

Thank you for purchasing. Your lead acid battery capacity indicator Qulon-12ns is designed for fast battery capacity estimation. With the help of the device, you can test new or used 12-volt lead acid batteries. This will help you to condemn defective batteries or batteries that have lost capacity. With Qulon-12ns, you will always keep your battery systems in perfect working order.

Qulon-12ns is designed for years of reliable work and does not need any service.

Qulon-12ns is designed for testing batteries without disconnecting them from the charger or rectifier.

Please read this manual! It contains significant instructions for using battery capacity indicator. Following this manual, you will keep device working and your batteries ready to take critical loads.

Keep this manual! In contains important safety precautions and warranty information.

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Introduction

The life of lead acid batteries is limited to several years and while working batteries loose capacity. When the battery capacity becomes unacceptably small, battery needs to be replaced. It is exceptionally important to determine correct time of battery replacement. If a battery is replaced too early – the owner of a battery loses money. If a battery is replaced too late, the loss could be even larger.

Qulon-12ns - lead acid battery capacity indicator is a device for battery capacity estimation. With Qulon, one can sort 12-volt batteries by their capacity and reject batteries that have lost capacity.

Memory for keeping test results helps user during testing large amount of batteries.

The battery capacity estimation is based on the dependence between battery capacity and battery ability to conduct electric current. Battery capacity indicator sends a test pulse to a battery and analyses the battery answer. Qulon-12ns utilises the most up-to-date method of battery capacity estimation taking into account the multifrequency battery response to test pulses.

Different battery producers use different technologies and battery designs. Therefore, the dependence between test pulse form and value and battery answer form and value could be slightly different. That is why Qulon-12ns is not a high precision device for capacity measurement. It estimates battery capacity

basing on electrical measurement and some algorithm saved in Qulon's microprocessor.

Qulon-12ns is calibrated on factory. Using this calibration, you can estimate the capacity of any 12-volt lead acid battery. Experienced user can reduce capacity estimation error by device recalibration basing on the battery with known capacity.

1. Safety precautions

Unpack Qulon-12ns and check if there are any transport damages. If any, appeal to your dealer or the transport company.

Attention! Lead acid battery under test is a source of possible danger. Battery terminals shorted with any metal detail could cause burn or fire. Please adhere to battery maintenance and service rules.

If battery under test is a part of high voltage battery system and battery test is conducted without battery disassembly be especially careful. Do not connect test clamps to several 12-volt batteries connected in series. If such case, device will not switch on. If summary voltage exceeds 400 volts device could be damaged.

Qulon-12ns is a complicated device. Do not try to disassemble it. There are no parts that need service inside. The device should be repaired only by certified personal.

Attention! Do not use device with back lid opened.

Attention! When using Qulon without disconnection batteries from the charger (rectifier) observe safety rules for working with electric facilities.

2. General description

There is a LCD display in the center of Qulon's front panel. It is used to show ampere-hour capacity, battery voltage and additional information: adjustment coefficient, number of recorded measurements and current croup of records. Qulon has memory for recording results of battery tests. The maximum number of recorded results is 200. User is free to separate recorded results to as many as 26 groups.

If it is impossible to estimate battery capacity because of some reasons, alarms are shown at the display.

There are two control buttons on the front panel to the left of display.

Right panel of Qulon is the place for test cable connector. Qulon is supplied with special test cables that use four-wire (Kelvin) connection. This type of connection is used in order to diminish contact resistance influence on the device results.

There is a lithium battery providing energy to the internal clock under the sliding cover on the rear panel of the device.

3. Battery capacity estimation

3.1. What is battery capacity

Battery capacity is an electrical charge (quantity of electricity) that battery can deliver under specified conditions. Usually battery capacity is expressed in ampere-hours (A*h or Ah). Capacity equals to discharge current (in amperes) multiplied by discharge time (in hours). Battery producers rate nominal battery capacity for some standard conditions. Usually (but not necessary), these conditions are: 20-hour discharge time, 20°C discharge temperature and 1.75 V final battery voltage (voltage limit at which discharge is considered to be complete).

3.1.1. Dependence between battery capacity and discharge current

Charge that a battery can deliver depends on the discharge current (discharge time). If discharge current grows (discharge time decreases), the battery capacity decreases. This dependence is an individual property of a specific battery. The dependence between relative battery capacity and discharge time for LCL-12V33AP battery is given in the table below.

Discharge time, hours	Relative capacity, %
0,1	37
0,3	48

Discharge time, hours	Relative capacity, %
0,7	53
1,9	76
4,2	84
9,2	92
20	100

Qulon-12ns always shows capacity for 20-hour discharge time. If you discharge your battery during smaller time, the capacity will reduce.

