Battery Maintenance

Using the Infratek 23DC-Source Tester

Infratek

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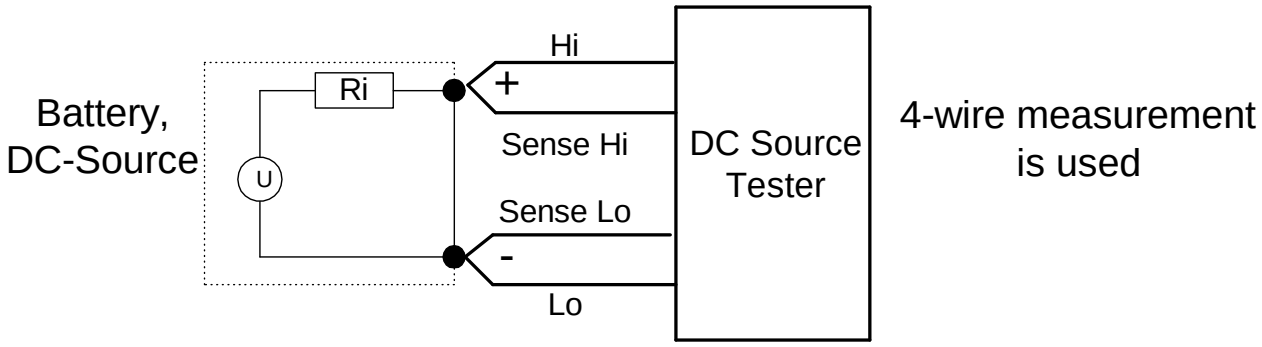
1. Maintenance of Lead Acid Batteries using the Infratek 23 DC-Source Tester

1.1. Introduction

The Infratek 23 DC-Source Tester is an instrument to quickly characterize DC power supplies or sealed and non-sealed lead acid batteries. The tester basically measures the no-load voltage and the internal resistance of the source. In case of a battery this tells something about its health or state it is in.
A voltage source can electrically be represented by an ideal voltage source (zero internal resistance) in series with a resistor. This is shown below.



The voltage of the ideal voltage source can easily be measured using a DC voltmeter. Determining R_i is not that simple because R_i is in the milliohm range. Often the measurement has to be performed with considerable noise superimposed.

1.1 Main Features of the Infratek 23 DC-Source Tester

- Tests batteries and cells 0.5Ah-2000Ah (lead acid/NiCd)
- Tests battery strings up to 120V
- Tests single cells, minimum voltage 1.65V
- Uses sophisticated state of the art electronics
- Exhibits extremely good measurement repetition of ±1 digit
- Turn on and measure, no zeroing, no adjusting, no range setting
- Wide voltage range 0-30V / 0-200V
- Wide resistance range 0-20mΩ / 0-400mΩ / 0-8Ω
- Stores 500 measurements (voltage and Ri)
- Comes with isolated RS-232 interface
- Easy to operate with only 3 controls
- Fully menu programmable
- Tester is light weight (400gr), operates on 9V cell/6-8h
- Label printer, windows software available

INFRATEK OFFERS BATTERY MAINTENANCE SOLUTIONS:

1. **For stationary batteries**
   DC Tester, Label printer, and carrying case (3kg) for on site maintenance decisions.

2. **For starter batteries (car batteries)**
   DC source Tester and battery load, optional printer (a novel approach for car battery testing)

3. **For traction batteries (motive power batteries)**
   DC source Tester holds the reference values of your batteries. Measure and compare to reach instant decision.

4. **For testing DC Power Supplies**
   It is simple to measure the internal power supply resistance under different load conditions.

BATTERY TEST PRODUCTS

Full: Infratek 23 DC-Source Tester with RS-232 and carrying case, windows software, label printer, battery pack for printer, 4-wire measuring clips, and RS-232 cable to PC. Weight 3kg

Med: Infratek 23 DC-Source Tester with RS-232 and carrying case, windows software, 4-wire measuring tips with spring contacts, and RS-232 cable to PC.

