"Charge & Testing" Battery Charger

Instruction Manual

ADELSystem reserves the right to change the contents of this document without prior notice.

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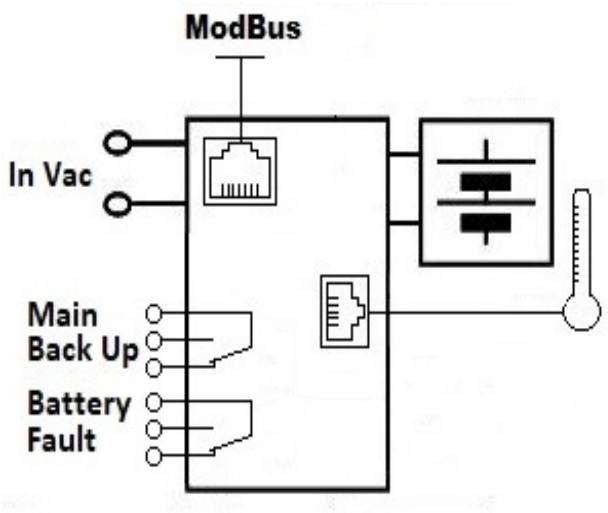
1 Charge & Testing

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 CB series is Charge & Testing devices in "Switching technology" and "Battery Care philosophy", since many years parts of the know-how ADEL system. This technology led to the development of this advanced multi-stage battery charging, completely automatic and suited to meet the most advanced requirements of battery manufacturers. The Battery Care concept is base on algorithms that implement rapid and automatic cycle of battery charging, battery charge optimization during time, flat batteries recovery and real time diagnostic during installation and operation. The Real Time Auto-diagnostic system, monitoring battery faults such as, elements in short circuit, accidental reverse polarity connection, disconnection of the battery, they can easily be detected and removed by help of Blink Code of Diagnosis Led; during the installation and after sell. Each device is suited for all battery types, jumper selection sets a predefined curves for: Open Lead Acid, Sealed Lead Acid, Gel, Ni-Cd and Li-Ion. 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
- Output Battery Charging:24 Vdc 10,20A; 12 Vdc 10,15,35A
- 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

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	CB120W devices	CB1210A
2	CB240W devices	CB2410
3	CB600W devices, Modbus RTU	CB1235, CB2420
4	CB280W device, selectable output 12/24V, Modbus RTU	CB122410A

4 Safety and Warning Notes

4.1 Safety Note

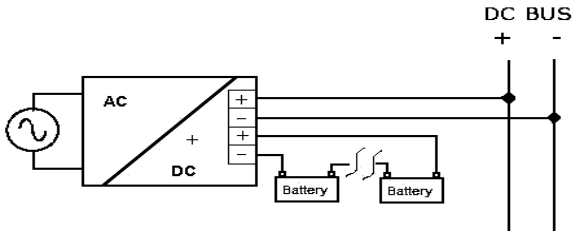
- WARNING – Explosion Hazard. Do not disconnect Equipment unless power has been switched off or the area is known to be non-hazardous.
- WARNING – Explosion Hazard. Substitution of components may impair suitability for class I, Division 2.
- WARNING – Switch off the system before connecting the module. 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 CB2420A
- 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;

6 Device Connections

6.1 Connection terminal and wiring

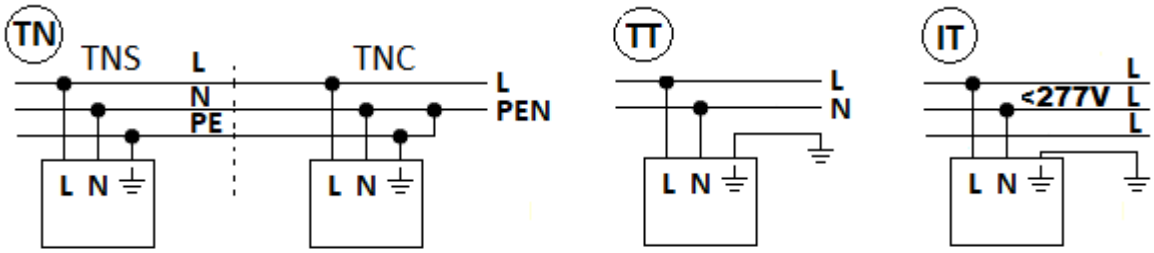
The following cable cross-sections may be used:

	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.