3.1.2. Battery capacity and battery state of charge

We need to distinguish capacity and state of charge. Capacity is the quantity of electricity that a fully charged battery can deliver. State of charge is a characteristic giving information on the degree to which the capacity is filled. For example 33Ah battery can contain 33 A*h if a battery is fully charged and 10 A*h if the battery charge is not full.

Qulon-12ns estimates capacity of fully charged battery and can't be used to determine state of charge.

3.1.3. Temperature dependencies

While testing battery under low or high temperature, dependence of battery capacity from the temperature should be taken into account. Qulon-12ns always shows the capacity that a battery could deliver during next discharge under the same condition. That is why if you get estimated capacity under plus 20°C as

large as 20 A*h you should not be surprised if the same battery will deliver only 10 A*h during discharge under minus 20°C.

Factory calibration of Qulon-12ns is conducted for use under room temperature (about 20°C). Therefore, in order to get most precise results of battery capacity estimation, keep batteries under room temperature before test for the time needed for temperature equalising.

3.1.4. New batteries

The majority of lead acid batteries increase capacity after their first discharge-charge cycles. That is why while testing absolutely new batteries (the batteries that never were charged or discharged) you could get estimated capacity less than rated (may be by 10 or 15 %). This is usual – the battery will increase capacity after several cycles (or several months under float charge).

3.2. Battery capacity estimation with Qulon-12ns

3.2.1. Device placement

Qulon-12ns can work in any position horizontal or vertical.

To avoid device errors do not use it near the sources of large electromagnetic noise.

3.2.2. Battery preparation

Correct estimation of battery capacity can be achieved for fully charged batteries only. Therefore, the battery should be fully charged before test.

Normally you need do disconnect battery circuit before test. If you plan to test battery without disconnecting it from the DC bus, it is recommended to sustain the battery at a constant charging voltage without any discharges for at least 2 days.

If battery terminals are dirty or oxidized – clean them.

3.2.3. Connection to a battery

Battery capacity indicator Qulon-12ns is supplied with special test cables that use four-wire (Kelvin) connection to a battery. Two halves of one (red or black) clamp are insulated from each other.

Verify that clamp halves do not have other connection with each other except battery terminal.

Observe polarity when connecting to a battery. Connect red clamp to positive battery terminal and black clamp to negative terminal. Qulon has reverse polarity protection – device will not switch on if you mistake.

Capacity estimation is correct only in case if device clamps have secure and reliable connection directly to battery terminals. Connect test clamps directly to battery terminals. Never connect clamps to wires or nuts that have connection with the terminal.

Do not connect clamp to a terminal by touching it with a side surface of a clamp.

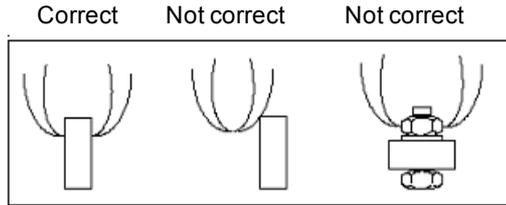


Fig. 1. Connecting clamp to a battery terminal

If the contact is not good, Qulon sends an appropriate message to the screen (see section 4). When such message appears, disconnect clamps from terminals, clean terminals and connect clamps once more.

Attention! Qulon feeds from the battery under test. To avoid battery discharge disconnect device from the battery after test.

Attention! When using Qulon without disconnection batteries from the charger (rectifier) observe safety rules for working with electric facilities.

3.2.4. Battery state of charge

Qulon-12ns estimates capacity for fully charged batteries only. The battery under test should have voltage not less than 12.6 V.

If a battery is deeply discharged (voltage less the 9 V) – device will not switch on.

If a battery is not fully charged (voltage is more then 9 V and less then 12.6 V), device shows a mes-

sage “Voltage low” and battery voltage at the screen. In this case, disconnect clamps from the battery and charge the battery in full according to the battery manual.

If Qulon is connected to a battery with voltage larger then 14 V, a “High voltage” warning and battery voltage would be shown on the screen. In this case wait for the transition charger to “floating” charge mode or adjust the charger (rectifier).

If a battery voltage is between 12.6 volt and 14 volt Qulon shows a battery voltage on the screen and begins the process of capacity estimation.

Attention! Qulon feeds from the battery under test. That is why the battery voltage shown on the screen can differ from the open circuit voltage measured by multimeter.

3.2.5. Battery capacity estimation

If a battery voltage is between 12.6 volt and 14 volt Qulon automatically starts battery capacity estimation.