Gen: Infratek 23 DC-Source Tester without RS-232 with carrying case, and 4-wire measuring clips.

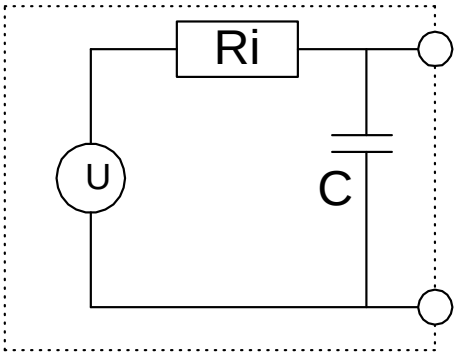
Car Full: Infratek 23 DC-Source Tester for car battery testing with RS-232 and carrying case, battery load, label printer, and measuring crocodile clips.

Car: Infratek 23 DC-Source Tester for car batteries without RS-232 with carrying case, battery load, and measuring clips.

Clips: 4-wire crocodile clips (1 red / 1 black)

1.3. "The Battery"

When we talk about batteries we mean large rechargeable lead acid and NiCd batteries 0.5Ah to 2000Ah. The Infratek 23 DC-Source Tester is not meant to be used to check small batteries, its price compared to the price of a small battery hardly can be justified.
Batteries store electrical energy. The storage effect is based on chemical processes which are well known but at the same time are not precisely defined. For example, the voltage on a fully charged cell varies between 2.19-2.35V. We might say, every cell has its own character even cells out of the same production batch.
Measuring the specific gravity of the acid of every cell is time consuming and gives little information about the electrical condition of the cell. More and more completely sealed (vented) cells, 6V- and 12V- blocks (modules) come in use and eventually will replace the old type. The measurement of the specific gravity will belong to the past by that time.
That's face it, the battery is an electrical source after all which can be characterized by an ideal voltage source and a small series resistor depicted below. C is an electrical capacitance ranging from 0.1 Farad to several hundred Farad (not micro-Farad).



Electrical representation of a lead acid battery

The table below lists typical values for R_i for fully charged cells, 6V-blocks, and 12V-blocks versus capacity in Ah.

Ah	Cell	6V-Block	12V-Block
1Ah	25mΩ	75mΩ	150mΩ
10Ah	8mΩ	25mΩ	50mΩ
100Ah	1.6mΩ	5mΩ	10mΩ
1000Ah	0.12mΩ	0.36mΩ	0.72mΩ

Table 1: R_i versus battery capacity

- As a rule of thumb R_i is inversely proportional to battery capacity.
- A 12V-block consists of six cells connected in series and therefore its R_i is approximately 6-times the internal resistance of a cell.
- As a battery is discharged its voltage drops and its internal resistance R_i increases drastically towards the end of 100 % discharge.

The following table shows typical Ri-values of a 100Ah 12V-block being discharged.

Discharge	0 %	20 %	40 %	60 %	80 %	100 %
R_i	10mΩ	11mΩ	12mΩ	15mΩ	30mΩ	120mΩ

- The influence of temperature on Ri and on battery voltage can be neglected for all practical purposes.

1.4. Types of Batteries in Use

A. Stationary Batteries (Standby Batteries)

There are huge numbers of this type of batteries in use all over the world just sitting there waiting for the day when they are needed. These batteries are normally being charged constantly keeping them at a preset float voltage. The maintenance people better make sure the back up system is ready when needed. These battery systems range from 6V up to several hundred volts and are up to 1000Ah large. Modern back-up batteries are all in sealed casing, the access to the acid is not possible.

B. Starter Batteries (Car Batteries)

Every car is equipped with a starter battery. When battery trouble arises there is not much available except exchanging the battery and hoping for the best.
We think we have a reliable test available.