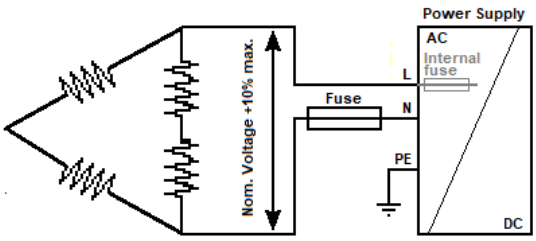
6.1 Connection Input Line System

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.



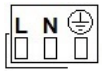
6.2 Operation on Two Phases

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:

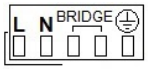


- Input 115 Vac (With Bridge Wiring Connected): max allowed Voltage 135 Vac
- Input 230 Vac (No Bridge Wiring Connected): max allowed Voltage 277 Vac

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 CB12xx;
- Two 12-V batteries connected in Series for CB24xx;

6.5 Connection Output Load: No.2

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

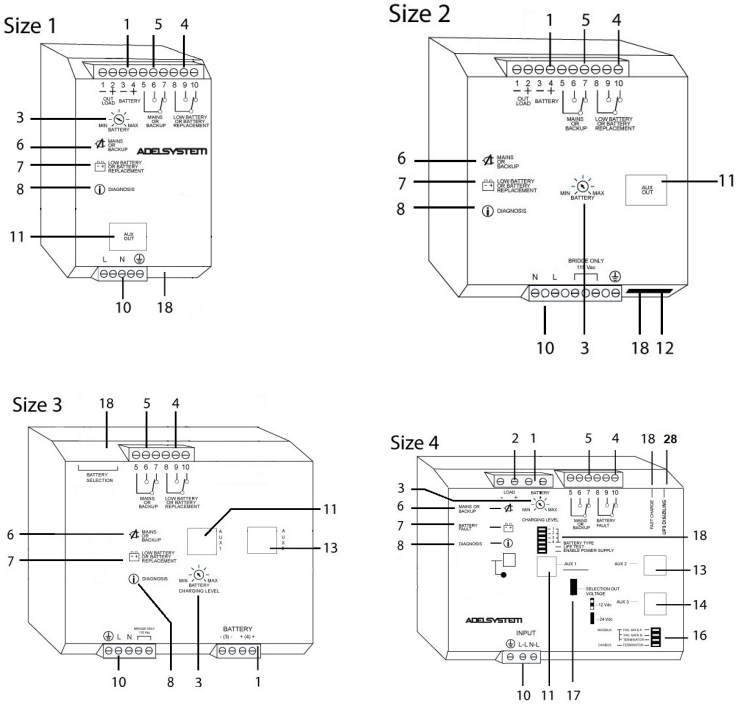
6.6 Select Output Voltage (Size 4 CB122410A)

6.6.1 Select Output Voltage on Size 4 CB122410A

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	Output 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
10	Input Vac
11	Aux1: RJ temp – DPY353 – DPY351-Modbus (RTU)
13	Aux2 Modbus “RTU” RS485
14	Aux3 Modbus “RTU” RS485 (Only on Size 4)
16	Bus Termination: Modbus Configuration: Fail Safe
17	12/24 Output Selection
18	Fast / Boost Charge/ Power supply config

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.

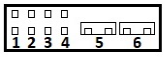
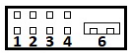
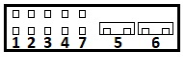
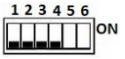
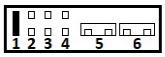
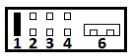
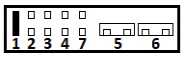
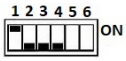
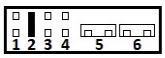
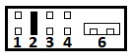
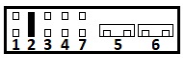
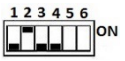
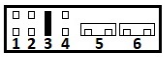
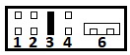
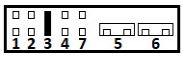
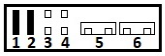
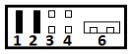
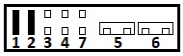
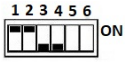
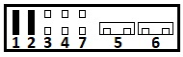
7.2 Charger