Capacity estimation needs time. The value appears on the screen after 3 seconds. Please wait until capacity value appears.

After capacity is estimated, Qulon shows the ampere-hour value of the battery and switches on the screen light for 10 seconds.

3.2.6. Battery capacity estimation without disconnecting it from the DC bus

Charger (rectifier) creates an electrical noise at battery terminals. Despite the enhanced filtering of the input signal, in some cases the capacity estimation becomes impossible or not very reliable. In this case, Qulon gives the display the appropriate messages and sound signals (if included). When the message "noise" arises it is recommended to repeat the battery capacity estimation without disconnecting clamps from the battery terminals. If several attempts bring no positive result, you can try to disconnect clamps from the battery terminals and connect them back. If this does not help, the noise level is too high to determine the battery capacity without disconnecting battery from the charger.

It should also be borne in mind that the charging and discharge currents affect the conductivity of the battery and, consequently, on the readings, so it is advisable to make the battery capacity estimation at the moment when they are small. Not recommended to determine the battery capacity when the battery is supplying the load, or shortly thereafter, when it is heavily charging. However, the influence of these currents on the readings is low and usually does not exceed 5-10%.

Readings obtained on a battery connected to a charger, as a rule, slightly are higher than the readings for the same battery with the open circuit.

3.3. Qulon's screen during battery capacity estimation

If battery capacity estimation succeeds, the capacity value is shown on the screen.

This result can be saved in memory. Qulon-12ns has two saving regimes (save modes): saving by default (result is saved immediately after it appears) and saving by command (one needs to push button for saving). Detailed description of both saving options is made in section 5.2.

The screen view is shown on the following figures depending on chosen regime.

3.3.1. Screen under "save by default" mode

Figure 2 shows screen view for the case when "save by default" mode is chosen.

Left part of the screen contains icons describing button functions.

Menu enter – press upper button to enter menu (see section 5).

Delete result – after pressing the lower button you will have 3 possibilities:

- a) to delete the just made estimation from the memory and repeat the test automatically;
- b) to delete the just made estimation from the memory without repetition;
- c) to return to the last screen.

The centre of the screen is occupied by esti-

mated capacity and battery voltage. If there was not possible to estimate capacity, the alarm message is sent to this screen zone (see section 4).

Battery capacity – measured in ampere-hours.

Battery voltage – measured in volts. If the noise level is rather high, the “noise” message arrives in this screen zone.

Right part of the screen (the zone of inversion) contains additional information.

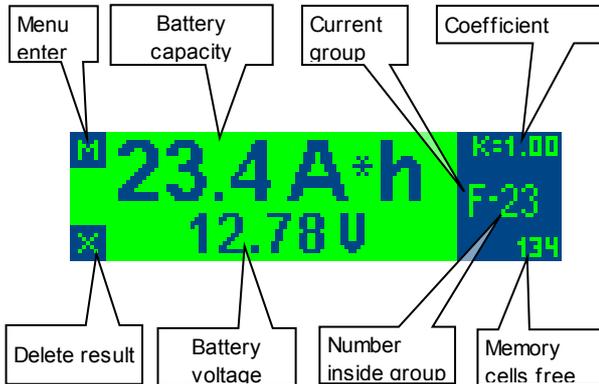


Fig.2 Screen under “save by default” mode

Coefficient – the multiplier (calibration coefficient) used to estimate capacity (see section 6.3).

Current group – the group to which just received test result was saved (memory organisation is described in section 5).

Number inside group – the number of just received test result inside current group.

Memory cells free – total number of test results that can be saved in memory (not more then 200).

Time – there is time indication at the most right part of the screen (not shown in fig.2).

3.3.2. Screen under “save by command” mode

Figure 3 shows screen view for the case when “save by command” mode is chosen.

When this mode is used, just received test result is not saved. There is no battery name (group and number inside group) on the screen. The function of the lower button is changed.

Save result – after pressing the lower button you will have 3 possibilities:



Fig. 3 Screen under “save by command” mode

a) to save the just made estimation to the memory (group name and the battery number is shown);

b) to return to the last screen;

c) to initiate the test repetition.

4. Alarm messages

Sometimes (mainly if the battery is not properly prepared for testing or extremely large electrical noise), Qulon-12ns fails to estimate capacity. If this happens, alarm message appears on the screen describing the reason for the fail. If sounds (see section 6.5) are on, then the message will be accompanied by beeps.

All alarm messages with their possible causes and recommended user actions are listed in the following table.

