable" control in the "Configuration->Device" panel of the webserver or the HR40088 UPS disable holding register. If the Start from battery remote contact (12) is shorted to ground (24), the UPS and therefore backup is enabled irrespective of the HR40088 setting and webserver control. If, on the contrary, the remote contact (12) is left open, the HR40088 and webserver control are used. Please refer to the following table for clarification.

	Start from battery (12) OPEN	Start from battery (12) SHORTED
HR40088 = 0 Webserver UPS disable not checked	Backup enabled	Backup enabled
HR40088 = 1 Webserver UPS disable checked	Backup disabled	Backup enabled

9.8 PC Shut Down

This feature allows to switch off a computer powered by the DC-UPS output load when the input mains becomes unavailable and the device powers the load from battery. If the PC shutdown feature is enabled, the DC-UPS monitors the mains status and drives the PC to initiate a controlled shutdown with precise timings.
In order to do that, it is necessary to install and configure the ADELViewSystem application to manage the PC shutdown using the ethernet-based Modbus TCP connection.
Setup of the DC-UPS:

- To enable the PC Shutdown feature, the value in HR40111 must be non-zero. Otherwise the PC shutdown algorithm will not be implemented and the UPS will turn itself off when the battery has discharged or when the buffering time (HR40104) has expired.
- After the DC-UPS setup steps have been done as described, in the case of mains outage the DC-UPS will implement the PC shutdown algorithm.
- Such algorithm is comprised of 4 steps, which are outlined below. Steps 1,2, and 3 have durations that can be configured by the user by means of specific holding registers, which are mentioned in the description of the relative step.
- The sequence of steps begins at the moment when mains becomes unavailable



A detailed description of each of the steps follows:

1 **Time Buffering**: During the Time Buffering phase, if the input mains becomes available again, the shutdown action is not done and the DC-UPS recharges the battery. The duration of this step can be set using HR40104 as described. If HR40104 = 0, the buffering time is limited by voltage or SoC only, as described in section 8.6 and the PC shutdown step is done only if HR40111 is nonzero, otherwise the device turns off.
- Write in the HR40104 the desired delay time value "Time Buffering". After such time has expired, the device to enters the PC Shutdown phase Step 2 if HR40111 is nonzero, otherwise the CBI will turn off.
- Moreover during the Time Buffering phase the device transitions immediately to Step 2 in the following cases:
  - if the battery voltage becomes lower than Low Bat HR40097
  - if the battery State-of-charge becomes lower than Low SoC HR40113
    - to enable this function it is necessary to configure at least one of the following Battery Capacity parameters HR40105,40106,40108,40109,40112
  - if the value 1is written into HR40041 "Force PC Shutdown"

2 **PC Shutdown**: at the onset of this step, the DC-UPS instructs ADELViewSystem to initiate the actual PC shutdown. If, during this step, the input mains becomes back available, the shutdown process continues without interruption.
- The duration of this step can be set using HR40111. It is important that the duration of this step be long enough to allow the PC to complete its shutdown.
  - Write in the HR40111 the desired time value for "Time PC Shutdown"; default value 60 sec.
- The device transitions to Step 3 at the expiry of this time

3 **Switch Off OUT**: during the "Switch Off OUT" time the device turns OFF the output Load terminals and keeps them off for the time specified in HR40034 even if the input mains becomes back available: the Switch Off OUT step cannot be interrupted.
- Write in the HR40034 the desired time value for "Switch Off OUT"; default value 20 sec. The value should be set long enough to ensure that the PC internal circuitry is completely reset – please refer to the PC user manual to set a suitable value

4 **Turn On Output**: in this step the DC-UPS performs its own shutdown if the input mains is not available, or turns back on the load output if the input mains is available.

9.9 Bar graph function

In normal operation the LED bar graph (No.19 in sect.7) gives an indication of the current (0 to 200% of In) as follows:

- In charge mode with mains: load current shown with **solid** light, battery charge current with **blinking** light
- In backup mode without mains: battery discharge current shown with **blinking** light, overload current (>In) with flickering light
- In boost mode with mains: total load current shown with **solid** light (up to In) and **flickering** lights (battery discharge current)

To display the current device configuration on the LED bar graph press the Config/Start button (No.9 in sect.7) briefly (< 1 sec). The display returns to normal operation after 10 seconds.