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

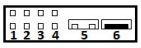
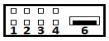
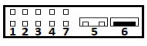
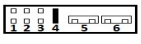
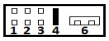
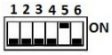
All devices are completely automatic and suitable to charge most batteries types thanks to the user-selectable charging curves by jumpers or dipswitches. The devices can charge open lead acid, sealed lead acid, Gel Lead, Lead crystal, NiCd, NiMH, Li-Ion (including LiFePO4) batteries. It is also possible 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)
LiFePo4: On ADELViewSystem, the number of cells can be reduced					3.45V/cell 12Vfield:13.8V(4cells) 24Vfield:27.6V(8cells) 48Vfield:55.2V(16cells)	3.65V/cell 12Vfield:14.6V(4cells) 24Vfield:29.2V(8cells) 48Vfield:58.4V(16cells)
Li-Ion “Only configurable” by ADELViewSystem, the number of cells can be reduced					4.1 V/cell 12V field:12.3V(3cells) 24V field:28.7V(7cells) 48V field:57.4V(14cells)	4.1 V/cell 12V field:12.3V(3cells) 24V field:28.7V(7cells) 48V field:57.4V(14cells)

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
Enabling Power Supply feature (2)					If Enabled, on the Battery Gate the device provide power with out the battery connected.

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.

2 In the first time the device must be connected to the battery, then the power supply feature it is enabled.

7.2.2.3 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.

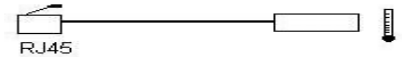
	Charging Stage	LED Diagnosis ⓘ	LED Fault Battery
Charging Type	Float	1 Blink/2 sec	OFF
	Absorption	1 Blink/sec	OFF
	Bulk	2 Blink/sec	OFF
	Recovery	5 Blink/sec	OFF
	Purification	On	OFF

7.2.4 Battery Charger in a Temperature Compensated Environment

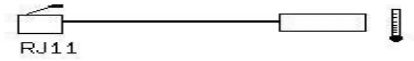
No. 11 - Remove the window label to find the connector: Auxiliary Output "AUX 1"

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
RJTEMP113	Length 3m. DC-UPS Sizes 4; DPY351

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 :

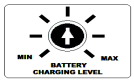
Fast Charge: Open Lead, AGM, Gel	Float charge: Open Lead, AGM, Gel
+/- 5mV/°C x n. of Cells from -8°C to +60°C +140 ÷ -200 mV/Cell compared to the value at 20°C	+/- 3mV/°C x n. of Cells from -20°C to +60°C +120 ÷ -120 mV/Cell compared to the value at 20°C
Fast Charge: Ni-Cd	**Float charge: Ni-Cd**
+/- 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
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

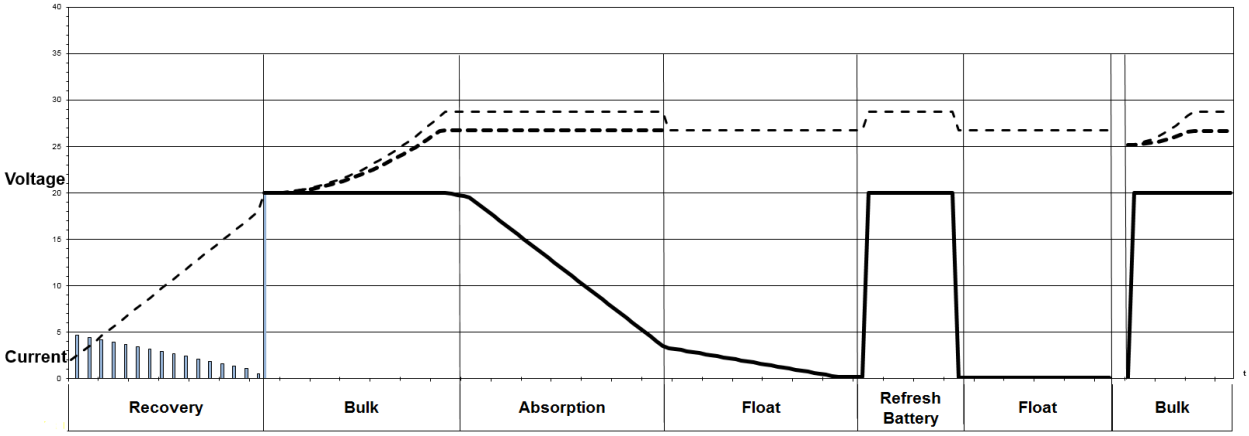
In devices Size 4 the charging current limit can be set either using the trimmer on the device front panel (No.3) or the Modbus RTU holding register HR40072. The latest setting is the one that is used, irrespective of it being set using the trimmer or the HR40072. By rotating the trimmer, the charging 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 PURIFICATION TECHNIQUES

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

- 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: 4.