Message	Possible cause	Recommended actions
Contact	Bad contact between any of test clamps and battery terminal	Disconnect clamps, clean terminals and connect clamps once more
Capacity low	Battery capacity is below 0.5 Ah, Qulon can't estimate it	
Capacity high	Battery capacity is too high (may be larger than 350 Ah), Qulon can't estimate it	
Voltage low	Battery is discharged	Charge battery in full and try once more
Noise	Large noise	recommended user actions are listed under the table
Voltage high	Battery voltage is too high	Disconnect the battery from the charger

Message "noise" appears in two cases:

1. If the noise is high enough to affect the result of capacity estimation, the estimated capacity is shown in the screen and the "noise" message arrives in the voltage line. In this case, we recommend that you try again (maybe several times) without disconnecting Qulon from the battery (by pressing the bottom button). If a result is the same or you get result without the "noise", then you can take it for a normal evaluation of capacity. Otherwise, it is recommended to disconnect the device from the battery and then repeat the test. If this does not help, then the noise level is too high for normal operation. You need to reduce the level of interference, for example by turning off (or disconnecting) the charger (rectifier) and repeat the test.

2. If the interference (noise) is so strong that there is not possible to estimate the battery capacity, then "noise" message arrives in the screen instead of the capacity. You should repeat the test, similar to the above algorithm. The purpose is to obtain the repeated capacity estimation. If this proves impossible, reduce the level of interference, for example by turning off (or disconnecting) the charger (rectifier) and repeat the test.

5. Memory

While testing batteries Qulon feeds from the battery under test. While working with save data or adjusting device, Qulon could be feed from any battery (9....15 V) or optional adapter.

5.1. Memory organisation

Battery capacity indicator Qulon-12ns has memory for 200 test results. For user's convenience, test results can be split to groups. Maximum number of groups is 26, each group is identified with a letter of Latin alphabet – from A to Z. A user arbitrarily manages the quantity of results inside group.

Each test result recorded is identified with a name that consists of a group name and a number inside group. If the whole memory were empty, the first test result recorded would be named A-1. Next test result recorded will have a name A-2 and so on. User can close current group at any time. In this case, the next test result recorded will be the first in the next group, which would be named in the alphabet order (e.g. B-1).

The following memory operations are possible.

A) Saving of test result just received (“save by command” mode);

B) Erasing of test result just saved (“save by default” mode);

C) Closing current group (next group opens automatically), if current group is not “Z”;

D) Erasing all saved test results from memory.

The following memory operations are impossible.

A) Saving test result to arbitrary chosen group or arbitrary chosen number in the current group;

B) Erasing of part of saved test results from memory;

C) Recording test result to a closed group;

D) Opening closed group.

All memory operations are made with the help of main menu.

5.2. Two save modes

Qulon-12ns has two save modes: “save by default” and “save by command”.

Under “save by default” mode just received test result is saved automatically. It can be erased by pressing lower button.

Under “save by command” mode just received test result is not saved automatically. It can be saved by pressing lower button.

User can choose save mode with the help of options menu. Chosen mode is valid for next tests until it is changed.

Under both modes saving is performed only if:

A. Battery capacity estimation was successful or

B. Qulon sent one of messages: “capacity low”, “capacity high”, “voltage low”, and “voltage high”.

If other messages appear, test result is not saved.

In “A” case (see above), the following information is saved: estimated capacity, calibration coefficient (for current test), battery voltage, group name and number inside group, test date and time. If rather large noise can make capacity estimation not reliable, the estimated capacity is accompanied with “noise” message.

In “B” case, the appropriate message is saved instead of estimated capacity.

If there are 200 test results saved in memory, a message “memory full” is displayed. After this message, saving is impossible. During next test, the number of free cells in memory in the right bottom corner of the screen is “0”. User should clean all memory (see section 5.3.3) in order to start saving test results again.

5.3. Main menu

After the battery capacity was estimated or alarm message shown, the user can come into the main menu by pressing the upper button.

If “save by default” mode is on user will be advised to erase just received test result. The user can agree (and the result will be erased) or disagree (and the result will be kept in memory) before entering menu.

Main menu has four items. The view of main menu is shown on figure 4.

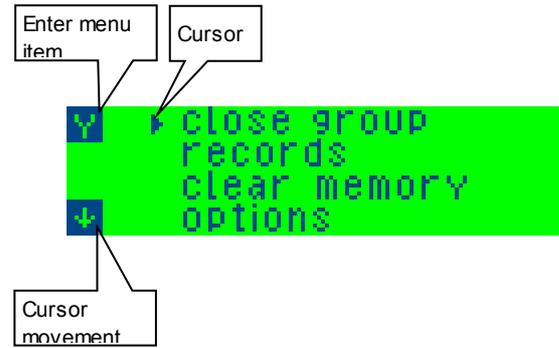


Fig. 4. Main menu

Pressing lower button brings cursor to next line. Pressing upper button enters the menu specified by cursor.