9.10 Protection Features

- **On the primary side**: the device is equipped whit an internal fuse. If the internal fuse is blown, most likely there is a fault in the device. In that case, the device must be returned to factory for analysis
- **On the secondary side (battery and load)**: The device is electrically protected against short circuits and overload.
- **Polarity reversal**: the module is automatically protected against reversal of battery polarity.
- **Over current and output short circuit**: the unit limits the output current (see the technical data).
- **Deep discharge**: not possible. The unit disconnects the battery when a minimum voltage level is reached.

9.11 Thermal behavior

No derating for surrounding air temperature up to 50°C. For ambient temperature above 50°C, the output current must be reduced by 2.5% per °C, max 70°C. At the temperature of 70°C the output current will be 50% of In. The equipment does not switch off in case of ambient temperature above 70°C or thermal overload. The devices are protected for Over temperature conditions "worst case"; in this situation the device shuts down the output and automatically restarts when the inner temperature falls within limit.

10 Networking

10.1 Device configuration by Ethernet

Configuration of the Ethernet interface by HTTP server via the Web browser:

10.1.1 Connect HTTP server for the first time

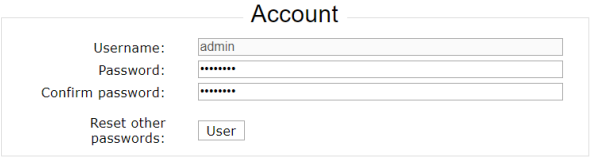
- Connect the device to the network with a standard CAT5e or better LAN cable plugged into the ETH connector (RJ45) on the device front panel. The device is factory-configured to operate with a fixed IP address (192.168.1.100) on the standard HTTP port (number 80).
- A different static IP address can be assigned to the device or a dynamic IP address can be assigned using the DHCP protocol. The network configuration can be carried out using the internal webserver. Type the IP address of the device into any browser's address bar (as an example "192.168.1.100") then the login page appears requesting the username and the password.
- To access the internal webserver, at the login page, the following credentials must be used:
- ***Username:*** *user, admin or service*
- ***Password:*** *password*
- Select the username according to the level of access required.
- Note: after 20 minutes of inacticity the login credentials must be entered again.

10.1.2 Customizing the ethernet interface and services

- Select "Configuration" and then "Network" to display the following groups of parameters and other informations:
- Account
- Generic configuration
- TCP/IP Configuration
- HTTP(s) Configuration
- SNMP
- CAN bus configuration
- e-mail

10.1.3 Account

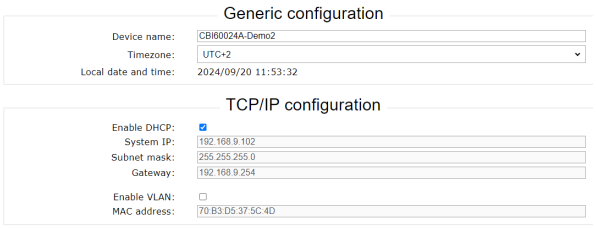
- The Account group allows the customization of the data for the HTTP server login page. Any changes must be confirmed with the confirm button at the bottom of the page.



Account settings

10.1.4 Generic and TCP/IP Configuration

- The picture below shows the TCP/IP Configuration group with parameter default values. They allow unique identification of the unit in the network.



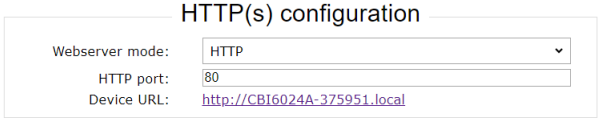
IP settings

If "Enable DHCP" is selected, the IP address is automatically assigned by a DHCP server, that must be active on the network; in this case the System IP, Subnet Mask and Gateway textboxes show the assigned values and are not editable.

The device supports access using the Virtual LAN protocol. In the case "Enable VLAN" checkbox is not selected the device will not operate in the VLAN. If "Enable VLAN" checkbox is selected then a "VLAN ID" textbox will appear and should be populated with an ID in the range 1 to 4094, matching the one of the VLAN the unit is operating in.
Any changes must be confirmed with the confirm button at the bottom of the page.

