DC Ups "All in One"

Instruction Manual

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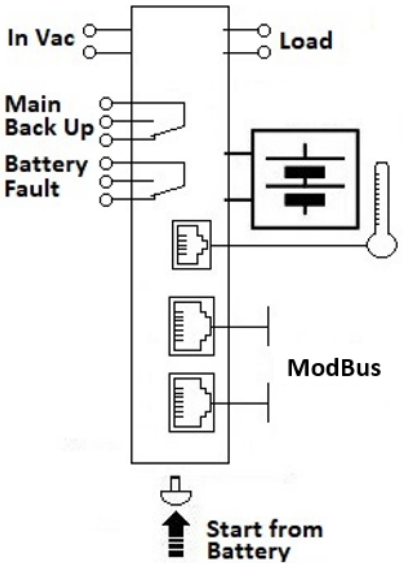
1 "All In One" DC Ups series

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

2 Product description

Thanks to the "All In One" CBI series of DC-UPS, it is 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 when required (Power Boost). When a mains failure occurs, the load continues to be supplied by the battery in backup mode without undershoot. It is also possible to switch on the device with no mains directly from battery. The "Battery Care" algorithm performs rapid and automatic charging, battery charge optimization over time, flat batteries recovery and real time diagnosis during installation and operation. Temperature compensation is possible by connecting the temperature sensor probe; it is provided as option. 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 unique blink code of Diagnosis LED or via Modbus (only in some models) in order to be easily detected and removed during the installation and normal operations. 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 by jumpers or DIP switches to optimize the charge of different battery types: Open Lead Acid, AGM, Gel Lead, Ni-Cd and Li-Ion (LiFePO4 and NMC), can be recharged using the same device. Charging curves can be customized via Modbus (only in some models). Output dry contacts are used to signal both backup and fault conditions. A rugged casing with bracket for DIN rail mounting provides IP20 protection degree.

3 Main Characteristics



- Universal input voltage: single-phase 115–230-277 Vac
- Load output:
  - 12 Vdc 3,6,10,15,35A
  - 24 Vdc 3,5,10,20A
  - 48 Vdc 5,10A
- Battery output:24 Vdc 3,5,10,20A; 12 Vdc 3,6,10,15,35A; 48 Vdc 5,10A
- "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 are available as options. 5-stage IUoU (Bulk, Absorption, Float, Battery Refresh) 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 reversed polarity
- Output dry contact for signaling Low Battery or Battery Replacement and System Fault.
- Output dry contact for signaling Mains or Backup
- IP20 protection degree
- Space saving on DIN rail
- ModBus RTU connection for Size3, Size4 and

3.1 Device sizes

Devices with the same "Size", as referred to throughout this document, share the same power and overall features. The following table allows identifying the size of a particular device

Size	Device family and overall features	Part numbers
1	CBI120W devices	CBI123, CBI126, CBI1210, CBI243, CBI245
2	CBI240W devices	CBI2410, CBI485
3	CBI600W devices, Modbus RTU, CAN	CBI1235, CBI2420, CBI4810
4	CBI280W device, selectable output 12/24V, Modbus RTU, CAN	CBI2801224A

4 Safety and Warning Notes

4.1 Safety Note

- 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. Substitution of components may impair suitability for class I, Division 2.

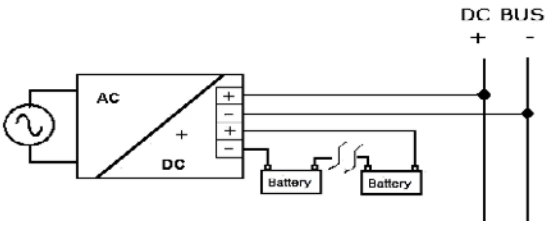
- WARNING – Switch off the system before connecting the module. Never work on the machine when it is live. The device must be installed in accordance with UL62368-1. The device must have a suitable isolating facility outside the power supply unit, via which can be switched to idle. Danger of fatal Injury!
- WARNING - Residual voltage. Wait for 10 seconds before operating on CBI2420A and CBI485A.
- WARNING - Caution high touch current.
- WARNING - Connect to earth before connecting to supply.

4.2 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.

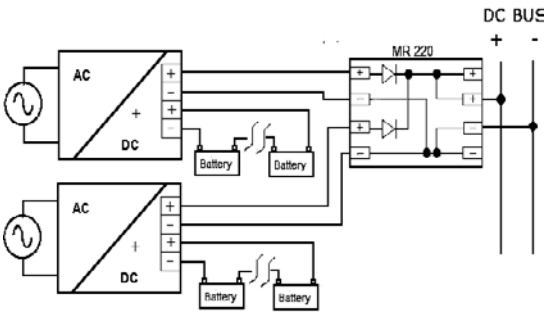
5 Diagram Configurations

5.1 Normal Configuration



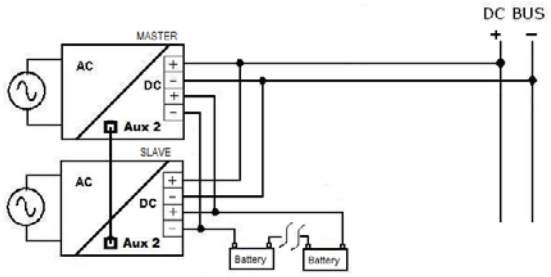
Typical application for All In One device, one output for Load “DC Bus”, one Input / Output for connection to the battery.
One 12-V battery for CBI 12xx;
Two 12-V batteries connected in Series for CBI 24xx;
Four 12-V batteries connected in Series for CBI 48xx;

5.2 Parallel Configuration “Redundancy”



Parallel connection “Redundancy”
Power supplies can be paralleled in case of redundancy to obtain a higher system reliability. Redundant systems may support N+1 redundancy to safeguard against single-point failures, or to enable hot-swapping of a failed supply without impacting the system. The simplest way is to put two CBI devices in parallel. In case one power supply unit fails, the other one is automatically able to support the load current without any interruption. To separate completely a hypothetical device failure, it is necessary to add the decoupling diodes which are included in the Redundancy Module MR220. Recommendations for building redundant power systems: a) Use separate input fuses for each CBI. b) Monitor the individual CBI units by three LED. Each unit has two relays: Mains or backup and Low Battery or Battery Replacement (faulty situation). This feature reports a faulty unit; see Relay Contact Rating for any technical detail. c) When possible, connect each power supply to different phases or circuits

5.3 Parallel Configuration “Double Power” (Size 3 devices only)

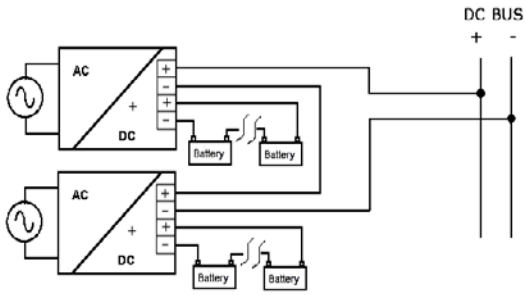


Two CBIs can be paralleled to increase the output power: devices can be paralleled for 1+1=2 to obtain double the power of a single unit. Only SIZE 3 devices can be connected in parallel to attain the sum of the currents at the same output voltage. For this, it is necessary to use a standard UTP cable or order the cable code: RJCONN45 for RJ45, and connect to Aux2 of each device. The communication protocol is based on ADELBus.
In this way the system has only one output for the Load and one connection for the battery. Use separate input fuses for each CBI.
How to configure the devices for parallel connection:

1 Connect the first device to the Input main Vac (the battery must be disconnected)
2 Set the Time Buffering rotary switch on position 9. Press 3 times the Config button N°9. After pressing the button 3 times, the Diagnosis LED N°8 starts Blinking 11 times.
3 The device is configured for parallel mode; set the Time Buffering rotary switch on position 0
4 Repeat steps 1,2, and 3 for the second device
5 Connect the Aux2 for each device with RJCONN45. Then, the two devices autonomously negotiate their role as master or slave. Such assignment is done at every power on, or after the connection of the RJ45 cable. The master device provides all the visual signaling; the Slave device keeps the diagnosis LED fixed ON.
6 Make sure that the two CBIs have the same settings: Battery type, Charging level current, Time buffering, Life test, etc..
7 Use the alarm contacts of both devices and drive them as needed.

8 In order to start the system from battery without mains voltage two possibilities exist:
   a. Press the Start button on both units
   b. connect Cable "RTCONN" on position 5, to connect the pushbutton to a remote control panel.

5.4 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 back feed voltage (e.g. from a decelerating motor or battery) to the output terminals.

6 Device Connections

6.1 Connection terminal and wiring

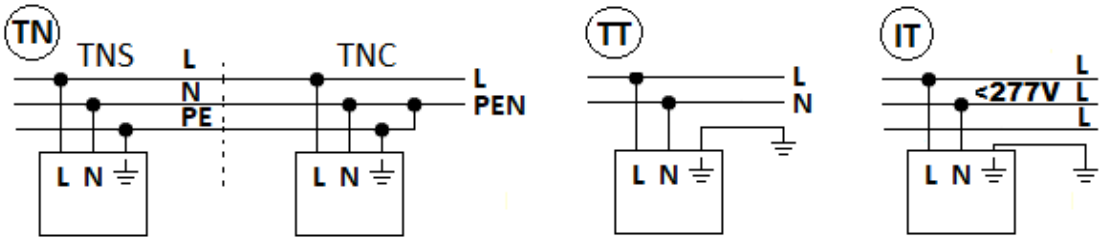
The following cable cross-sections may be used:

	Solid mm²	Stranded mm²	AWG	Torque (Nm)	Stripping Length	All In One (Size)
In:	0.2 – 2.5	0.2 – 2.5	24 – 14	0.5 – 0.6 Nm	7 mm	Size 1, 2
	4.0	6.0	30 – 10	0.8 – 1.0 Nm	7 mm	Size 3 and 4
Out:	0.2 – 2.5	0.2 – 2.5	24 – 14	0.5 – 0.6 Nm	7 mm	Size 1, 2
	4.0	6.0	30 – 10	0.8 – 1.0 Nm	7 mm	Size 3 and 4

Screw connection, type 2.5 mm² or 4.0 mm² terminal blocks. Wiring terminal shall be marked to indicate the proper connection for the power supply. Use copper cables only for supply connections.
AC main wirings shall be suitable for minimum 80 °C.
Protective Earth connection section must be minimum 4mm²/10AWG.

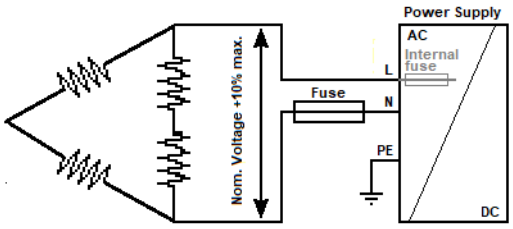
6.1 Connection Input Line System

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) with rated voltage 110 -240, 50 – 60Hz. Output Voltage 12 -24-48 VDC , isolated and no-load proof.