First three menu items serve for memory operations, the last one – for device adjustment.

To exit menu – disconnect test clumps from the battery terminals - all adjustments are saved automatically.

5.3.1. Close group

This menu item is used for closing the current group of test results.

After entering item, a question “close group?” will appear. If you answer “yes” by pressing upper button – you will see the message “Group X closed”. After it device goes to the main menu. If you answer “no” by

pressing lower button the device goes to main menu without closing group.

If you try to close the last group (Z), you will see a message “no groups available”. All test results saved after it will be in Z group.

If you try to close the empty group, you will see the appropriate message. The empty group cannot be closed. You can not undo the close group operation. You can not save data to the closed group.

5.3.2. Records

This menu item is used for viewing saved test results.

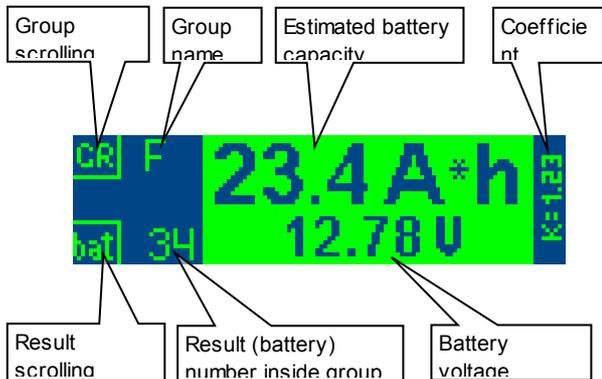


Fig. 5 Screen while viewing test results

After entering this menu item the screen view is as in figure 5.

There is an F-34 test result shown on the screen. Date and time is not shown in the figure.

There is a result of battery estimation or a message in the up center of the screen. Next line is for battery voltage and the last one – for date and time (not shown). The left part of the screen is occupied with the battery group and number. The right part of the screen is for coefficient, used for battery capacity estimation.

By pressing the upper button, one can view the first test result of the next nonempty group. Long pressing causes fast group scrolling. After last nonempty group is reached result A-1 is shown.

By pressing lower button, one can view the next result in the same group. Long pressing causes fast result scrolling. After last result of the group is reached, the result number 1 of the same group is shown.

To exit the viewing mode disconnect test clamps from battery terminals.

5.3.3. Clear memory

This menu item is used for complete erasing of test results saved in memory.

Warning! Memory clearing is irreversible action. Thus, all the results that have been saved in memory will be removed, and their restoration will be impossible.

Up to 200 test results can be stored in memory. If you are going to save test results in memory, it is necessary to correlate the number of empty memory cells with prospective quantity of batteries that you wish to

test. The number of empty memory cells is displayed in the right bottom corner of the display (see figure 1 and figure 2).

After entering this menu item, user is offered to press four times device buttons in the specified sequence.

To avoid casual removal of saved results, the button pressing sequence, necessary for clearing memory, varies for each time the device is connected to a battery.

5.3.4. Options

This menu item is used to change device operating modes.

All adjustments are kept in the flash memory of the device until their following change. Flash memory holds its content without the need of a power supply.

Qulon-12ns adjustment is described in the following chapter of the manual.

6. Adjusting Qulon

Qulon-12ns is issued completely adjusted and can be used for lead acid batteries diagnostics right after purchases. By manufacture, Qulon-12ns is adjusted as follows.

Save mode - by default.

Calibrating coefficient $k=1.00$.

Language of messages - English.

Time – GMT+3

All sounds are on.

The user can change factory adjustments. It is recommended to study the present manual before any adjustment of Qulon-12ns.

6.1. Options menu

To change adjustments it is necessary to connect Qulon to a battery or optional adapter and after the device will estimate its capacity or will give out the message, - press the top button (icon "M" - menu entrance) to enter the main menu. In the main menu – press lower button three times to note last menu item "Options" and the top button to enter menu of adjustments.

The view of options menu is presented in figure 6.

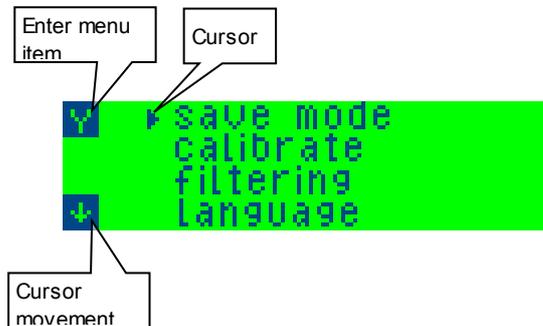


Fig. 6.Options menu

Pressing lower button brings cursor to next line. Pressing upper button enters the menu item specified

by cursor.