10.1.5 HTTP(s)

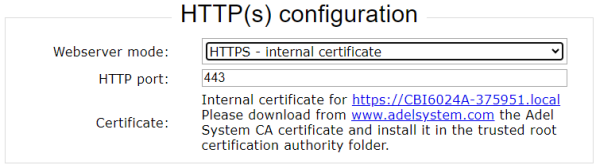
The DEVICE supports HTTP and HTTPs protocols. If the client system supports multicast DNS (mDNS) the device can be accessed by its name (as set under Generic Configuration) followed by ".local".



HTTPconfiguration

HTTP Port allows redirecting the HTTP traffic to a port different than the standard HTTP port 80. In that case, access to the HTTP server from a browser must be made using the syntax http://ipaddress:portnumber.
As an example, if the IP address is 192.168.1.100 and the selected HTTP port is 5678 then the following IP string should be entered in the browser http://192.168.1.100:5678.

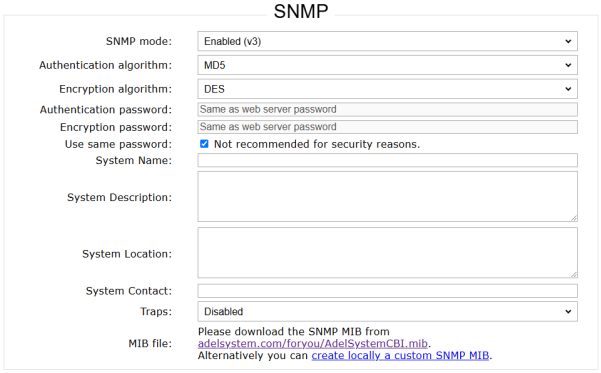
Secure HTTP (HTTPS) can also be selected, using an internal certificate or a certificate provided by the customer.



HTTP(s) configuration

10.1.6 SNMP

The device can act as SNMP server. An ADELsystem MIB table file can be downloaded from the webserver, which consists of a list of parameters that can be remotely read, or read-written through the SNMP protocol. Each parameter (OID) is mapped one-to-one to a Modbus RTU holding register. Refer to the document "Adelsystem parameter table" for the description of each parameter.



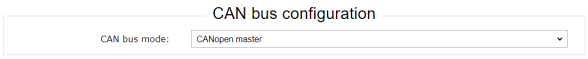
SNMP settings

All the fields in the SNMP group of settings allow a maximum of 31 characters, except "System Description" and "System Location", which allow 255 characters maximum. The actual content of the page depends on the SNMP version selected (v1, v2c or v3).

Any changes must be confirmed with the confirm button at the bottom of the page.

10.1.7 ADELBus configuration

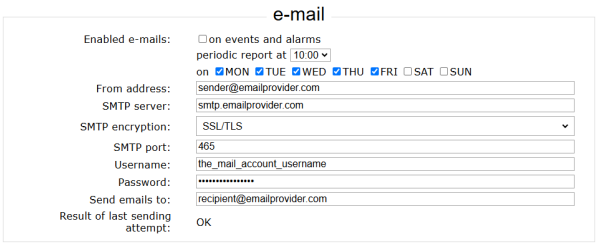
ADELBus is a CAN-based communications bus which is compatible with the CANopen standard protocol. For the correct functioning of the Adelsystem devices connected with the CBI via the ADELBus, the "CAN bus mode" must be set to "CANopen master".



CAN bus configuration

10.1.8 Email configuration

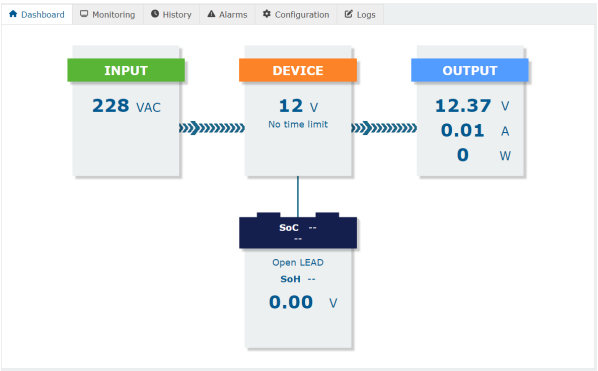
The device can be configured to send emails using the SMTP protocol on specific events and when one or more alarms are detected, or periodically to report alarms and events that occurred since the previous report along with the current operating data. Please refer to the SMTP server provider to set the correct "SMTP server name" and supported "SMTP encryption" and "SMTP port". Moreover, "Username" and "Password" refer to the credentials connected with the account of the "From address" mail account.