6.2 Operation on Two Phases

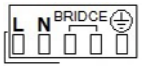
The power supply can also be used on two-phases of a three-phase-system. Such a phase-to-phase connection is allowed as long as the supplying voltage is below 277 V$^{+10\%}$.
Ensure that the wire, which is connected to the N-terminal, is appropriately fused.
The maximum allowed voltage between a Phase and the PE must be below 277 Vac.
In the devices Size 2 and 3 with the Bridge selection for nominal input 115 or 230Vac the max Voltage is:



- Input 115 Vac (With Bridge Wiring Connected): max allowed Voltage 135 Vac
- Input 230 Vac (No Bridge Wiring Connected): max allowed Voltage 277 Vac

6.3 Connection Input AC Port L – N: No.10

Single phase Switching Power Supplies L, N, PE ⊕.



Size 2 and Size 3 BRIDGE ONLY for input 115 Vac, and connect L, N, PE ⊕.

6.4 Connection Battery port: No.1

Connect the battery between: terminal 3 (–) and 4 (+)

In case of a system that utilizes 12-V batteries, wire as follows:

- One 12-V battery for CBI12xx;
- Two 12-V batteries connected in Series for CBI24xx;
- Four 12-V batteries connected in Series for CBI48xx;

Ready-made 24-V and 48-V battery packs are also available, especially in the case of NiMH and Li-Ion chemistries.

6.5 Connection Output Load: No.2

Connect this Output to the load, terminal 1 (–) and 2 (+).

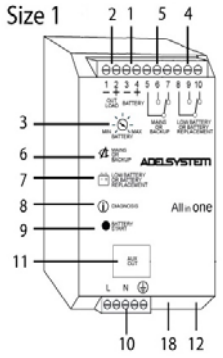
6.6 Select Output Voltage (Size 4 CBI280)

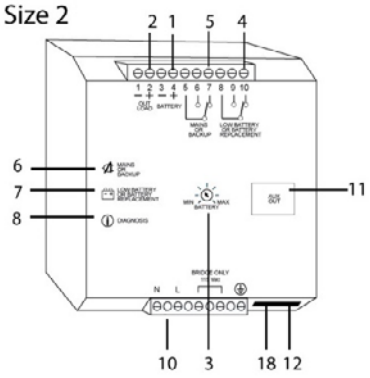
6.6.1 Select Output Voltage on Size 4 CBI280

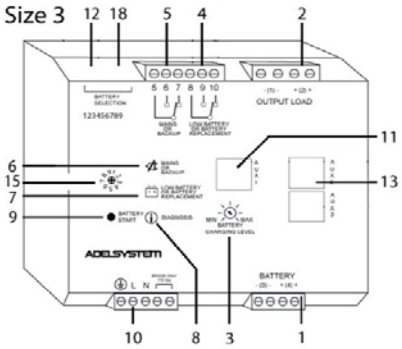
No.17: Caution: Switch off the system before setting the Jumper. The Jumper is detected at the device power-up only.

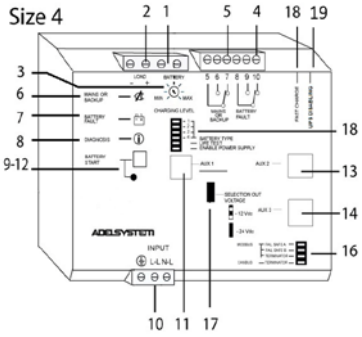
Output Voltage Selection	 – 24 Vdc	Jumper: 24V Output Voltage
Output Voltage Selection	 – 12 Vdc	No Jumper: 12V Output Voltage

6.7 Lay-Out and Connections









1	Battery
2	Load
3	Charging Current Limiter
4	Battery or System fault Alarm (or reconfigurable by Web Server)
5	Mains-Back Up
6	Mains-Back Up LED
7	Battery fault – System fault LED
8	Diagnosis LED / Charging
9	Configuration – Start from Battery - Push Button
10	Input Vac
11	Aux1: RJ temp – DPY353 – DPY351- Modbus (RTU)
12	Start From Battery (for Size2 only /S)
13	Aux2 Modbus “RTU” RS485 CAN
14	Aux3 Modbus “RTU” RS485 CAN
15	Time Buffering
16	Bus Termination: Modbus Configuration: Fail Safe and CAN
17	12/24 Output Selection
18	Fast / Boost Charge
19	Battery Config - Life test – Fast Charge – UPS Disabling- Time Buffering
21	Network Communication LED
22	ADELBus (CAN)
25	Battery Sense: Connect to pole + and – of the battery for SoH detection.
26	120 Ohm LT CAN. Insert Jumper or switch for Enabling
27	Option

7 Charge & Testing

7.1 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 the all basic battery check 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 ModBus.

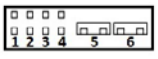
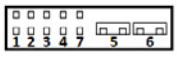
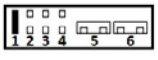
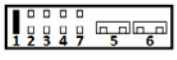
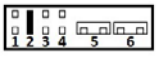
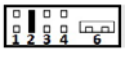
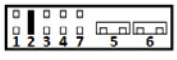
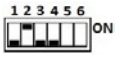
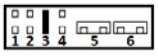
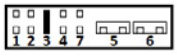
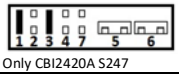
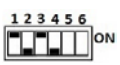
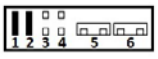
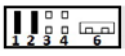
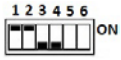
7.2 Charger

7.2.1 Battery Management Configurations for Size 1,2,3,4

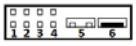
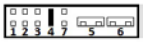
All devices are completely automatic and suitable to charge most batteries types thanks to the user-selectable charging curves by jumpers or dipswitches. The devices can charge open lead acid, sealed lead acid, Gel Lead, Lead crystal, NiCd, NiMH, Li-Ion (including LiFePO4) batteries. It is also possible to customize the charging curves with the DPY351 or ADELViewSystem.
Please notice that the battery type is read at the device power-up only, so it is not possible to modify it during operations.

7.2.2 Battery Type chemistry Selection

7.2.2.1 Battery Type chemistry Selection by means of dipswitches or jumpers

	Jumper Position Size 1	Jumper Position Size 2	Jumper Position Size 3	Dip Switch Position Size 4	Float charge (Volt/Cell)	Fast charge (Volt/Cell)
Open Lead Acid					2.23	2.40
Sealed Lead AGM / Lead Crystal					2.25	2.40
Sealed Lead GEL					2.30	2.40
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)
Ni-MH	-	-	 Only CBI2420A S247		1.5V/cell (24V:20 cells)	/
LiFePo4 Cell: 4-12V / 8-24V					3.45V/cell 12V system: 13.8V 24V system : 27.6V 48V system : 55.2V	3.65V/cell 12V system : 14.6V 24V system: 29.2V 48V system: 58.4V
Li-Ion Cell: 3-12V / 7-24V Configurable By ADELViewSystem					4.1 V/cell 12V system: 12.3V 24V system : 24.6V 48V system : 49.2V	4.1 V/cell 12V system: 12.3V 24V system : 24.6V 48V system : 49.2V

7.2.2.2 Setup to optimize the charging and the testing

	Jumper Position Size 1	Jumper Position Size 2	Jumper Position Size 3	Dip Switch Position Size 4	Function
Fast Charge Enable (1)					Jumper present: Fast Charge enabled. Remote Fast Charge enabling possible by RTCONN cable or via Modbus
Battery Life test ON					Jumper present or dip switch ON: Life test enabled, or via Modbus. Refer to section 7.3.3.1

1 If the Fast-charge jumper is inserted when a lead-based chemistry is selected, every 288h the device performs the "Cyclic Refresh Charging". This charging activity is aimed at rejuvenating and exercising the electrolyte of the battery after prolonged floating. Such stage lasts 85 minutes and subjects the battery to the fast-charge voltage level of bulk charge, e.g. 2.4V/cell.
In the case of Size 3, the jumper activates the fast charge only if the UPS Disabling function is not Enabled, otherwise such jumper acts as UPS Disabling (refer to section UPS Disabling)

7.2.2.3**Charging the NiMH batteries (devices Size 3 and Size 4 only)**

The NiMH charging algorithm requires that the battery temperature probe RJTEMP be connected to the CBI AUX1 connector, otherwise charging is not activated and an error is signaled by means of a 12-blink pattern of the diagnosis LED 8 while the fault LED 7 is lit. Accordingly, the fault system relay 4 is on alarm. The same condition is signaled over the Modbus by means of bit HR40032.10 = 1. The sensor end of the RJTEMP cable must be attached to the battery pack, so that the CBI can detect the steep increase in battery temperature that occurs when the NiMH battery is fully charged. Other charging termination criteria include flat battery voltage profile, charging timeout and charging current below Charging Absorption end of Charging current threshold % (HR40080).
When NiMH is selected, in the case of devices Size 3, the charging current limit is set using the trimmer only: HR40072 is just a readout of the current limit set by the trimmer. If the trimmer position is set for a current higher than 5A, charging is not activated or, if it has already started, it is stopped and an error is activated by means of a 14-blink pattern of the Diagnosis LED 8 (in conjunction with Fault System LED 7 and relay 4).
When the battery is fully charged, the CBI transitions to float charging implementing the so-called "*Intermittent float*" which alternates 1 minute of charging and 29 minutes of battery left floating.

7.2.2.4 **Variable number of cells for Li-based batteries**

Adelsystem provides two different charging profiles for two of the most common types of Li-based chemistries: LiFePO4 (3.2V/cell nominal voltage) and LiIon (3.6 or 3.7V/cell nominal voltage). To better fit the common battery packs commonly found in the industry, Adelsystem devices allow configuring the number of cells of the Li-based batteries using AdelViewSystem, writing parameter HR40157, according to the following table:

Output voltage	Chemistry	Default number of cells	Min number of cells	Max number of cells
12V	**LiFePO4**	4	3	4
	Li-Ion	3	3	4
24V	**LiFePO4**	8	6	8
	Li-Ion	7	6	8

7.2.3 Displaying the ongoing charging stage

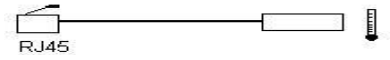
When mains is available and the battery is connected, the LED Diagnosis N°8 displays the ongoing charging stage by means of a blinking code. The same information is provided via Modbus, also.

	Charging Stage	LED Diagnosis ⓘ	LED Fault Battery
Charging Type	Float	1 Blink/2 sec	OFF
	Absorption	1 Blink/sec	OFF
	Bulk	2 Blink/sec	OFF
	Recovery	5 Blink/sec	OFF
	Purification	On	OFF

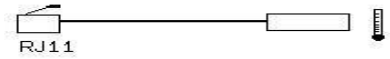
7.2.4 Battery Charger in a Temperature Compensated Environment

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.

Size 1,2,3



Size 4



P. Number	Device
RJTEMP451	Length 1m. DC-UPS Sizes: 1,2,3
RJTEMP453	Length 3m. DC-UPS Sizes: 1,2,3
RJTEMP111	Length 1m. DC-UPS Sizes 4; DPY351, CBI60
RJTEMP113	Length 3m. DC-UPS Sizes 4; DPY351, CBI60

7.2.4.1**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. of Cells from -8°C to +60°C +140 ÷ -200 mV/Cell compared to the value at 20°C	+/- 3mV/°C x n. of Cells from -20°C to +60°C +120 ÷ -120 mV/Cell compared to the value at 20°C
Fast Charge: Ni-Cd	**Float charge: Ni-Cd**
+/- 2.5 mV/°C x n. of Cells from -20°C to +60°C +100 ÷ -100 mV/Cell compared to the value at 20°C	+/- 2.5 mV/°C x n. of Cells from -20°C to +60°C +100 ÷ -100 mV/Cell compared to the value at 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.