To exit menu – disconnect test clumps from the battery terminals.

6.2. Save mode

When you enter this menu item you are offered to choose one of two save modes: save by default or save by command. Move cursor to the desired line. Your adjustment is saved automatically. Now you can go to the main menu by pressing top button or disconnect Qulon from the battery.

6.2.1. Save by default

If you choose this save mode Qulon will save the test result automatically, right after the result is received. Screen view for this save mode is shown in figure 2. If you do want to hold just saved result press lower button – you will have 3 possibilities:

- a) to delete the just made estimation from the memory and repeat the test automatically;
- b) to delete the just made estimation from the memory without repetition;
- c) to return to the last screen (fig. 2).

6.2.3. Save by command

If you choose this save mode Qulon will not save the test result automatically. Screen view for this save mode is shown in figure 3. If you need to save just

received result – press the lower button. You will be asked for confirmation to save the result to a designated group and battery number inside group. You will have 3 possibilities:

- a) to save the just made estimation to the memory (group name and the battery number is shown);
- b) to return to the last screen (fig. 3);
- c) to initiate the test repetition.

6.3. Calibrate (coefficient adjustment)

Warning! Lead acid battery capacity indicator Qulon-12ns is a complicated device. Therefore, its recalibration should be made by the qualified user who studied the present manual and who distinctly understands the sequence and probable results of the action.

Qulon-12ns is calibrated at the factory with the use of average characteristics of 12-volt lead acid batteries. Some specific battery may need some other calibration. To diminish capacity estimation error user can recalibrate device for testing of some specific battery type or confirm the validity of factory calibration.

User can do Qulon-12ns recalibration by changing the calibration coefficient.

Qulon-12ns calculates the estimated battery capacity according the following formula:

$$E = E_0 * K,$$

where: E_0 – estimated capacity without user's corrections, K – calibration coefficient.

When issued from the factory Qulon-12ns has calibration coefficient $K = 1$.

To recalibrate Qulon-12ns you need: a) determine the value of calibration coefficient for your batteries (see section 7) and b) adjust Qulon for work with this coefficient (save this coefficient in Qulon's memory).

To change calibration coefficient enter main menu, select item "options", enter options menu and select item "Calibrate". After entering this item, you will see the current coefficient. You will be asked if you want to change coefficient.

After "no" answer (lower button), you will return to the main menu.

After "yes" answer (upper button), you will see the screen with current coefficient. Pressing upper button increases coefficient (you see the current value on the screen). Pressing lower button decreases coefficient (again you see on the screen the new value). Holding button causes fast coefficient changing. After the desired coefficient is on the screen, disconnect Qulon from the battery. The coefficient is saved in memory. It will be used during further capacity estimations until it is changed once more. Any time you test a battery, you see the coefficient value in the right top corner of the screen.

6.4. Date and time

Qulon-12ns features quartz clock with a calendar (pre-programmed to 2049) for dating the test results. Since the accuracy of the clock is limited, but user can

check and adjust the time. This procedure should also be carried out after battery replacement (see section 7).

To set the date and time you need to connect the device to the battery or optional adapter, enter the main menu (Figure 4) and follow to "settings" menu (Figure 6). Then choose time/sound item and go to "date and time" item.

You'll see the current time and date. After confirming your desire to change date and(or) time by pressing the top button, you will see the date and time changing screen. The cursor moves to the right with the top button. Lower button is used to change the selected number. The only possible clock mode is a 24-hour mode.

After the desired date and time is on the screen, disconnect Qulon from the battery.

6.5. Sound

For user's convenience the device is equipped with an acoustic signal. It is especially useful when working in tight places, so as to judge the correctness of connecting the device to the battery and the success of the capacity estimation without seeing the display. To enable the buzzer, enter the main menu (Figure 4), go into the settings menu (Figure 6), move the cursor to the line "time/sound", and press the top button. Then select "sound" and enter this menu by pressing the top button.

You will be offered three options:

A. "all sounds" - sound will accompany all

battery tests;

B) "main sounds" - audio signals will accompany only in case if some message arrives;

C) "no sounds" - the buzzer is completely disabled.

Exit this menu by pressing the top button or unplugging the device from the battery.

6.5. Language

Qulon can issue messages using two languages: (e.g. Russian or English). Consult your dealer concerning your particular version.

To change message language enter main menu, choose item options, choose item language. Now you see the current language. Choose desired language by pressing lower button.

To exit menu disconnect Qulon from the battery.