7.2.9 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

Feature	Description	Read/ Write	Holding Address	Category
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
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 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

8 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: Only for CB122410A

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)

8.4 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.

8.5 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.

9 Networking

9.1 ModBus RTU

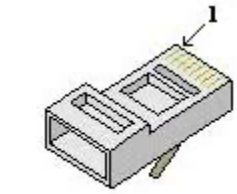
Adelsystem Size 3, Size 4 devices support the Modbus RTU protocol based on an RS 485 bus. The protocol requires that only one device be the master, all the other devices shall be slave devices.

9.1.1 Electrical characteristics RS485

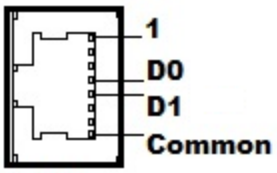
The unit is a **SLAVE** in a MODBUS network, with the following specifications:

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

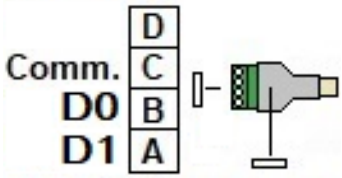
Slave address:	configurable in the range 1 (default) to 247
Connector type:	RJ45
Cable:	wire RJ-45 plug



RJ-45 Connector



RJ45
Side female connector



EPR.J45.003

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

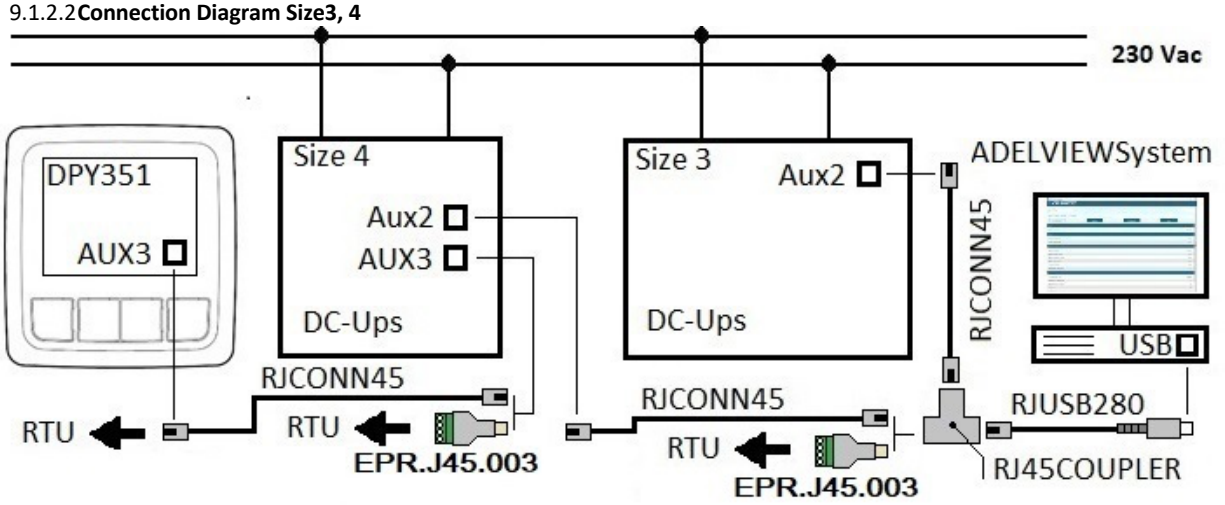
9.1.2 How to connect the device to Modbus

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.