In the CBI250 (Size5) the device stops charging the battery if the temperature is above +60°C. The sensor head of the RJTEMP temperature cable must be applied on one of the battery longer sides. In the range between -20 to -40°C the charger maintain the same charging voltage calculated for -20°C

In the case of NiMH and lithium-based chemistries, no temperature compensation is implemented.

7.2.5 Charging Current "limiter":

No.3 - In order to protect the battery from excessive charging currents, the device allows to limit the maximum charge current by adjusting the trimmer from 20% (Size 1, 2) or lower (Size 3, 4) to 100% of the rated current. The charging current limit range of the devices Size 3, Size 4 is according to the following table:

Size	Nominal output voltage (v)	Default value (mA)	Range (mA)
3	12	35000	1750-35000
	24	20000	1000-20000
	48	10000	500-10000
4	12	15000	300-15000
	24	10000	200-10000
5	12	10000	500-10000
	24	10000	500-10000

To determine the maximum battery charge current, see the battery manufacturer's Data Sheet or, if not available, consider that typically the maximum charge current is 10% of Ah's rated battery current, for all the chemistries.

7.2.5.1 Displaying and setting the charging current limiter in devices Size 3

In devices Size 3 the charging current limit can be set either using the trimmer on the device front panel (No.3) or the Modbus RTU holding register HR40072. In that device the trimmer as a priority comparing the HR40072. For this reason, if you want to use Modbus register it is mandatory rotate the trimmer in Max position and consequently insert the charging current limit value on the HR40072, such new value is used as charging current limiting value.

7.2.5.2 Displaying and setting the charging current limiter in devices Size 4

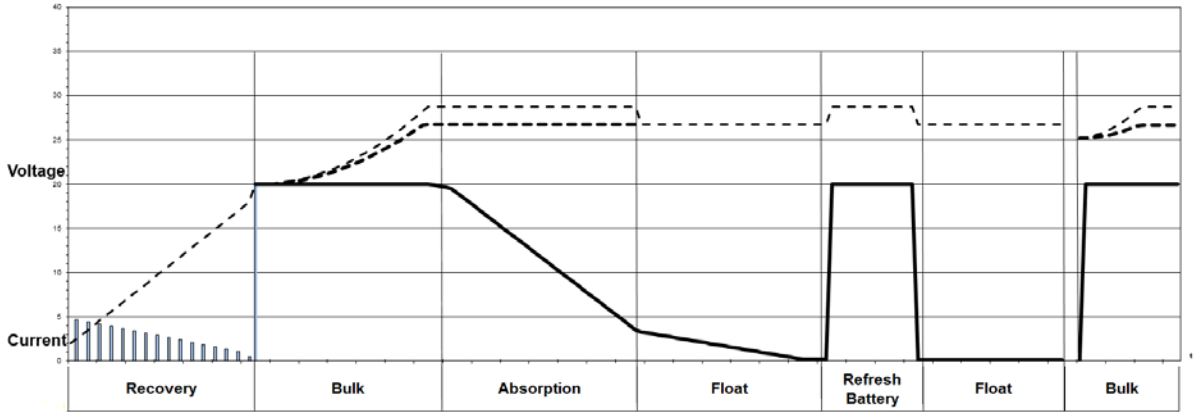
In devices Size 4 the charging current limit can be set either using the trimmer on the device front panel (No.3) or the Modbus RTU holding register HR40072. The latest setting is the one that is used, irrespective of it being set using the trimmer or the HR40072. By rotating the trimmer, the charging current limit value thus modified is displayed on HR40072. The value thus obtained is the new charging current limit value. If, on the contrary, a new value is written in HR40072 using the Modbus, such new value is used as charging current limiting value.

7.2.6 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 7.2.3).
When a battery is found to be deeply-discharged, the device activates the Recovery charge phase, which gently charges the battery up to the level at which bulk charge can be effected. Bulk charge is a constant-current phase which provides up to the 80% of the battery internal charge. When the bulk voltage has been reached, the device switches to absorption charging: such phase is a constant-voltage charging technique. When the decreasing charging current has reached the Charging Absorption end of Charging current threshold %, the device transitions to float charging.

7.2.7 Fast charge

The fast-charge function allows to select between two different voltage-profiles applicable to the sequence of charging phases outlined so far. If the fast-charge functionality is not active, the bulk and absorption charging stages are carried out at the same voltage level as the float charging stage. This selection allows to keep the Output Load voltage close to the nominal voltage (12, 24, 48V). If, on the contrary, the fast-charge jumper is engaged, the bulk and absorption charging stages are performed at their particular voltage levels which, by default, are significantly higher than the float level (refer to section 7.2.2.1). Moreover, when the fast charge is engaged the device activates the "Cyclic Refresh Charging" every 288h for 85 minutes at the bulk level.



7.2.7.1**Fast charge with Size 3 devices**

The fast charge with Size 3 devices can be remotely controlled using the Fast Charge/UPS disabling jumper (No.18).
The HR40088 "UPS Disable" parameter determines the function of the mentioned jumper.

If HR40088 = 1, the jumper is assigned to the UPS Disabling functionality, and the fast charge is only managed by means of HR40083 "Fast charge" holding register: if HR40083 = 1 the fast charge is enabled, if HR40083 = 0 the fast charge is disabled.

If, on the contrary, HR40088 = 0, the jumper is assigned to the activation of the fast-charge along with its respective parameter HR40083. The jumper takes precedence over HR40083: irrespective of the previous holding register value, if the jumper is inserted the fast-charge is enabled; if the jumper is removed, the fast-charge is disabled, but it is not possible to disable the fast-charge with the holding register while the jumper is engaged.
If, on the contrary, the jumper is not present, the holding register can be used to activate/deactivate the fast-charge feature as desired.
When the device is doing float charge, it is always possible to write the value 1 in the holding register or to insert the jumper to force a return-to-bulk charging.

7.2.7.2**Fast charge with Size 4 devices**

The management of the fast-charge feature for the Size 4 devices leverages the availability of a dedicated removable jumper for that purpose (other than the UPS Disabling jumper). The fast-charge functionality can be enabled both with the fast-charge jumper and the holding register HR40083.
The jumper takes precedence over the mentioned holding register: irrespective of the previous holding register value, if the jumper is inserted the fast-charge is enabled; if the jumper is removed, the fast-charge is disabled, but it is not possible to disable the fast-charge with the holding register while the jumper is engaged.
If, on the contrary, the jumper is not present, the holding register can be used to activate/deactivate the fast-charge feature as desired.
When the device is doing float charge, it is always possible to write the value 1 in the holding register or to insert the jumper to force a return-to-bulk charging.

7.2.8 Purification Charge

7.2.8.1**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:

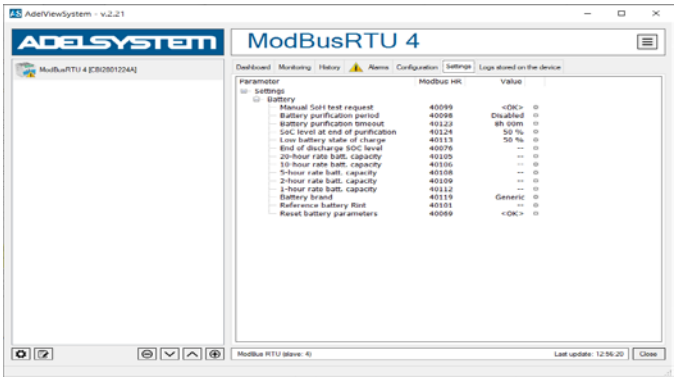
7.2.8.2**Two PURIFICATION TECHNIQUES**

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 jumper or switch is engaged.
     - For Lead-acid batteries only
     - Feature present in devices Size: 1,2,3,4.
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:
  - Feature present in device Size3 and 4
  - A Modbus connection to the CBI's AUX2 connector is needed, because purification is configured and activated only using the Modbus
  - Install ADELViewSystem on the PC, otherwise it is necessary to use a custom-developed software
  - Connect the CBI to the PC or PLC through a RJUSB280-1 cable; Cap. 11
- 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 HR40098 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



7.2.9 Charger Fail – Rectifier Alarm

To provide 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 alarm is activated.

7.2.9.1 How to test the Charger Fail

It is possible to simulate the function of the Charger Fail detector in CBI280 (Size4) and CBI600 (Size3) by double-clicking the Start Button to temporarily stop the charger. In a very short time the Charger Fail detector, independently, detects an unexpected issue in the charger and, as a consequence, provides the alarm on the register HR40043 bit 0 via Modbus and activates the fault relay and displays the fault by means of a pattern of 7 blinks of the Diagnosis LED.

Charger fail - Rectifier alarm test conditions:

- Test conditions:
  - Mains must be available
  - A battery must be connected with correct polarity

Start the Manual test

- Double-click the start button (size 3 and size 4).
- The internal switching power supply is temporarily deactivated
- The device detects a Rectifier Failure condition and activates the alarm providing the following information:
  - Battery Fault Alarm: ON
  - Diagnosis LED: blink 7 times
  - HR40043: bit0=1

- The internal switching power supply is automatically reactivated in 30s
- The device returns to the previous charging stage and provides the following information:
  - Battery Fault Alarm: OFF
  - HR40043: bit0=0
  - Diagnosis LED according to table in section 7.2.3

7.2.10 Charger parameters

The charger parameters are quantities that can be read only or read and written via the Modbus RTU interface of devices Size 3, Size 4.

It is possible to manage the device from an external device such as DPY351, AdelViewSystem or a custom software connected to Aux2 (Size 3 and 4). Below are the parameters related to the Charger function

Feature	Description	Read/ Write	Holding Address	Category
Battery Info	Battery Brand (set by user)	R/W	40119	Settings
Battery Curent	Battery type currently selected	R	40024	Monitoring
Battery Status Alarm	Battery Alarm "Temperature sensor failure"	R	40044	Alarm
Battery Status Alarm	Battery Alarm NiMH charging: temperature probe not connected	R	40032.10	Alarm
Battery Status Alarm	Battery over temperature	R	40032.5	Alarm
Battery Temperature	Battery temperature	R	40026	Monitoring
Battery Temperature	Battery temperature	R	40026	Monitoring
Battery Type	number of Cells inside the battery	R	40089	Monitoring
Battery Voltage	Voltage Charging level "instantaneous value"	R	40008	Monitoring
Battery Voltage	Current Charging level "instantaneous value"	R	40014	Monitoring
Charging Curve Configuration	Charging Current limiting Value	R/W	40072	Configuration
Charging Curve Configuration	Charging Bulk voltage	R/W	40073	Configuration
Charging Curve Configuration	Charging Bulk Timeout	R/W	40074	Configuration
Charging Curve Configuration	Charging Bulk min. duration	R/W	40075	Configuration
Charging Curve Configuration	Charging Absorption Voltage	R/W	40077	Configuration
Charging Curve Configuration	Charging Absorption Timeout	R/W	40078	Configuration
Charging Curve Configuration	Charging Absorption min. duration	R/W	40079	Configuration
Charging Curve Configuration	Charging Absorption end of Charging current threshold %	R/W	40080	Configuration
Charging Curve Configuration	Charging Absorption end of charging delay	R/W	40081	Configuration
Charging Curve Configuration	Charging Float Voltage	R/W	40082	Configuration
Charging Curve Configuration	Boost Charge Enabling	R/W	40083	Configuration
Charging Curve Configuration	Charging Float to Bulk Voltage	R/W	40084	Configuration
Charging Curve Configuration	Charging Float to Bulk delay	R/W	40085	Configuration
Charging Curve Configuration	Charging temperature coefficient	R/W	40090	Configuration
Charging Curve Configuration	Battery overtemperature threshold	R/W	40093	Configuration
Charging Curve Configuration	Charger Chemistry selection	R/W	40091	Configuration