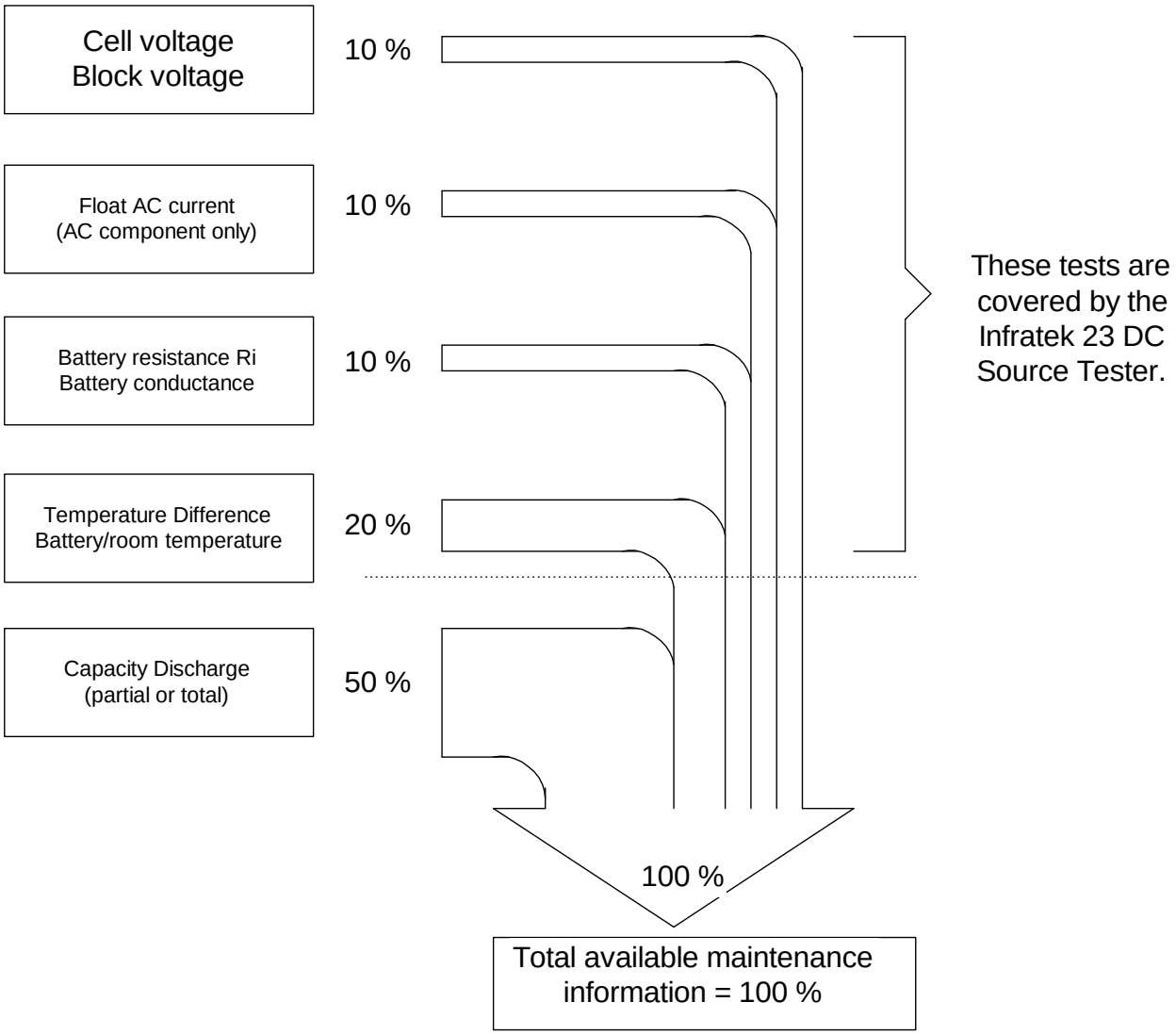
C. Traction Batteries

These batteries move electrical vehicles. Of course, the battery always breaks down at the wrong time. The batteries are of diverse shape and have typical voltages of 24V or 48V.