7. Replacing clock battery

The internal clock is powered by a lithium battery, fixed in a holder under a sliding cover on the rear panel. Estimated battery life - at least one year. If date or time information is correct – it may be because of the discharged battery. In this case the battery must be replaced.

Do not leave empty battery in the device. The absence of a battery in a device affects only the clock malfunction, all other functions work as usual.

To replace the internal battery unplug Qulon

from the battery under test, open the sliding cover on the rear panel and remove the battery from the holder. After this, insert the new battery into the holder with plus terminal up and close the rear lid.

Observe polarity when replacing battery.

Operation of the device with the open rear cover is not allowed.

Connect the device to a battery or adapter and set the time and date in accordance with section 6.4 of this manual.

Please use only the correct size lithium batteries CR2032 (diameter 20 mm, thickness 3.2 mm). Do not attempt to charge the empty battery (they are not designed for this purpose).

Do not replace the lithium battery with other sources of power!

8. Calibrating Qulon (how to determine right coefficient value)

Qulon-12ns is calibrated at the factory with the use of average characteristics of 12-volt lead acid batteries. Some specific battery may need some other calibration. To diminish capacity estimation error user can recalibrate device for testing of some specific battery type or confirm the validity of factory calibration.

User can perform the recalibration by changing the calibration coefficient.

Qulon-12ns calculates the estimated battery

capacity according to the following formula:

$$E = E_0 * K,$$

where: E_0 – estimated capacity without user's corrections, K – calibration coefficient.

When issued from the factory Qulon-12ns has calibration coefficient $K = 1$.

To recalibrate Qulon-12ns you need: a) determine the value of calibration coefficient for your batteries and b) adjust Qulon for work with this coefficient (see section 6.3).

You have several following possibilities to determine the calibration coefficient.

A) Get coefficient value from the producer's Internet site www.at-systems.ru, if there is data available for your battery type (see section 7.1).

B) Determine coefficient by testing your battery with Qulon and the following measured discharge (see section 7.2) – **this is the best and most recommended option.**

B) Determine coefficient using “method of average” after testing a group of batteries with Qulon (see section 7.3) .

C) Determine coefficient using “method of maximum” after testing a group of batteries with Qulon (see section 7.4).

D) Determine coefficient using “method of battery history” after testing batteries with Qulon (see section 7.5).

8.1. Coefficient from the producer's site

Recommended coefficients for some battery types are placed in the Qulon producers Internet site www.at-systems.ru. They are mainly received by comparing the estimated battery capacity and measured discharge results.

Before use of such data check battery type for which coefficient is recommended.

If there is no data for your battery type on the site, e-mail the your battery information (battery type, producer, country of production) to qulon@at-systems.ru. May be it would be possible to get newer information. Your own coefficient information is appreciated at the same address – this will help other Qulon users.

8.2. Measured discharge method

Warning. Measured discharge should be done by the qualified user who studied the present manual and who distinctly understands the sequence and probable results of the action.

Measured discharge method of Qulon adjustment is a **preferable and most recommended method**. It is based on the comparison of estimated battery capacity produced by Qulon with calibration coefficient $K=1$ and measured discharge data for the same battery.

This method is the most correct. Nevertheless the accuracy of the method is strongly dependent on the accuracy of measured discharge.

Therefore you need to use a special device (device set) for measured discharge with the characteristics not worse than following: discharge current stabilization (error < 3 %) or discharge current registration (error < 1 %, sampling rate < 1 minute); automatic cut off with cut off voltage 10.5 V; automatic discharge time registration (error < 1 %).

To get the most accurate result keep the battery under room temperature for time needed for temperature equalizing.

Charge battery in full and keep it under float charge at least for 24 hours. Disconnect battery from the charger and from any loads. After 20-30 minutes (or later) connect Qulon-12ns (adjusted for work with K=1) to the battery (see section 3.2). Write down the estimated capacity E_0 .

Connect the battery to your device for measured discharge. Set the discharge current to receive discharge time about 15-20 hours and cut-off voltage 10.5 V. Switch discharge on. After battery is cut off write down the discharge time and calculate battery capacity using one of two formulas:

a) for device set with stabilized current:

$$E_m = I * T, \quad (1)$$

where: E_m – measured capacity, A*h; I – stabilized discharge current, amperes; T – discharge time, hours.

b) for device set with current registration:

$$E_m = \int_0^T I(t) dt, \quad (2)$$

where: E_m – measured capacity, A*h; $I(t)$ – current, changing in time, amperes; t – time; T – full discharge time, hours.

Calculate calibration coefficient for your battery according to formula:

$$K = E_m/E_0$$

Coefficient error could be reduced if you make measured discharge for several batteries of the same type and take the average coefficient for the group of batteries.