Feature	Description	Read/ Write	Holding Address	Category
Charging Curve Configuration	Battery undertemperature threshold	R/W	40094	Configuration
Charging Curve Configuration	Charger Float/Trickle selection	R/W	40147	Configuration
Charging Status	Charging status: 0=None / 1=Recovery / 2=Bulk / 3=Absorption / 4=Float/5=Purification	R	40005	Monitoring
Fail Internal device	Rectifier fail	R	40043.0	Alarm
History Data Charger	Number of completed charge cycles	R/W	40048	History
History Data Charger	Number of not completed charge cycles	R/W	40049	History
History Data Charger	Total Ampere-hours charged	R/W	40050	History
History Data Charger	Total run time in charging mode	R/W	40051	History
History Data Charger	Highest voltage acquired at the battery terminals	R/W	40059	History
Jumpers Configuration	Jumper selected	R	40025	Monitoring
Purification Charge	Purification period	R/W	40098	Settings
Purification Charge	Battery Setting Purification: Timeout of the battery purification	R/W	40123	Settings
Purification Charge	Battery Setting Purification: state of charge level to reach to end the battery purification	R/W	40124	Settings
Switch off charger	Disable charging	R/W	40148	Configuration

7.3 Battery Tester

7.3.1 Diagnosis and Control by Blink LED

All CBI devices support the user during 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.

	Status	Diagnosis	Fault Battery
Auto Diagnosis System	Reverse polarity or high battery Voltage (over 32.5Vdc for CBI 24xxA)	1 Blink/pause	ON
	Battery not connected	2 Blink/pause	ON
	Battery element in Short Circuit	3 Blink/pause	ON
	Overload or short circuit on the load	4 Blink/pause	ON
	Bad battery; high internal impedance or bad battery wiring	5 Blink/pause	ON
	Life test not possible	6 Blink/pause	ON
	Charger Fail	7 Blink/pause	ON
	Boost condition; battery discharge after 10 sec. of overload	8 Blink/pause	ON
	Internal fault	9 Blink/pause	ON
	Low battery (under 20Vdc for CBI 24xxA) Only if started from battery, no Mains input, from Jumper N°5 or Push Button	10 Blink/pause	ON
	Master-Slave connection lost between the master and slave on parallel configuration, (AP device only 500W)	11 Blink/pause	ON
	Battery temperature cable not connected – charging cannot start (only when NiMH is selected)	12 Blink/pause	ON
	Bad battery wire connection; Parallel mode on Slave Device (AP device only 500W)	13 Blink/pause	ON
	Charging current limit too high – charging cannot start (only for Size 3 when NiMH is selected)	14 Blink/pause	ON
	Boost condition; battery discharge after 4 min. of overload; Parallel mode on Slave Device (AP device only 500W)	15 Blink/pause	ON

7.3.2 SoC "State of Charge"

The algorithm for the estimation of the battery State-of-Charge "SoC" implemented in Sizes 3,4, 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.

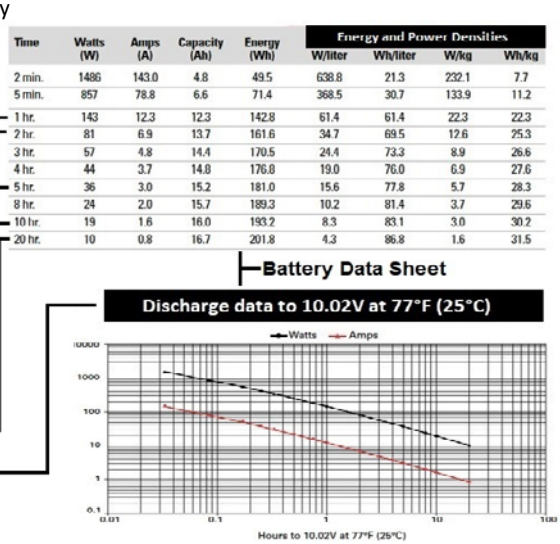
Since both the state-of-charge and the state-of-health depend on the battery ratings, it is essential that the correct battery parameters be set in the CBI. Such group of parameters will be referred to as the "Battery settings"; they can be dialed in the CBIs using the Modbus Holding Registers as the other Modbus parameters.

7.3.2.1**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 are provided .

The values must be entered in units of 10th 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. Similar to all the Battery Settings parameters. However, it can be written even if the battery is wired.

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 10th 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.

7.3.3 SoH "State of Health"

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

7.3.3.1 Set Up the device for SoH Measurement – Activation of the Life test

In order for the device to be able to carry out SoH measurements, the Life test must be enabled.
In devices Size 1 and Size 2 the Life test is enabled simply inserting the jumper in position 4.
In device Size 3, Size 4 the Life test can be enabled/disabled both via a local control or remotely via HR40092 using the Modbus connection.

The local control of the Life test for the various device is as follows:

- Dipswitch N°5 in position ON for CBI280 Size 4
- Jumper in position N°4 for device Size 3

In the case of devices Size 3 and Size 4 the jumper or dipswitch takes precedence over HR40092: irrespective of the previous holding register value, if the jumper/dipswitch is engaged the Life test is enabled; if the jumper/dipswitch is disengaged, the Life test is disabled, but it is not possible to disable the Life test with the holding register while the jumper/dipswitch is engaged.
If, on the contrary, the jumper or dipswitch is not engaged, HR40092can be used to activate/deactivate the Life test feature as desired.

7.3.3.2 Cable Configuration

It is necessary to set how the multimeter inside the device should test the battery with or without the Battery Sense connection. The SoH measurements can be carried out directly from the battery power cables. In such case the cables resistance must be known and set into the CBI. For this purpose, the CBI can conveniently and autonomously compute the cables resistance. The Battery Sense Connection allows taking the measurements directly at the battery posts thus bypassing the resistance of the power cables connected between the device and the battery, thus providing a higher degree of measurement accuracy at the expenses of a slightly more complicated harness (four cables instead of two).

So, it is possible to choose to configure the devices with or without the Battery Sense connection

- Battery Sense connection YES; only for the device Size4 (Fig.5)
  - Connect the N°2 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
- Battery Sense connection for the device Size3 and device Size4 (Fig.6)

  It is possible to acquire the cable resistance in auto acquisition mode, by using the Wizard provided by ADELViewSystem Software or,
  - It is possible to provide the cable resistance, if it is known, by entering the value in HR40102

The Size 4 devices can operate either with or without the battery sense connections. If the battery sense cables are correctly connected as in Fig.5, the device automatically detects them and uses them for the battery internal resistance measurements. In such case the battery cables resistance measurement information (HR40102) is neither needed nor used. This configuration is the one which ensures the maximum measurement accuracy because it is not influenced by the battery cables resistance.
If, on the contrary, the battery sense cables are not wired or are not correctly wired (e.g. wired with reverse polarity), the Size 4 device will make use of the battery cables resistance (direct write to HR40102 in units of 0.1mohm or use the mentioned wizard) to compute the battery internal measurement; if no cable resistance is provided (HR40102=0) the device will not carry out the battery internal resistance measurement.

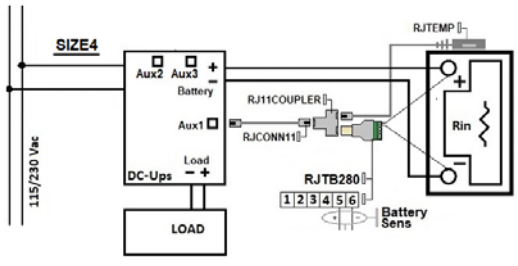


Fig.5

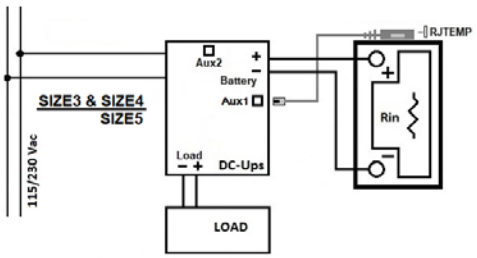


Fig.6

7.3.3.3 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: 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

7.3.3.4**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 Rint Nom 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

7.3.3.5**SoH Operation: Manual Test**

The Manual test allows carrying out a battery internal resistance measurement on demand. Since the measured battery internal resistance may vary according to the actual battery state of charge, such measurement is, for all product size, carried out only during float charging, when the battery has been fully charged.

For Size 5 devices, in addition to float charging, it is possible to carry out the Manual Test at any time during charging by activating the Service Mode (activated by writing 1 to HR40156). This mode allows interrupting the charging process at any time, not only when the battery is fully charged. In such condition it is possible to request a Manual Test. Since the Service Mode can be activated at any point in the charging process, it is up to the user to make sure that the battery is fully charged prior to carrying out a Manual Test; otherwise the measured battery internal resistance might be less accurate.
However, in many situations such as battery commissioning, it is important to have a first evaluation of the battery SoH even if not extremely accurate: this allows avoiding installing a battery that already damaged or even dead-on-arrival, thus saving time and enhancing the system reliability.

The Manual test can be triggered by means of the DPY351, ADELViewSystem or by a customized SW.

Procedure for the Manual Test:

- For all product sizes: after 150 minutes 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

Note that in the case of Size 5, in order to restart the charging, the service mode should be deactivated (by writing HR40156 = 0) if it had been previously activated to carry out the manual test.

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.

7.3.3.6**SoH Operation: Automatic SoH Test**

The Automatic test can be carried out by means of DPY351, ADELViewSystem or by a customized SW.
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 long as the respective internal algorithm.

7.3.3.7 SoH Logging

The data logging can be configured by means of DPY351, ADELViewSystem or by a customized SW. According to the specified data sampling period, the latest sample of "Long Term Rint Meas" (HR40028) is stored in a circular non-volatile buffer that can be accessed by means of DPY351, ADELViewSystem or by a customized SW.

Procedure for Setup the Data Logging:
The device is able to log 250 values of the "Long Term *Rint Meas"* collected, using the Automatic Test HR40028.

- Data Sampling period of Rint Meas. : HR41003 (range: 7 – 365 days; default 30 days)
- To read the logged value, write 27 to HR41002
- Test Result
  - Age of the latest sample: HR41004
  - Number of samples in the log: HR41005
  - Logged values: HR41007 – HR41256

7.3.4 Battery Alarm

By the contact Relay N°4 the device switch when happen fail on the battery, or bad connection, or bad charging system. To understand the right cause of the failure the device provides two way to understand:

1. True Blink code by the LED Diagnosis N°8
2. True Modbus Holding Register

- The Main register for the **Battery Fault** is HR40032
  for all Bit 1…10 provide Alarm data for bad Battery or bad battery condition as:
  - HR40032.0 Reverse Battery Connection
  - HR40032.1 Battery not connected
  - HR40032.2 Internal Battery cell shorted
  - HR40032.3 Sulphated or damaged Battery; if Life Test Enabled
  - HR40032.7 Bad battery Cable or connection

- The register **Low Batt**: HR40035.1
  Provide Alarm Information about the Battery energy below the threshold value default 30%; in the state of Charging and Back Up situation.
  Alarm goes to 1 when, the Battery Voltage or the Battery SoC goes lower than the following Parameters:
  - by Voltage Low Batt threshold HR40097
    or
  - by Low Soc threshold HR40113 and One of the 5 parameter Battery Capacity

7.3.5 Battery tester parameters

The battery tester parameters are quantities that can be read only or read and written via the Modbus RTU interface of devices Size 3 and Size 4 only.