1.5. Battery Maintenance and Battery Monitoring Applied to Stationary Batteries

Stationary battery systems can not be left on its own. They must be checked periodically to avoid break down in case of emergency.
In Switzerland alone there are 600 back-up battery system just to keep all the cell phones / mobile phones communicating. The maintenance of 600 systems is quite a job.
The Swiss Battery manufacturer Oerlikon proposes the following multiparameter monitoring for preventive maintenance.

D. <u>Multiparameter Maintenance Plan</u>



The first 50 % of the tests of this maintenance plan are the measurement of cell voltage, float ac current, internal resistance R_i and temperature difference. The second 50 % of this maintenance plan is the capacity discharge procedure which is very time consuming and is only done when absolutely necessary.
The Infratek 23 DC-Source Tester covers all parts of the first 50 % of this multiparameter monitoring scheme. The tester determines the cell or block voltage and the internal resistance R_i in 0.6 seconds. The measurement of R_i also takes care of the float ac current and the temperature difference between battery and environment. Why? The reasons are given below.

- The ac float current is an indirect measurement of the internal resistance. When Ri is known the ac float current contains no new information Uac = RiIac.

- The temperature difference between battery and environment is determined by the internal power loss given by Ri ·I2 (I = total current). Because current in series connected batteries is equal the temperature difference is directly proportional to Ri. Therefore, when Ri is known the measurement of temperature difference contains now new information.

Conclusion: The measurement of battery voltage and internal resistance R_i delivers 50 % of the available maintenance information.

- **R_i is the most valuable maintenance parameter of a stationary battery.**

- **Its relative increase over time reflects capacity deterioration.**

- **The 23DC-Source Tester does this job better than any other available product.**

1.6. Testing Stationary Batteries Using the Infratek 23 DC-Source Tester

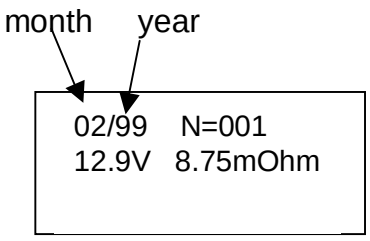
The idea: Measurements of R_i and battery voltage are taken in one year interval at same conditions and are compared to **individual reference** values. When R_i has increased more than 30 to 40 % the battery is replaced on site. (A battery system can be in use up to 15 years).

Reference values: These are the values of voltage and R_i printed on a sticker or listed in a computer file.

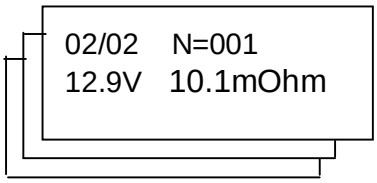
a) given by the manufacturer
b) measured by the user when system is new
c) measured by the user the first time a maintenance plan is started (part of ISO 9000 requirements).

Test Method 1

Test Method 1 uses the Infratek 23 DC-Source Tester and a label printer. Every battery has its individual reference values printed on a label which is attached to the battery. Every year maintenance measurements are made and a new label is put on top of the label of the previous year. The user can set its own limits for the increase of R_i. In general limits of 30 % to 40 % increase are applied. When these limits are reached the battery cell or module is replaced.
This test method is reliable and efficient at the same time. Stationary batteries are being charged constantly and therefore R_i is measured under the same condition from year to year. An increase of R_i of 30 % indicates an approximate 30 % loss of battery capacity.
The measured values are also stored in the tester and can be transferred to a PC file for maintenance records.



Reference Label



Label stack from periodic maintenance measurements

Test Method 2

Test method 2 uses the Infratek 23 DC-Source Tester, the Infratek PC software, a RS-232 interface cable (max. 15m) and a notebook computer. Every battery block is labeled N=001 to N=xxx. A 120V back-up system, for example contains 10 battery blocks of 12V each. In this case the blocks are numbered N=1 to N=10.

The testing proceeds as follows:

- Select the file with the reference values for this particular battery system.

- Connect the RS-232 interface cable and start measurement with block N=1. The measured values are transferred to the notebook by pressing the key “STORE”. The measurement is right away compared to the reference value of this block. When limits are exceeded the maintenance person is alerted. When finished you have the whole picture as well as a data record.