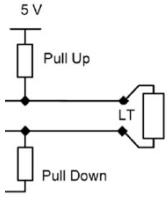
9.1.2.2 Connection Diagram Size3, 4



- 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:

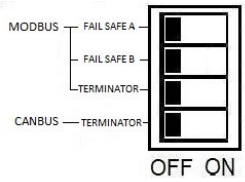
- 560 Ohm (Pull Up) to 5 V: Not Present
- 560 Ohm (Pull Down) to common: Not Present
- Load Terminations: 120 Ohm (LT) between lines A – B: Not Present

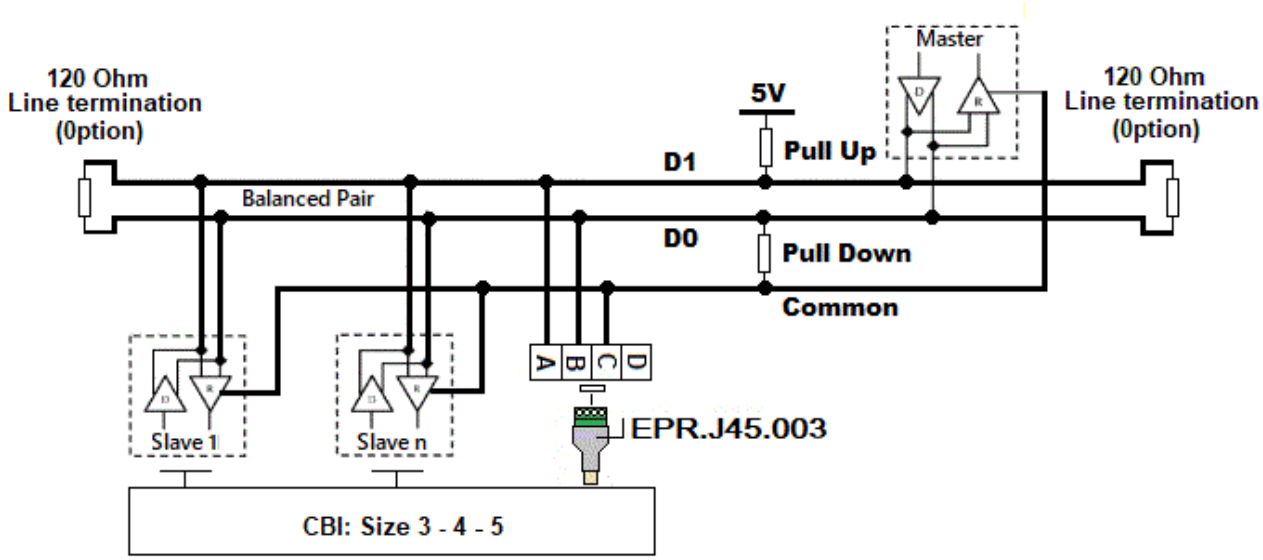
9.1.2.4 **Bus Termination (Size 4 and 5)**

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

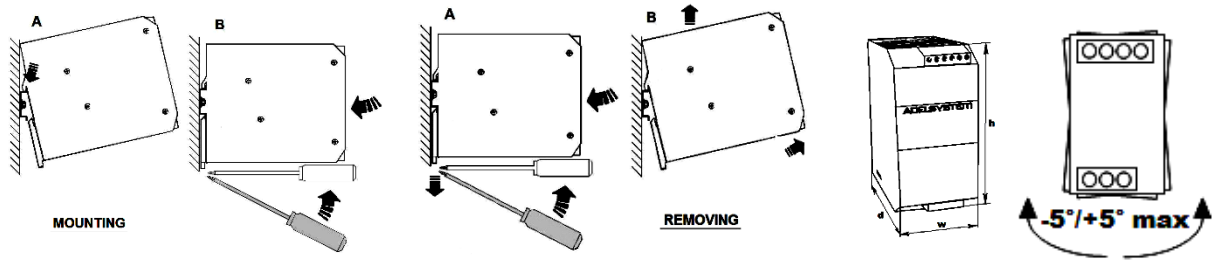
In a Modbus network there can only be one master. Normally the DPY351 is the master, it polls the network and it receives information from other ADELSystem devices, which are the slaves. If it is necessary to connect *N* DPY351 in the same Bus network, then *N-1* displays shall be configured in View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

12.2 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)

12.3 Cable Connectors

- RTCONN: Connector Cable Start from battery

12.4 Interfaces

- MR220: DECOUPLER

12.5 Monitor & Control

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