It is possible to manage the device from an external device such as DPY351, AdelViewSystem or a custom software connected to Aux2 (Sizes 3 and 4). Below are the parameters related to the battery tester

Feature	Description	Read/ Write	Holding Address	Category
Alarm Battery Status	Reversed polarity	R	40032.0	Alarm

Feature	Description	Read/ Write	Holding Address	Category
Alarm Battery Status	battery not connected	R	40032.1	Alarm
Alarm Battery Status	internal cell shorted	R	40032.2	Alarm
Alarm Battery Status	Sulfated Battery in Life Test	R	40032.3	Alarm
Alarm Battery Status	bad battery cable or connection	R	40032.7	Alarm
Alarm Battery Status	"Nominal voltage battery Wrong"	R	40035.0	Alarm
History Data Fail Charger	Low battery voltage events (Lower than HR40097)	R/W	40052	History
History Data Fail Charger	Number of high voltage events at the battery output	R/W	40053	History
History Data Fail Charger	Lowest voltage acquired at the battery terminals	R/W	40062	History
SoC & SoH Reset	Battery Setting: Reset the parameter to Default	R/W	40069	Settings
SoC Battery Setting	Battery capacity "C20"	R/W	40105	Settings
SoC Battery Setting	Battery capacity "C10"	R/W	40106	Settings
SoC Battery Setting	Battery capacity "C5"	R/W	40108	Settings
SoC Battery Setting	Battery capacity "C2"	R/W	40109	Settings
SoC Battery Setting	Battery capacity "C1"	R/W	40112	Settings
SoC Battery Setting	Battery capacity Voltage at 100%	R/W	40120	Settings
SoC History Data	Maximum depth of discharge	R/W	40061	History
SoC History Data	Average depth of discharge	R/W	40064	History
SoC Measurement	Capacity consumed in discharge	R	40016	Monitoring
SoC Measurement	Effective battery capacity	R	40018	Monitoring
SoC Measurement	Remaining time to 0% during discharge	R	40022	Monitoring
SoC Measurement	Periodic Test Value %	R	40023	Monitoring
SoH Battery mOhm	Manual test: Battery resistance RintMeas	R	40015	Monitoring
SoH Battery mOhm	Automatic test: Battery resistance RintMeas	R	40028	Monitoring
SoH Battery mOhm	Manual test: Battery resistance RintMeas	R	40115	Monitoring
SoH Battery Setting	internal resistance from datasheet SoH	R/W	40101	Settings
SoH Cable Enabling Test for	Start cable resistance Measurement SoH	R/W	40040	Settings
SoH Cable Setting	Cable resistance SoH from ex. Data	R/W	40102	Settings
SoH Control Indicators	Battery sense voltage	R	40004	Monitoring
SoH Control Indicators	Battery Alarm SoH: Check battery sense cable	R	40032.8	Alarm
SoH Control Indicators	battery sens cable - reverse polarity	R	40032.9	Alarm
SoH Control Indicators	Battery Alarm SoH periodic "SoH lower than 30%"	R	40033.0	Alarm
SoH Control Indicators	"Rin Meas not possible"	R	40033.10	Alarm
SoH Control Indicators	"SoH calculation not possible"	R	40033.11	Alarm
SoH Control Indicators	"measurement of Rint not possible: battery resistance is too high"	R	40033.12	Alarm
SoH Control Indicators	Manual SoH test "SoH lower than 30%"	R	40033.7	Alarm
SoH Data Logger	Battery Internal resistance (RintMeas) Time-course stored in the Device SoH	R/W	41002	Log
SoH Data Logger	Time between two consecutive (RintMeas) readings SoH	R/W	41003	Log
SoH Data Logger	Age of the latest sample (RintMeas) in the Log SoH	R/W	41004	Log
SoH Data Logger	Number of samples (RintMeas) currently in the Log"	R/W	41005	Log
SoH Data Logger	Sampled values (RintMeas) currently in the Log SoH	R/W	41007-41256	Log
SoH Enabling Manual test	Launch Manual test SoH	R/W	40099	Settings
SoH Enabling Manual test	Manual SoH test Possible	R/W	40100	Monitoring
SoH Enabling Test	SoH Enabling Measure	R/W	40092	Configuration
SoH Progress type test	Test in progress: No test/Manual/Periodic	R	40117	Monitoring
SoH Value in %	Automatic Test:SoH Value %	R	40021	Monitoring

Feature	Description	Read/ Write	Holding Address	Category
SoH Value in %	Manual Test:SoH Value %	R	40116	Monitoring

8 DC Ups

8.1 Monitoring status and Fault conditions

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

Below are the conditions of Relays Contacts and LEDs

		Main Input Present		Fault System/Battery	
		Yes	No	Yes	No
Fail / Low Batt < 30%	LED		- <30%		
	Relay Contact 8-10		batt < 30%		
Main/ Back Up (1)	LED				
	Relay Contact 5-7				
LED Diagnosis	Charging	Cyclic			Cyclic
	Diagnosis			Blinking	

Note:
(1) Contact relay Mains/Backup switch at least 5 seconds after disconnection of Power.

8.1.2 Relay Contact Rating

Max.DC1: 30 Vdc 1 A; AC1: 60 Vac 1A: Resistive load (EN 60947-4-1).Min.1mA at 5 Vdc: Min. permissive load

8.2 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 the measure and the record the data voltage min. max. and Avg. in real time. It is also possible to log the Data; only for Size3, Size4 by Modbus

8.3 Output Load Device

8.3.1 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:
CBI 12xx:11 – 14,4 Vdc; 15,5 Vdc for NiCd (Without battery connected out. Voltage fixed at 12Vdc)
CBI 24xx:22 – 28.8 Vdc; 30 Vdc for NiCd (Without battery connected out. Voltage fixed at 24Vdc)
CBI 48xx:44 – 57.6 Vdc; 62 Vdc for NiCd (Without battery connected out. Voltage fixed at 48Vdc)

8.3.2 Power Management Philosophy

Thanks to the All In One units, it is possible to manage the available power and automatically sharing it between load and battery: supplying power to the load is the top priority of the unit; thus it is not necessary to double the power and also the power available for the battery will be smoothly transferred to the load if the latter requires it.
In "Power Boost Mode" the maximum current on the load output is the 2 times the rated current 2 x In (Iload = In+ Ibatt) in continuous operation and 3 times the rated current 3 x In (Iload = 2In+ Ibatt) for 4 seconds; after this power the devices is electrically protected against overload and short circuit.

- In "Power Boost Mode", if, despite the mains being available, the battery provides current to the load for more than 10 sec., the device outputs a message (8 Blink) to warn that the battery is discharging.
- If the Mains Input Voltage falls below a Threshold level (50% of the Typ. Vac input) the battery is immediately connected to the Output Load, without any interruption.
- Voltage dips: In this situation the voltage in the output load is the same of the battery.
- **To avoid Low Voltage Deep Discharge battery (LVD)**, the battery will supply the load until the battery voltage reaches the minimum V/cell. Below this level the device automatically switches off to prevent Deep discharge and battery damage.

8.4 Back up conditions: Time remaining, Current on the Load, Battery Size

Some example of buffering time depending on the LOAD Output as a function of the Ah of the battery.

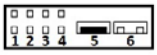
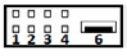
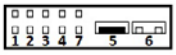
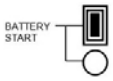
Back Up Time	BATT1.2 Ah	BATT 3 Ah	BATT7.2 Ah	BATT12 Ah	BATT100 Ah
Load 1.5 A	20 min	60 min	200 min	400 min	➢ 1gg
Load 3 A	8 min	30 min	120 min	240 min	21 h
Load 5 A	3 min	15 min	55 min	100 min	12 h
Load 7.5 A	2 min	10 min	30 min	60 min	8 h
Load 10 A	No	7 min	20 min	45 min	6 h
Load 12 A	No	3 min	12 min	30 min	300 min
Load 15 A	No	No	9 min	20 min	250 min

Load 20 A	No	No	7 min	13 min	180 min

8.5 Start from Battery Only, No Input Mains Vac

The feature allows turning on the device and the load connected to it with the only 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. (Not present in CBI 2410XX and CBI 485XX)
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 Jumper n.5 (No.12). The function is the same as the push button. The function is standard for all products, for Size 2 only with code CBI2410A/S and CBI485A/S Jumper n.6 (No.12). Use only a remote momentary pushbutton, do not leave any jumper in this position, otherwise the system will discharge completely the battery in the case mains is not available.

	Jumper Position (Size 1)	Jumper Position (Size 2)	Jumper Position (Size 3)	Dip Switch Position (Size 4)	Function
"Start from Battery" (No Input Mains)					The device Turn ON from battery without mains. For the connection to external the Push button in front panel, use RTCONN cable.

Only for Size3 and Size4 : if the battery is too Low the device provide an Alarm on the Holding Register HR40035.2

8.6 Low Bat and Protection against total battery Discharge

During Backup, the device continuously monitor the state of the battery.

8.6.1 Low Bat - Threshold alarm of Battery almost flat -> Alarm in HR40035.1

- When the battery voltage becomes lower than the fixed value in **Volt**
  - The default values are on the data sheet for each product
    - the device switches the Relay and Turn ON the LED. Please see the chapter 9.1.1
  - For the product of Size3 and Size4 it is possible to use Modbus to configure the alarm and receive it:
    - Modify the Low bat Threshold alarm by means of the Holding Register HR40097
- When the battery goes less than the fixed value in **SoC**
  - For the product Size3 and Size4 it is possible to use Modbus to configure the alarm and receive it:
    - Modify the SoC-low alarm threshold by the Holding Register HR40113

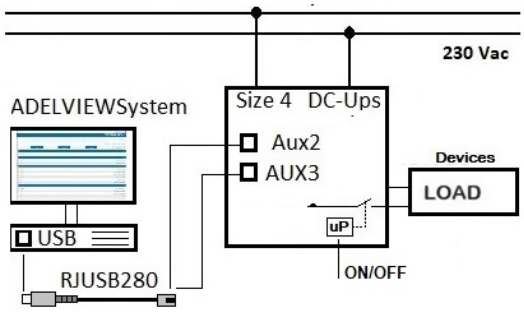
8.6.2 Low Voltage Deep Discharge battery - LVD Protections against total Battery discharge -> device turns off

- When the battery becomes lower than the fixed value in **Volt**
  - The default values are on the data sheet for each product
    - the device automatically turns off to prevent a battery deep-discharge
  - For the product Size3 and Size4 it is possible to configure the threshold and delay time for the automatic power OFF using Modbus as follows:
    - To modify the voltage threshold for switch off, Holding Register HR40071
    - To modify the Delay for switch off, Holding Register HR40107
- When the battery goes less than the fixed value in **SoC**
  - For the product Size3 and Size4 it is possible to configure the threshold and delay time for the automatic power OFF using Modbus as follow:
    - To modify the SoC turnoff threshold for switch off, Holding Register HR40076
    - To modify the Delay for switch off, Holding Register HR40107

8.7 Output Load Management

8.7.1 Output Load Switch Off (Size 4)

This feature allows to switch off the output load, such as for rebooting the device connected to the output load. A battery must be connected to the CBI for this feature to work properly.
The timeout of the load-off condition can be set by means of an holding register. Moreover, please notice that the load off condition is NOT preserved through a power-cycling.
In order to configure and activate the output load switch off, it is necessary to connect the DC-UPS device to computer by means of the Adelsystem Modbus cable P/N: **RJUSB280-1** and configure the ADELViewSystem application to manage this functionality.