Test Method 3

Test method 3 is almost identical to test method 2. In this case data are not directly transferred to the notebook. The measurements are first stored in nonvolatile memory of the tester under N=1 to N=xxx (max. 500).
When the testing is finished the data are read into a notebook on site or are transferred to a PC in the office. The supplied software gives quick answers.
The Infratek 23 DC-Source Tester can store up to 500 values of battery blocks or cells. This will be enough storage even for very large systems.

Note: Stored data are not lost when 9V battery is removed from the tester.

1.7. Testing Car Batteries (Starter Batteries) Using the Infratek 23 DC-Source Tester

Starter batteries have a capacity of 50-120Ah. When fully charged their internal resistance is from 3mΩ to 20mΩ. There is a large range of battery types (different manufacturer) on the market, and therefore the measurement of R_i alone can not be used to detect bad batteries. Furthermore, when a car is brought in with battery trouble the battery is in an undefined state. Therefore, without using additional means the health of a care battery can not be determined. Infratek has devised a test method using the change of R_i as a function of applied load. The load applied to the battery is a “soft” load which draws a precisely defined current of 30A. For the test the battery does not have to be removed from the car electronics. This is for all practical purposes a very important aspect.
The test takes 6 seconds. Its outcome is displayed and can also be printed on a label for customer proof.
The car battery tester is equipped with two high current clips and two measuring clips. You can test the car battery under load condition as follows:

- Select “LDT” in the menu “MODE SELECT”.
- Attach the high current clips to the plus and minus pole of the battery (red + / black).
- Attach the measuring clips, red to plus and black to minus.
  Caution: Pick a free spot on the poles. Do not attach the measuring clips to the high current clips, this would result in false measurements.
- Start the load test by pressing “Ri/LOADTEST”.

The following sequence starts:

1. R_i and battery voltage at no load is measured and displayed.
2. The 30A load is applied. The voltage display is updated every second.
3. At the end of the load interval R_i and voltage is measured and displayed for two seconds.
4. Finally, the test result is displayed as follows:
   TEST: CHARGE GOOD / FAIR / FAIL
   CHARGE is used when the battery voltage is less than 12V.
   GOOD / FAIR / FAIL is a grading of the internal source resistance Ri under load condition.

All test data can be printed on-line.

1.8. Testing Traction Batteries Using the Infratek 23 DC-Source Tester

Traction batteries are used to move all kinds of vehicles. The batteries are of diverse size, shape, construction, have different voltages, and different capacity size.
The owner of several traction batteries can use the Infratek 23 DC-Source Tester as follows:

- When the battery is fully charged he measures the battery voltage and R_i and stores the values at N=401. The values of the next fully charged battery is stored at N=402 and the batteries are labeled N=401, 402, ... This way for every battery a reference value is established.

- In case of trouble these reference values can be used. For this purpose the battery is first fully charged and then its voltage and Ri measured. In the “COMPARE” measurement mode the actual measurement can be compared to the reference number N=xxx. A 30 % increase of Ri at comparable battery voltage the battery probably needs service or replacement.

SPECIFICATIONS

Size of Batteries	Tests batteries 0.5Ah-2000Ah and voltages up to 120V	sealed, non-sealed; lead acid and other
Voltage UB	Ranges 2; 0-30V, 0-200V Resolution; 10mV, 0.1V Accuracy; 1 % ±1 digit	200Vdc maximum Display; 3 digits 23° ±3°C
Source Resistance Ri	Ranges 3; 0-20, 0-400mΩ, 0-8Ω Resolution; 0.01, 0.1mΩ Measurement repetition; ±1 digit Accuracy: 1 % ±1 digit	U_B: 1.6V-120V Display 3 digits S/N >20dB S/N >20dB
Display	6.5mm, 16 character LCD	V, mΩ, Mode
Interface	RS-232, isolated from batteries	300V CAT II
Operation / Time	Via menu, 3 controls	0.6s measurement time
Data Storage	500 complete sets U_B, R_i	N=1 to N=500
Supply	9V battery or accumulator	for 10h operation
Size / Weight	155 x 90 x 35mm; 300 gr.	
Temperature	Operating: 0-30°C; storage: -10 -40°C	
Tester versions	Full: Tester, printer, software Med: Tester, software Gen: Tester, no interface Car: Tester including battery load Car Full: Tester including battery load, printer	Stationary Batteries Stationary Batteries Traction / Stationary Batteries Car batteries Car batteries