Email configuration

10.1.9 Device Dashboard

The Dashboard page shows the main operating parameters of the device.



Device status

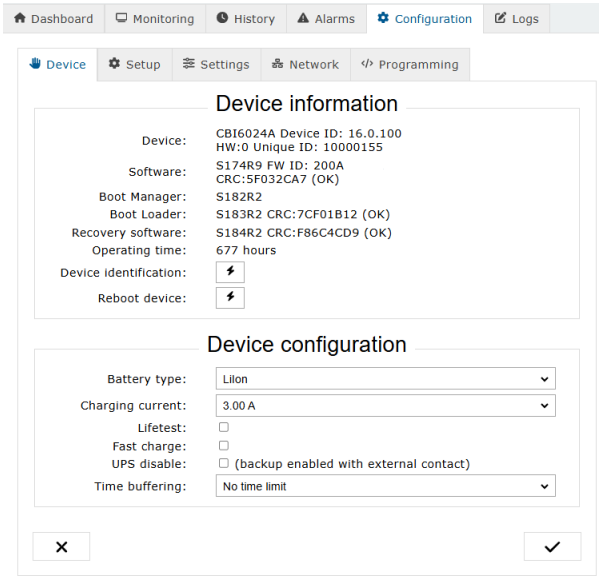
10.1.10 Device configuration by Web-Server

The Device page under Configuration shows detailed information on the device and installed software, to be communicated to the service technician if requested. The picture below shows example information: the actual values will be different.

The "Device Identification" button allows to locate the device by emitting a beep and turning on all the LEDs in sequence.
The "Reboot device" button allows to reboot the device remotely. Current settings will be maintained. Any changes not saved with the confirm button will be lost.

"Device configuration" replicates the settings some of which are also accessible on the device front panel by pressing the "battery start /Config" button (refer to section 7.2.2). Any changes must be confirmed with the confirm button at the bottom of the page.
"Battery type" selects the battery chemistry from a drop-down list.

The "Charging current" sets the battery charge current limit.



Device settings

10.1.11 Saving the customized parameters

To save the changes into the device non volatile memory press the confirm button at the bottom of the page.

10.2 How to restore default values in the device (Customer service)

10.2.1 Resetting the customized parameters to their default values

In case the login user name or password was forgotten, or the TCP/IP configuration was set incorrectly and the device is no longer reachable, please follow this procedure to restore the default settings:

- Turn OFF the device
- Press the CONFIG button 9 on the front panel and keep it pressed
- Turn ON the device and continue to keep the button pressed (all the 9 configuration LEDs (19) will stay ON during this time)
- After 5 seconds the 4 top configuration LEDs (n. 6 to 9) will blink alternatively in pairs while LED n.1 will blink slowly, indicating the first option is pending.
- Release the button
- Now click briefly on the button to select one of 4 options listed below, as shown by the configuration LEDs (19) n.1 to 4
- Confirm the choice by keeping the CONFIG button pressed for 5 seconds until the LEDs stop blinking. After that the device reboots automatically and is then ready for use

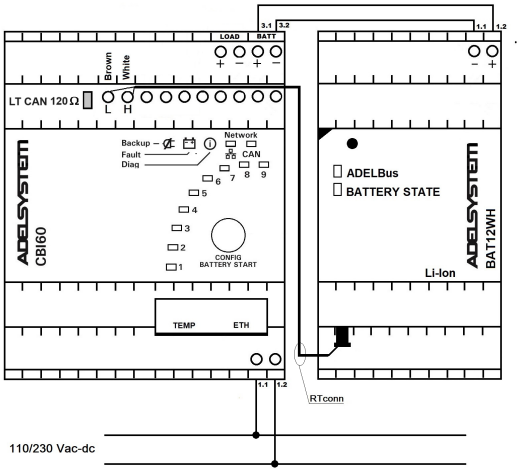
The four options help solve issues that may potentially occur especially during system installation and commissioning