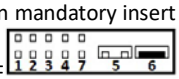


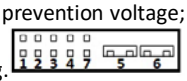
DC-UPS Setup:

- To activate the Output shutdown, write the value 32001 in HR40133.
  This will cause the HR40133 to display the value 1, meaning the load has been switched off
- To signal this condition the Diagnosis LED starts flickering

- To turn ON the Output back again write the value 32000 in HR40133. This will cause HR40133 to display 0
- Write a non-zero value in HR40135 to configure a timeout for the output load off duration; ex.: 10 sec 30 sec. … after this time the output Load turns on back again.

8.8 Time Buffering Setting

In Size 3 device, it is possible to set a buffering time by selecting on the rotary switch N°15. Buffering time is initiated when the mains is switched OFF. The LOAD output will be ON for the selected time.
To enabling this Function it is necessary insert the Jumper in the position 6 because the Jumper is shared with the fast-charge function. In this condition mandatory insert the jumper in the position 6 because the function became UPS Enabling, otherwise the output device switch OFF 

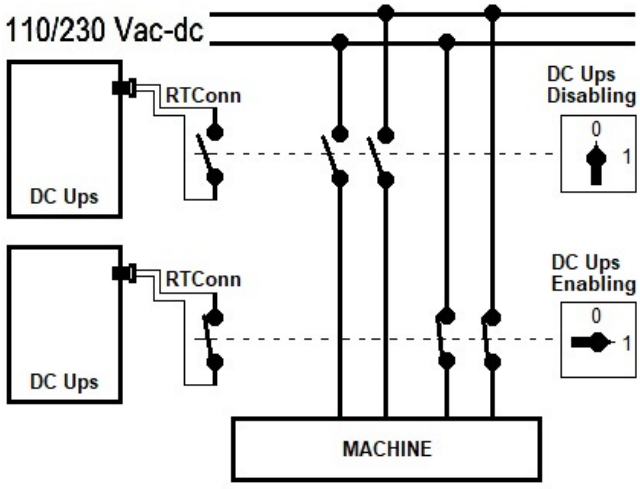
If the switch is in position 0, the LOAD output will be in ON state until the battery reaches the deep-discharge prevention voltage; chapter 8.6. In this condition it is not necessary the jumper in the position 6, the function is Fast Charge Enabling. 

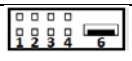
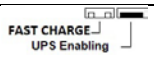
Switch position	0	1	2	3	4	5	6	7	8	9
Buffering Time (min.)	∞	0.5	2	5	10	15	20	30	45	60

For Size 1 and 2 units it is possible to request factory customized versions with specific buffering time setting, choosing the extension CBIxxxxASDx. For Size 4 it is possible to set a buffering time only by Modbus RTU RS485 or via ADELViewSystem software, Holding Register 40104, same feature also for Size 3.

8.9 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 the case the mains outage occurs when the machine is on. Please refer to the following figure



	Jumper Position (Size 1)	**Jumper Position** (Size 2)	**Jumper Position** (Size 3)	**Dip Switch Position** (Size 4)	**Function**
UPS Disabling					If jumper removed: UPS function disabled. Use RTCONN cable for connection to external Switch

To enable this function the following condition must be met:

- Size 1 and 2 “CBI245ASDx and CBI2410ASDx”, the function is already enabled.
  - Connect cable RTCONN to jumper position 6, on the side opposite to external Switch. The function “fast charge” is replaced by “UPS disabling”
- Size 3: please connect the RTCONN cable to jumper position 6 (No.18) (shared with the fast-charge function) as per the previous table.
- Size 4: please connect the RTCONN cable to the dedicated jumper (No.19) as per the previous table.

- Size 5: please connect two separate wires to the Fast charge /UPS Disabling push-in contacts (No.18) and connect the other ends to a voltage-free remote contact.

8.9.1 UPS disabling function

The UPS disabling function of the devices Size 3, Size 4 employs the combination of HR40088 and the remotable UPS disabling jumper to achieve a high degree of flexibility and error-proof configuration.
In the case of Size 3 the UPS disabling jumper is the same fast-charge jumper (No.18), in the case of Size 4 the UPS Disabling jumper is a dedicated jumper (No.19).

The holding register HR40088 acts as the activation of the sensitivity to the UPS disabling jumper.

If the holding register value is zero, the UPS disabling function is not enabled: this means that the device always does the backup in the absence of mains. In such case, for devices size 3 and 5, which have a shared Fast-charge /UPS disabling jumper (No.18), the jumper is assigned to the fast-charge activation.

If the value in the holding register is one, in the case of Size 3 the fast-charge /UPS disabling jumper (No.18) is used for the UPS disabling function; on the contrary, the Size 4 devices have its own separate jumper (No.19).
With HR40088 = 1, if the UPS disabling jumper (No.18 or No.19 as explained) is NOT engaged, the backup is not enabled so the UPS function is disabled; on the contrary, if the jumper is engaged the UPS function is enabled and backup is allowed in the absence of mains.

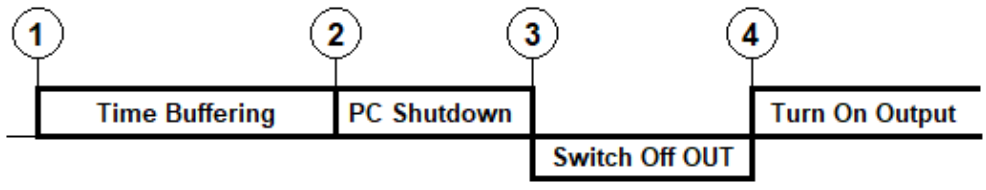
If the UPS is disabled, the behavior of the CBI with respect to the load in the case of mains outage depends on whether the PC shutdown is enabled or not: in the case HR40111 is zero (PC shutdown not enabled), when a mains outage occurs with UPS disabled, the device immediately turns off. If, on the contrary, the HR40111 is non-zero (PC shutdown enabled), when a mains outage occurs with UPS disabled, the device immediately initiates the PC shutdown algorithm from the Step 2 of the Pc shutdown algorithm - for more information refer to Section 8.10 – PC Shut Down

8.10 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 connect the DC-UPS device to a computer by means of the Adelsystem Modbus cable P/N: RJUSB280-1 and configure the ADELViewSystem application to manage the PC shutdown.

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 or in the case that UPS is disabled
- 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 **Step 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.

2 Write in the HR40104 the desired delay time value “Time Buffering”. After such time has expired, the device 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,..106,..108..109.112
  - if the "Force PC Shutdown" HR40041 is written the value 1

3 **Step 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

4 **Step 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

5 **Step – 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.

8.11 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.

8.12 Thermal behavior

Surrounding air temperature 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.

8.13 DC-UPS Parameters

The DC-UPS parameters are quantities that can be read only or read and written via the Modbus RTU interface of devices Size 3 and Size 4 only.

It is possible to manage the device from an external device such as DPY351, AdelViewSystem or a custom software connected to Aux2 or Aux3 (Sizes 3 and 4) or Aux1 (size 5). Below are the parameters related to the DC-UPS

Feature	Description	Read/ Write	Holding Address	Category
Back Up Disabling	UPS Enabling /Disabling	R/W	40088	Configuration
Back Up Discharge Current	Battery Monitoring Current: Discharge Current	R	40017	Monitoring
Back Up Low batt (SoC)	LVD Battery disconnection, level setting by SoC	R/W	40076	Settings
Back Up Low batt (SoC)	Alarm Level "Low SoC"	R/W	40113	Settings
Back Up Low batt (SoC)	Alarm SoC lower than HR 40113	R	40033.8	Alarm
Back Up Low batt (V)	LVD Battery disconnection V/cell	R/W	40071	Configuration
Back Up Low batt (V)	Alarm Level: Low Battery V/cell	R/W	40097	Configuration
Back Up Low batt (V)	LVD Delay Battery disconnection for V/cell	R/W	40107	Configuration
Back Up Low batt (V)	Download the current from the battery in power boost condition	R	40032.4	Alarm
Back Up Low batt (V)	"Low battery Voltage in Back Up"	R	40035.1	Alarm
Back Up Low batt (V)	Battery Start "Battery voltage too low"	R	40035.2	Alarm
Back Up Low batt (V)	Deep discharge Battery during Recovery Charge	R	40035.3	Alarm
DC UPS Status	DC Ups State: BackUp, Charge, Power Boost, No Charge	R	40006	Monitoring
DC UPS Status	Nominal output voltage	R	40007	Monitoring
DC UPS Status	On-board temperature inside the device	R	40029	Monitoring