8.3. Method of average

The method of average is used if making measured discharge is impossible or inconvenient. This method is based on the assumption, that batteries to be tested are part of some group (for example, intended for connection in the battery system or already connected in the battery system) and on the average have known capacity (in the elementary case - nominal capacity). This method is recommended for use with the new or poorly worn out batteries.

Connect Qulon-12ns (with $K=1$) to each battery of the group and write down the estimated capacity. Calculate the average estimated capacity for the group E_{av} , then calculate calibration coefficient for your battery

according to formula:

$$K = E_n/E_{av},$$

where: E_n – nominal battery capacity or capacity less than nominal, appointed in view of deterioration of batteries.

8.4. Method of maximum

The method of maximum is applied if carrying out the measured discharge is impossible or inconvenient. It is based on the assumption, that in the group of testing batteries (for example, intended for connection in the battery system or already connected in the battery system) the least worn out battery has known capacity (in the elementary case - nominal capacity).

This method is recommended for use with the worn out batteries.

Connect Qulon-12ns (with $K=1$) to each battery of the group and write down the estimated capacity. Find the maximum estimated capacity for the group E_{max} , then calculate calibration coefficient for your battery according to formula:

$$K = E_n/E_{max},$$

where: E_n – nominal battery capacity or capacity less than nominal, appointed in view of deterioration of batteries.

8.5. Method of battery history

The method of battery history is used during scheduled service of individual battery, if carrying out the measured discharge is impossible or inconvenient. The method is based on the assumption, that in the beginning of the battery service life (right after the first connection of Qulon-12ns to the battery), the capacity of the battery is accepted known (for example, it is considered that it is equal to nominal capacity). During further service battery capacity estimated by Qulon-12ns is compared to this value.

Connect Qulon-12ns (with $K=1$) to the battery and write down the estimated capacity E_{m1} , then calculate calibration coefficient for your battery according to formula:

$$K = E_n/E_1,$$

where: E_n – nominal battery capacity or capacity less than nominal, appointed in view of deterioration of the battery.

9. Appendix: test cable checking

Qulon-12ns is equipped with special cables with clips utilizing four-wire (Kelvin) connection. At the negligent treatment - for example, a detachment from the device by pulling by a cable, they could be damaged. If you have any doubts about cables, it is possible to check them up, using a digital tester as follows.

A. Attach cable to Qulon-12ns.

B. Disconnect halves of both clamps from each other (for example by installing a piece of cardboard or plastic between halves).

C. Switch tester to resistance measurement mode.

G. Connect tester to the halves of black (negative) clamp - the tester should show resistance to the order of 0.65 Mohm.

D. Connect tester to the halves of the red (positive) clamp - the tester should show resistance at least 2 MOhm or no contact.

E. Connect the halves of clamps (half crocodile clips) to each other — remove insulators, placed before.

J. Connect tester between the black and red clamps - tester should show resistance to the order of 0.25 Mohm.

10. Specifications

1. Working voltage range - 9 V to 15 V.
2. Recommended range of nominal capacity of batteries to test – 0.9 to 350 ampere-hours.
3. Battery voltage range for battery capacity estimation – 12.6 to 13.9 B.
4. Battery testing time under basic filtering mode – up to 1.5 s.
5. Powered – from the battery under test.
6. Test cable length – 0.6 m.
7. Weight – 0.4 kg.
8. Dimensions without cable - 135 x 70 x 23 mm.
9. Working temperature range - from 10 to 35 °C.
10. Humidity up to 95 % without condensation.
11. Display type – graphical LCD.

Warranty

The manufacturer warrants Qulon-12ns to be free of defects in parts and workmanship for one year from date of shipment (a two month limited warranty applies on test cables) and not more then 15 months from the date of production.

If it becomes necessary to return the device for service during or beyond the warranty period, contact your dealer. Describe your problem in details (may be it would be possible to solve it by e-mail) and request the address for shipment. The sender is responsible for shipping charges, freight, insurance and proper packaging to prevent damage in transit.

This warranty does not apply to defects resulting from action of the user such as misuse, improper wiring, operation outside of specification, improper maintenance, or unauthorized repair or modification.

The manufacturer is not being liable for any direct, indirect, incidental or consequential damages. The manufacturer's total liability is limited to repair or replacement of the product. The warranty set forth above is inclusive and no other warranty, whether written or oral, is expressed or implied.

Type: Qulon-12ns.

Serial number _____

Manufactured: " ____ " _____ 201__

Signature _____

Sold by _____

" ____ " _____ 201__

Signature _____