Menu Selection

• **MODE SELECT >SET**	Select OPERATING MODES (MAN, AUT, RD, CMP, LDT)
• **INCR 10** • **INCR 1** • **DECR 10** • **DECR 1**	Increment memory location by 10 Increment memory location by 1 Decrement memory location by 10 Decrement memory location by 1
• **SET MONTH** • **SET YEAR**	Select month to be printed Select year to be printed

Month and year are stored in non volatile memory.

Operating Modes

Operating mode selection is done in the menu **"MODE SELCT>SET"**. The following operating modes can be selected.

•MANUAL STORE: **MAN**	A measurement can be stored and printed by pressing the key "STORE". N is incremented by 1.
•AUTO STORE : **AUT**	After a measurement the values are automatically stored and printed. N is incremented by 1.
•READ MEMORY : **RD**	Measurements can be read from the memory and can be displayed. N is decremented by 1.
•COMPARE : **CMP**	The present measurement can be compared to a reference value stored at memory location N. After each new measurement N is incremented by 1 to the next reference value.
•LOAD TEST : **LDT**	With the key "LOADTEST" the test sequence for car batteries is started.

1.10. Windows Software for the Infratek Battery Tester DC 23

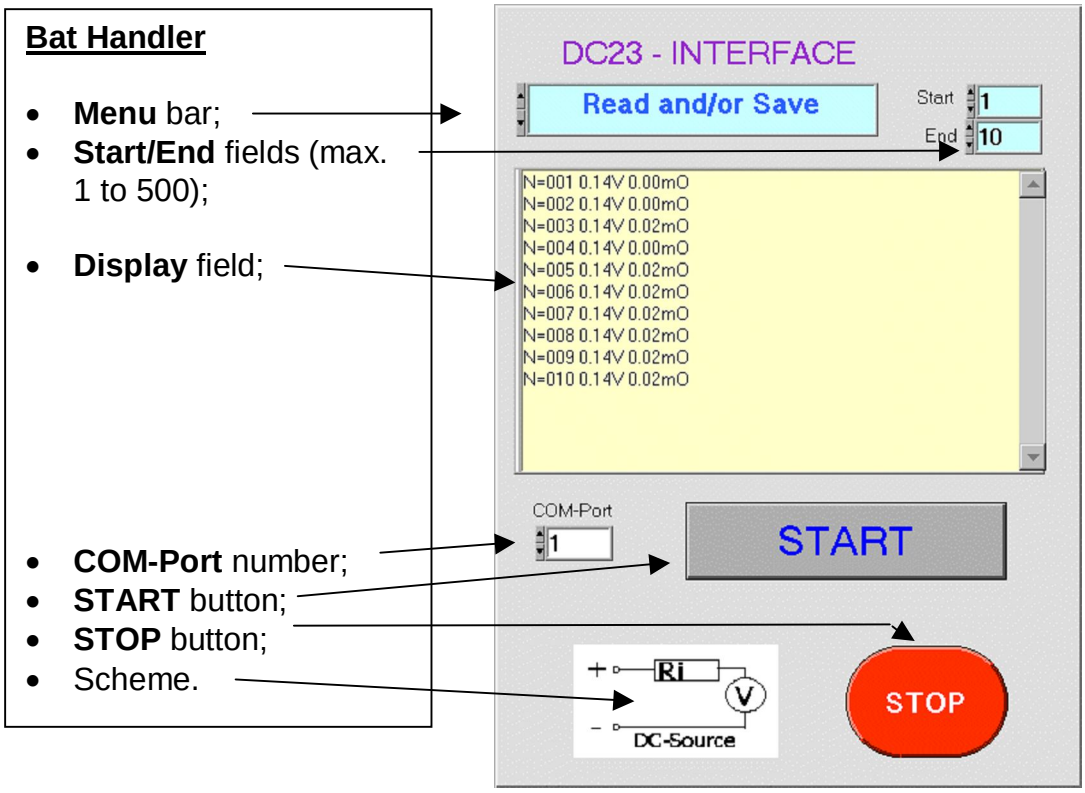
1.10.1. Overview

There are 3 different kind of programs to read, organize and analyze your battery data in a fast and easy way. Just set your COM-Port in the mask, choose a command from the menu and press START.

- **BatHandler** (Trigger a measurement from your PC, read the display values or read the data stored in the DC23 memory to your PC);
- **BatAnalyze** (Compare your measurements (files) and get a fast battery status overview);
- **BatAlarm** (Check measurements online with your reference values);

1.10.2. BatHandler