Feature	Description	Read/ Write	Holding Address	Category
Device Info	Identifier of the release of the device parameter map	R	40009	Monitoring
Device Info	Software ID	R	40010	Monitoring
Device Info	Serial Number - least significant part	R	40012	Monitoring
Device Info	Serial Number - most significant part	R	40013	Monitoring
Device Info	Start From Battery or Fast Charge	R	40031	Monitoring
Device Info	Device variant	R	40039	Monitoring
Device Info	Product name	R	40067	Monitoring
Device Info	Displays the function of the device: 1 = DCUPS, 2 = CB	R	40068	Monitoring
Device Info	Firmware ID	R	40103	Monitoring
Device Info	Operating time (least significant part)	R	40136	Monitoring
Device Info	Operating time (most significant part)	R	40137	Monitoring
Digital Inputs State	State of the Digital Inputs	R	40145	Monitoring
Factory Default	Device Configuration Factory default	R/W	40066	Configuration
Fail Internal device	Temperature inside the device is too high	R	40047	Alarm
Fail Internal device	mains detector failure	R	40043.1	Alarm
Fail Internal device	device not calibrated	R	40043.2	Alarm
Fail Internal device	lifetest not possible	R	40043.3	Alarm
History Data	Input Voltage history Event: Lowest AC voltage at mains input	R/W	40122	History
History Data Clear	Device Configuration History: Clear All	R/W	40065	Configuration
History Data in Powerboost	Battery history Alarm: Number of download battery in powerboost condition	R/W	40058	History
History Data Out Voltge	Output history Event "Highest voltage"	R/W	40060	History
History Data Out Voltge	Output history Event "Lowest voltage"	R/W	40063	History
History Data Overtemperature	Number of internal overtemperature events	R/W	40056	History
History Data Voltage	Input Voltage history Event: Number of low AC input voltage events at mains input	R/W	40054	History
History Data Voltage	Input Voltage history Event: Number of Hight AC input voltage events at mains input	R/W	40055	History
History Data Voltage	Input Voltage history Event:Number of mains-backup transitions	R/W	40057	History
History Data Voltage	Input Voltage history Event: Highest AC voltage at mains input	R/W	40121	History
Input Config. Alarm Voltage	Input Configuration Voltage: Low Alarm	R/W	40036	Configuration
Input Config. Alarm Voltage	Input Configuration Voltage: Hight Alarm	R/W	40037	Configuration
Input Config. Alarm Voltage	Input Configuration Voltage: Delay Alarm	R/W	40118	Configuration
Input Voltage Alarm	Input Voltage Alarm: high AC input voltage	R	40045.0	Alarm
Input Voltage Alarm	Input Voltage Alarm: low AC input voltage	R	40045.1	Alarm
Input Voltage Alarm	Input Alarm: Main / BackUp	R	40046.0	Alarm
Input Votage	AC Input voltage	R	40030	Monitoring
Output Configuraitin	State of the outputs	R	40146	Monitoring
Output Load Alrm	Output Load Alarm: Short Circuit or Over Load	R	40038	Alarm
Output Load Curent	Current Measured value drawn from the output load terminals	R	40020	Monitoring
Output Load Driver	Output Load Configuration: On / Off Mode	R/W	40133	Settings
Output Load Driver	Output Load Configuration: On / Off Mode	R/W	40134	Settings
Output Load Driver	Output Load Configuration: On / Off Mode	R/W	40135	Settings
Output Load Power	Power Measurment Output load	R	40042	Monitoring
Output Load Voltage	Voltage measured at the output load terminals	R	40011	Monitoring
PC Shutdown	Load output off duration after PC shutdown	R/W	40034	Configuration
PC Shutdown	Force PC shutdown	R/W	40041	Configuration
PC Shutdown	Time buffering setting in backup	R/W	40104	Configuration
PC Shutdown	PC power supply removal delay	R/W	40111	Configuration

Feature	Description	Read/ Write	Holding Address	Category
PC Shutdown in Progress	Input Alarm: PC Shut Down Started	R	40046.1	Alarm
Relay Alarm Output	Fault relay Setting Alarm: assign to the alarm type	R/W	40139	Alarm
Relay Alarm Output	Mains BackUp Relay Setting Alarm: assign to the alarm type	R/W	40140	Alarm
Relay Alarm Output	Rectifier Relay Setting Alarm: assign to the alarm type	R/W	40141	Alarm

9 Networking

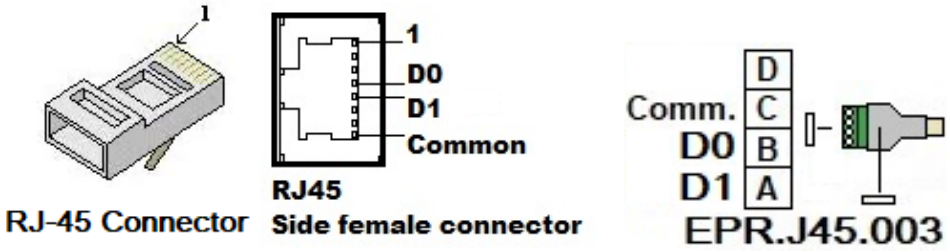
9.1 ModBus RTU

Adelsystem Size 3, Size 4 devices support the Modbus RTU protocol based on an RS 485 bus. The protocol requires that only one device be the master, all the other devices shall be slave devices.

9.1.1 Electrical characteristics RS485

The unit is a **SLAVE** in a MODBUS network, with the following specifications:

Transmission mode:	MODBUS RTU
Electrical Interface:	RS485 half-duplex serial line
Baud rate:	4800 / 9600 / 19200 / 38400 (default) bps
Data format:	8 data bits
Parity and stop bits:	Parity None with 2 stop bits Parity Odd with 1 stop bit Parity Even with 1 stop bit (default) Parity None with 1 stop bit
Slave address:	configurable in the range 1 (default) to 247
Connector type:	RJ45
Cable:	wire RJ-45 plug



Pin Number:	Modbus RTU: Pin Name	Alternative Name
4	D0	D-
5	D1	D+
8	Common	Common

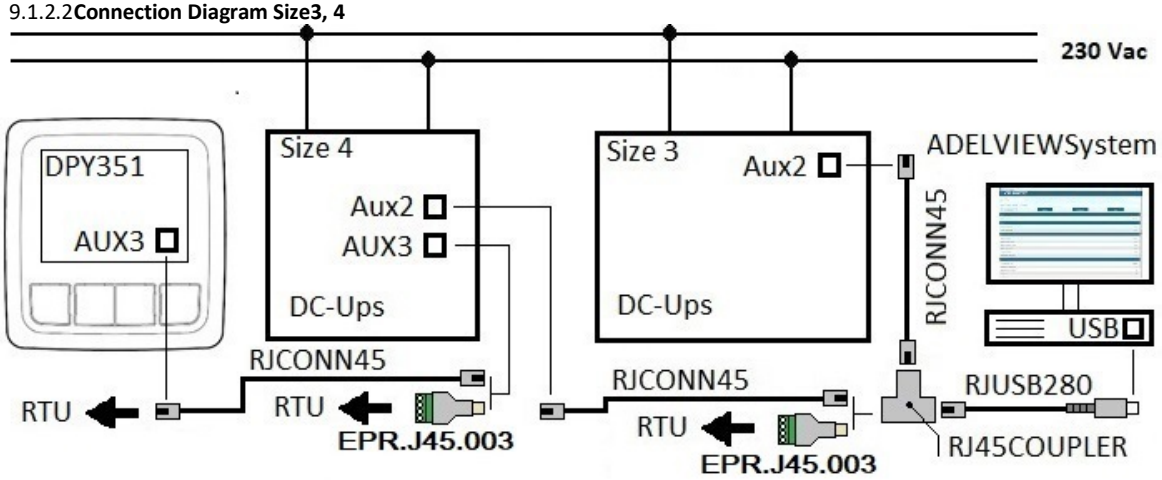
9.1.2 How to connect the device to Modbus

9.1.2.1 Daisy Chain general connection Diagram

To connect the device to Modbus, please use AUX2 Port (for Size 3 and Size 4).

- Port: AUX 2 No. 13 is available only in Sizes 3 and Sizes 4, MODBUS connection via RJ45 connector.

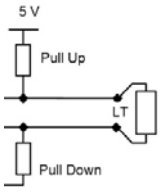
9.1.2.2 Connection Diagram Size3, 4



- RJCONN45: standard RJ45 cable also provided by ADELSystem. It is possible to connect in daisy chain up to 32 devices, max distance 1000m, from the AUX2 connectors.
- In the connection scheme shown above, each slave device must have a unique Modbus device address for proper communication. In order to avoid signal noise, the use of line termination resistors (120 Ohm) is recommended. The effect of signal noise becomes more relevant with long cable length and/or high baud rates. The serial Modbus connection uses an RS485 port for connection between the master port and the corresponding interfaces of the slave according to the EIA/TIA RS485 standard.
- RJUSB280-1: cable interface RS485 – USB, max length 2m, for connection to PC
- Note: If both, DPY351 and ADELViewSystem, are running in the same network at the same time, The DPY351 must be set for the Modbus "Viewmode".
- RJ45COUPLER: is a T connection RJ45 for the implementation of daisy-chain with CBI Size3 and 4 devices

9.1.2.3**Bus Termination (Size 3)**

The fail safe and Line termination resistors for the RS-485 bus are not provided inside the device and must be installed externally, if necessary, according to the following scheme.



Fail-safe:

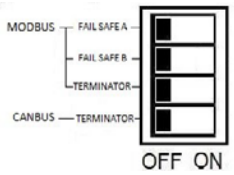
- 560 Ohm (Pull Up) to 5 V: Not Present
- 560 Ohm (Pull Down) to common: Not Present
- Load Terminations: 120 Ohm (LT) between lines A – B: Not Present

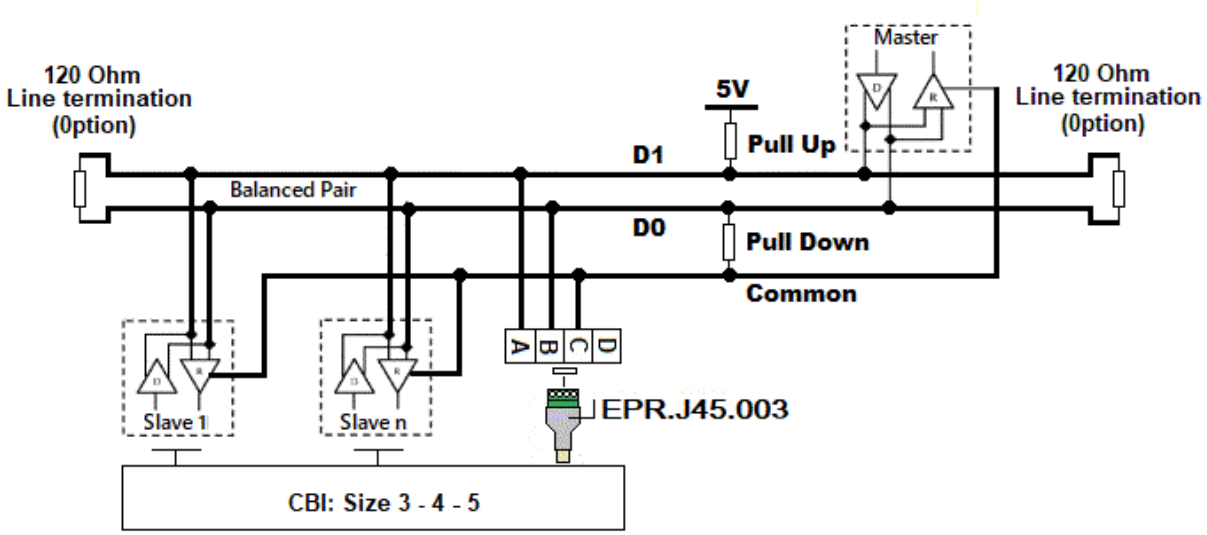
9.1.2.4**Bus Termination (Size 4 and 5)**

No.16: The Size 4 devices includes a full "fail safe" polarization and the bus termination. In such devices, the fail safe function and line terminators can be individually enabled or disabled by means of the dip-switches located on its front panel, as shown in the following figure:

Fail-safe:

- Fail Safe A, 560 Ohm (Pull Up) to 5 V
- Fail Safe B, 560 Ohm (Pull Down) to 0 V
- Terminations: 120 Ohm (between Modbus lines)
- Terminations: 120 Ohm (between Can lines)





9.1.2.5**Functional characteristics of the Adelsystem devices using Modbus**

The CBI, which is a Modbus slave device, waits for a request from the master, and checks the received packet before performing the action requested in it. In case of errors in the request (e.g. illegal function, illegal address, etc..), the master is notified with an error packet. If no errors are found, the requested action is performed and a reply is sent to the master. All the parameters are 16 bit Holding Registers (HR), with address range starting from 40001. Information contained in the Holding Registers is to be interpreted as 16-bit unsigned integer (Range 0 … 65535).