- **1 – Force DHCP**: restarts the device with the DHCP enabled until reboot, in the case the DHCP was accidentally disabled leading to the device no longer being reachable via infrastructure. Notice that the TCP/IP configuration must be changed on the HTTP server in order to make this setting permanent
- **2 – Recovery application**: runs a tiny application that allows uploading a new application firmware in the unlikely event the current application is not operable or corrupted. Only to be used if instructed by customer service
- **3 – Reset network configuration**: restores the default values of the networking parameters, including the login credentials. After this operation, the device will be accessible at the default static IP address http://192.168.1.100
- **4 – Restore to factory defaults**: restores all the default values of the device. Notice that all the user's data such as battery chemistry selection, parameter customizations, histories, logs, etc. will be lost

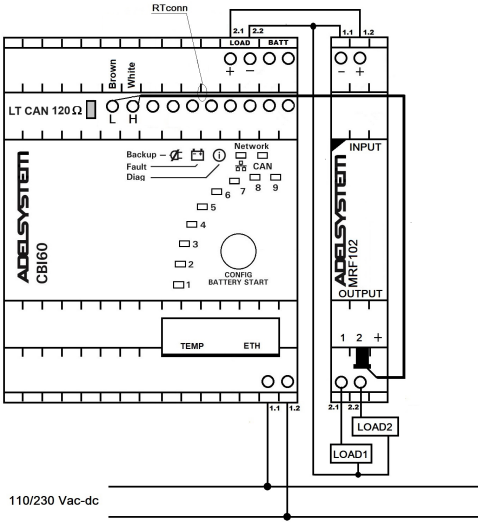
10.3 Connect ADELBus to devices

Remote device connection by terminals No 22.

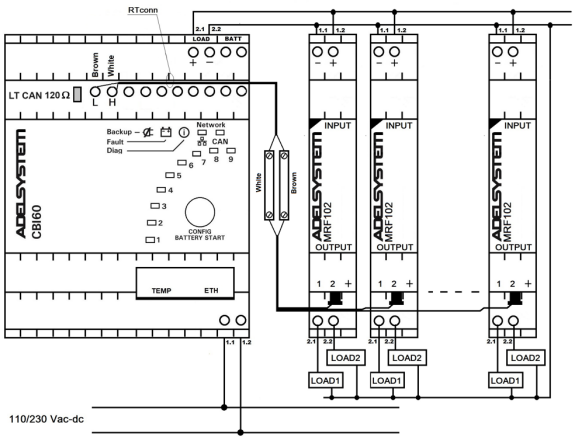
This device features thru the ADELBus name use CAN bus communication protocol for the connection of other devices, for monitoring, configuring, driving and updating them; follow the diagrams below:



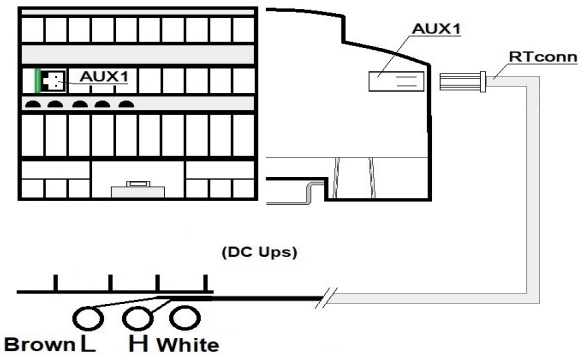
Connect DC Ups to Batt12Wh



Connect DC Ups to MRF102



Connect DC Ups to more than one MRF102



Connection RTConn cable

For the ADELBus connection, please connect the cable RTConn to AUX1 on the device as shown in the picture above and connect the other side of the cable to the CAN terminals L (Brown) and H (White) of the CBI60. The line termination (LT) is already enabled with Jumper present inside the device No 26.

11 Disposal guideline

Recycling all package and packaging aids. The device must be recycled not in domestic recycling.

12 Technical Data

Please Refer to the product Data Sheet

13 Din Rail Mounting

All modules must have a minimum vertical and horizontal distance of 10 cm to this power supply in order to guarantee sufficient auto convection. Depending on the ambient temperature and load of the device, the temperature of the housing can become very high.