The BatHandler front panel looks similar like the DC23 instrument. With this program you are able to trigger battery measurements from your PC. First set the COM-Port in the mask, choose a command from the menu and press START. To trig a measurement for example just select "**Trig / Read measurement**" and press the START button. To read the display values use "**Read display**" and press START.
If you are going to read out the stored values from the DC23 Battery Tester choose "**Read and/or save**", set your desired battery numbers at the Start/End fields (max. 1 to 500) and press START.



The program asks "Choose file to write". Type your filename and your data will be stored in a spreadsheet compatible mode.

RefBat1 - Editor

Datei Bearbeiten Suchen ?

Bat-Nr.	Voltage	Resistance
N=001	12.3V	33.7mOhm
N=002	12.3V	33.7mOhm
N=003	12.3V	33.7mOhm
N=004	12.3V	33.7mOhm
N=005	18.3V	33.7mOhm
N=006	12.3V	33.7mOhm
N=007	12.3V	33.7mOhm
N=008	12.3V	33.6mOhm
N=009	12.3V	33.6mOhm
N=010	12.3V	13.7mOhm

After the file-header you'll find your data stored by the battery number (Bat-No.), the voltage value (Voltage) and the resistance in mOhm or Ohm (Resistance).

To define a **Reference-Battery-File** there are two possibilities:

- Make an initial measurement from your battery system and declare it as your reference file;
- Take a text editor and create a new file which is based on a primary measurement of the battery system.
- When you had to replace a battery by a new one, measure it after installation, and edit the existing reference file with the new reference value.

1.10.3 BatAnalyze

The BatAnalyze front panel gives a fast overview from two measurement files. The result signs show, ordered by the battery number, **GOOD** with a green and **FAIL** with a red indicator.

Just follow the instructions at bottom step by step and you'll be informed suddenly about the status of your battery system.

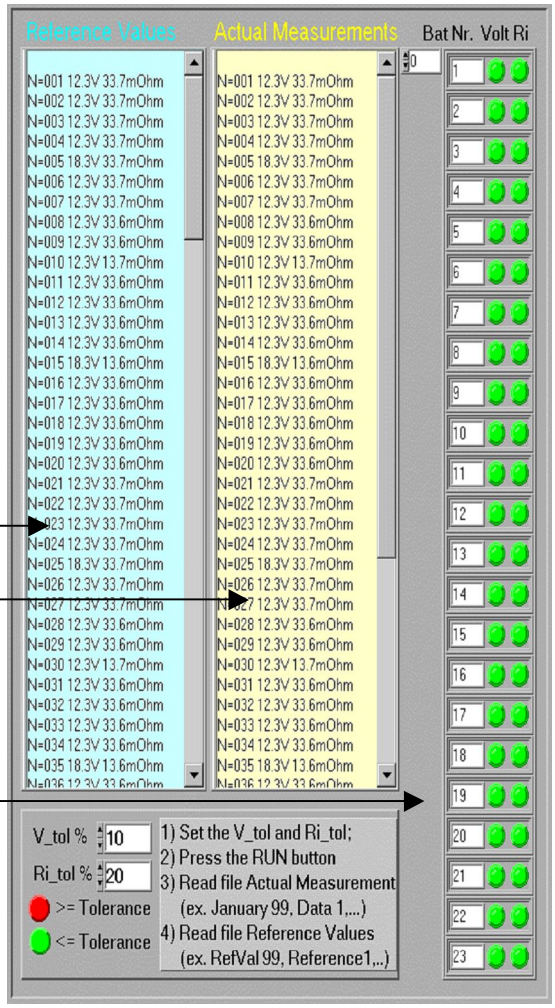
With the tolerance fields you set your own battery fail criteria.