The following settings can NOT be modified using Modbus:

- The battery chemistry selection
- The "Selection out voltage" setting, read at powerup only, and used to select the device rated output voltage (size 4 only – refer to section 6.5 and 6.7)

Finally, some controls such as the fast-charge jumper of the UPS disabling jumper have a different management based on the product size.
The alarms that are mapped as bitmask in holding registers are active when the bit value is 1.
Note that valid values written to writable holding registers are automatically stored in the device non-volatile memory.
The following Modbus functions for HR management are supported: function code 3 (read holding registers), function code 6 (preset single register), function code 16 (preset multiple registers). A summary of the implemented function codes follows.

In all cases, the slave address must be within 1 and 247; the data addresses are computed subtracting 40001 from the holding register number, e.g. to access holding register 40092 the value (40092 – 40001) = 91 = 0x5B must be entered. DAmax is the data address of the holding register with the highest address 40xxx from the parameters map and expressed as (40xxx – 40001). The CRC at the end of each frame is computed as detailed in the "Modbus over serial line specification and implementation guide V1.02" document, available for free from www.modbus.org.

Function code 3 (0x03): Read Holding Register

Request (Master to Slave)

Field name ->	Slave address	Function code	Start address	Number of registers (N)	CRC
Field bytes ->	1 byte	1 byte	2 bytes	2 bytes	2 bytes
Range ->	0x01 – 0xF7	**0x03**	0x0000 – DAmax	0x0001 – DAmax+1	see text

Example 1 - reading the first holding register (i.e. the slave address) of a CBI device having slave address 1 (factory default):
01 03 00 00 00 01 84 0A
Example 2 - reading the first 114 holding registers of a CBI device having slave address 1 (factory default).
01 03 00 00 00 72 C5 EF

Response (Slave to Master)

Field name ->	Slave address	Function code	Number of data bytes to follow	Registers data	CRC
Field bytes ->	1 byte	1 byte	1 byte	N * 2 bytes	2 bytes
Range ->	0x01 – 0xF7 (same as the request)	**0x03**	2 * N	actual data read	see text

Example: response of a CBI having slave address 1 (factory default) to a read request of the first holding register (i.e. its own slave address):
01 03 02 00 01 79 84

Error (Slave to Master)

Field name ->	Slave address	Function code	Exception code	CRC
Field bytes ->	1 byte	1 byte	1 byte	2 bytes
Range ->	0x01 – 0xF7 (same as the request)	**0x83**	0x01 - 0x02	see text

Function code 6 (0x06): Write Single Register

Request (Master to Slave)

Field name ->	Slave address	Function code	Data address of the register	Value to write	CRC
Field bytes ->	1 byte	1 byte	2 bytes	2 bytes	2 bytes
Range ->	0x01 – 0xF7	**0x06**	0x0000 – DAmax	0x0000 to 0xFFFF	see text

Response (Slave to Master)

Field name ->	Slave address	Function code	Data address of the register	Value written	CRC
Field bytes ->	1 byte	1 byte	2 bytes	2 bytes	2 bytes
Range ->	0x01 – 0xF7 (same as the request)	**0x06**	0x0000 – DAmax (same as the request)	0x0001 – 0xFFFF (same as the request)	see text

Error (Slave to Master)

Field name ->	Slave address	Function code	Exception code	CRC
Field bytes ->	1 byte	1 byte	1 byte	2 bytes
Range ->	0x01 – 0xF7 (same as the request)	**0x86**	0x01 - 0x02	see text

Function code 16 (0x10): Write Multiple Register

Request (Master to Slave)

Field name ->	Slave address	Function code	Data address of the first register (addr)	Number of registers to write (N)	No. of data bytes to follow	Values to write	CRC
Field bytes ->	1 byte	1 byte	2 bytes	2 bytes	1 byte	N * 2 bytes	2 bytes
Range ->	0x01 – 0xF7	**0x10**	0x0000 – DAmax	0x0000 to DAmax+1	2 * N	data @addr, data @(addr+1) etc.	see text

Response (Slave to Master)

Field name ->	Slave address	Function code	Data address of the first register	Number of registers written	CRC
Field bytes ->	1 byte	1 byte	2 bytes	2 bytes	2 bytes
Range ->	0x01 – 0xF7 (same as the request)	**0x10**	0x0000 – DAmax (same as the request)	N	see text

Error (Slave to Master)

Field name ->	Slave address	Function code	Exception code	CRC
Field bytes ->	1 byte	1 byte	1 byte	2 bytes
Range ->	0x01 – 0xF7 (same as the request)	**0x90**	0x01 - 0x02	see text

9.1.2.6 Communications parameters settings

Devices are configured for communications at **38400bps** with **even parity (1 stop bit)** by default. The permissible slave address range is 1-247. Such address must be unique for every slave in the same Modbus network and it is stored in HR 40001. Its default value is 1. Similarly, it is possible to modify the serial communication default settings (baud rate and parity), that are stored in holding registers 40002 and 40003. **After any of them are modified, power must be cycled in order to apply the new settings. Instead, a change in the slave address (HR40001) becomes effective immediately.** Holding register 40003 sets the parity value for the serial communications and also the number of the expected stop bits. It always uses the communications parameter (HR40001 thru HR40003) values stored in the internal user non-volatile memory.

9.1.2.7 Restoring communication parameters to factory settings (Size 3 and Size 4)

To restore the communication parameter values (slave address, baud rate, parity):

1. switch off the device disconnecting both the AC mains and the battery;
2. turn the "BATTERY CHARGING LEVEL" trimmer fully counterclockwise to position MIN;
3. press the "BATTERY START" button and then switch on the device connecting the AC mains;
4. keep pressed the "BATTERY START" button for 10 seconds during which the 3 LEDs stay steady ON; at the end all 3 LEDs (together with the 2 relays) will toggle 3 times, and then the unit starts up with default communication settings restored.

If during the 10 seconds the "BATTERY START" button is released or the other controls are changed , the LED sequence is terminated and the default communication settings are NOT restored.

9.1.2.8 Restoring communication parameters to factory settings (size 5)

The device must be in the Device Configuration Mode. Please refer to section 6.7

9.1.2.9 Restoring battery parameters to factory settings

Writing the value 1 to Holding Register 40066 restores the default values of the active chemistry with battery not connected.

9.1.2.10 Restoring the device to its factory settings (Size 5 only)

The device must be in the Device Configuration Mode. Please refer to section 6.7. Please notice that this will also revert the Output voltage range to 24V so please make sure that the connected equipment can withstand such voltage

9.1.2.11 How to configure Modbus

AUX2 ports (Sizes 3 and 4), are provided for the connection to an external device like: RTU, PC , DPY351.

- For configuration and monitoring of the parameters inside the devices, download and install "ADELViewSystem" from the Web Site: www.adelsystem.com.
- Download the Modbus table from Web Site: www.adelsystem.com, section Additional Data, with details about all the data and the parameters exchanged between a CBI and a Master Device.
- For the Monitoring and Configuration of one or more ADELSystem devices from an user friendly unit, please use the Plug and Play unit DPY351.

9.1.3 Connect the DPY351 to Modbus in View Mode

In a Modbus network there can only be one master. Normally the DPY351 is the master, it polls the network and it receives information from other ADELSystem devices, which are the slaves. If it is necessary to connect *N* DPY351 in the same Bus network, then *N-1* displays shall be configured in View Mode. In this case only one DPY351 is a master and it polls the devices, the other

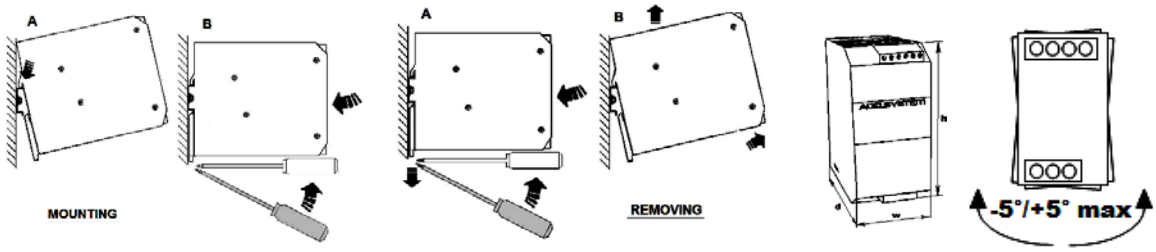
DPY351s receive the data from the Bus and they take the information into consideration only if these parameters are originated from a device in their list, otherwise they ignore the information.
View Mode is useful also when the master of the network is an external device such as a PC, but there is the need to monitor the status of the network from other places.
To configure the DPY351 in View Mode it is necessary to go in:
Menu>Menu Config>Other Settings>Modbus View Mode.

9.1.4 ADELBus connection (CAN)

To permit the permanent connection to Modbus RS485 and in the same time provide the Services function of maintainers, the device CBI2801224A CAN Version, is provided of additional CAN output present on the port Aux 2 and Aux 3. This connection permit to monitoring and manage the Modbus Holding Registers without disconnect the device to Modbus RS485 connection. For the connection from the device and the personal Computer is necessary connect the cable RJUSBCAN.

10 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.



11 Technical data

For all technical data, please download the data sheet on the relevant Website for the specific Product.

12 Accessories

12.1 Battery Bank 12V

- BATT 123: Battery Bank 1 Battery+Enclosure
- BATT 123DIN: Battery Bank 1 Battery+Enclosure DIN
- BATT 127: Battery Bank 1 Battery+Enclosure
- BATT 127DIN: Battery Bank 1 Battery+Enclosure DIN
- BATT 1212: Battery Bank 1 Battery+Enclosure

12.1 Battery Bank 24V

- BAT1.2VRLA: Battery Bank 2 Batteries+Enclosure DIN
- BAT3.4VRLA: Battery Bank 2 Batteries+Enclosure DIN
- BAT7.2VRLA: Battery Bank 2 Batteries+Enclosure DIN
- BAT12VRLA: Battery Bank 2 Batteries+Enclosure
- BTH1.2VRLA: Battery Bank Enclosure No Battery DIN
- BTH3.4VRLA: Battery Bank Enclosure No Battery DIN
- BTH7.2VRLA: Battery Bank Enclosure No Battery DIN
- BTH12VRLA: Battery Bank Enclosure No Battery

12.2 Digital Cable

- RJCONN45: Cable RJ45/RJ45 Aux2
- RJ45COUPLER: RJ45 Three way "Daisy Chain"
- RJ11COUPLER: RJ11 Three way coupler Connect
- RJUSB280-1: Cable RJ45/USB Size3 - Size4
- RJUSBSD: Connector Cable Shut Down/USB
- ERPJ45003: Connector RJ45/Terminal Block 4 pin
- RJTB280: Connector RJ11/Terminal Block 6 pin

12.3 Temperature Sensor

- RJTEMP451: Temperature Probe Size:1,2,3 (1 m)
- RJTEMP453: Temperature Probe Size:1,2,3 (3 m)
- RJTEMP111: Temperature Probe Size: 4 (1 m)
- RJTEMP113: Temperature Probe Size: 4 (3 m)

12.4 Cable Connectors

- RTCONN: Connector Cable Start from battery

12.5 Interfaces

- MR220: DECOUPLER
- MRF102: Electronic circuit Breacker

12.6 Monitor & Control

- DPY351 CONTROL PANEL
- DPY353 DISPLAY PANEL
- DPY354 “ADELViewSYSTEM” PC SOFTWARE