Reference File

Actual Measurements

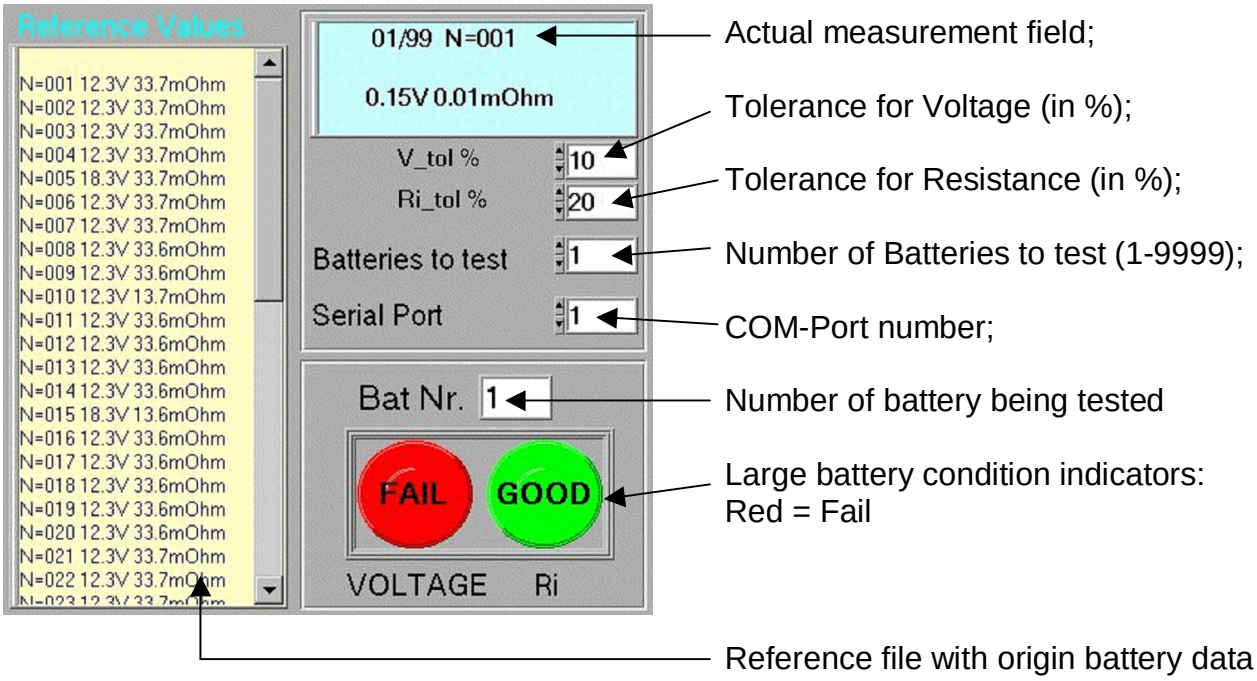
Alarm Display (Bat-Nr., Voltage, Resistance)

Tolerance Selectors



1.10.4. BatAlarm

The BatAlarm program is an extremely helpful tool for your decision making in battery management.
Simply connect the DC23 Battery Tester with a serial cable to your host PC, select the COM-Port and the reference file with the origin battery data and compare your actual measurements with the file values. The result is an immediate indication over the battery status.



There is a large variety of RS-232 cables with different lengths to give you a good movement range.

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