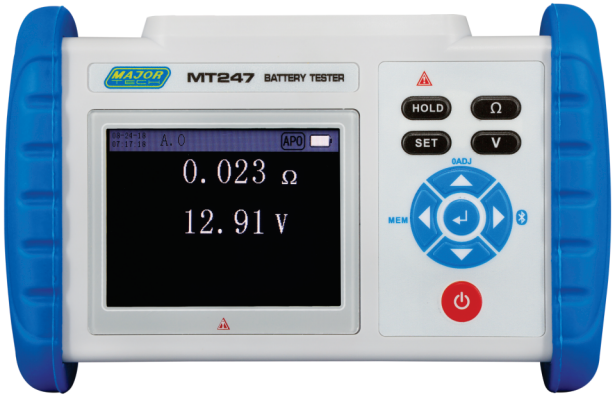
INSTRUCTION MANUAL

MT247

BATTERY INTERNAL RESISTANCE TESTER



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1. INTRODUCTION

The MT247 Universal Rechargeable Battery Internal Resistance Tester is an essential measuring instrument designed to assess the internal resistance, voltage, and temperature of rechargeable batteries like lead storage batteries and lithium batteries, providing crucial insights into battery health. Additionally, it can serve as a meter for ESR parameter measurement in electrolytic capacitors (for reference only).

Utilizing the AC 4-terminal test method, this tester ensures accurate measurement values, unaffected by contact resistance between test leads, terminals, and battery electrodes. It comes equipped with features such as data storage, data access, alarm functions, and automatic shutdown.

With a wide measuring range, high resolution, user-friendly operation, portability, accuracy, reliability, stable performance, and strong anti-interference capability, the MT247 proves indispensable in various scenarios, including battery production, battery installation, equipment production, and equipment maintenance.

Controlled by a microprocessor, the MT247 incorporates a 16-bit internal ADC for precise detection of battery internal resistance, voltage, and temperature. Noteworthy is its ability to measure without disrupting the UPS system, employing AC low-resistance measurement and noise reduction technology. This allows testing to occur without interrupting the normal operation of the device under test, significantly reducing test time.

Moreover, the MT247 features functions such as data storage, histogram display, data upload, and compatibility with computers, mobile phones, tablets, and other smart devices through Bluetooth connectivity, enabling wireless measurement and data access for enhanced convenience.

1. SAFETY RULES AND PRECAUTIONS

The instruction manual must be read and the safety rules and precautions listed in this manual must be strictly observed. Strict attention must be given before you use this instrument in order to avoid possible electric shock or personal injury.

When using this instrument please pay special attention to safety.

- This tester conforms to IEC61010 safety specifications for design, production, and test.
- Please pay attention to the polarity (+/-) of the battery and do not insert it backwards.
- Do not measure the battery voltage exceeding the voltage range.
- When the meter displays battery low voltage symbol "▭" put the

meter on charge immediately, otherwise it will lead to measurement errors.

- Fully charge the meter every 3 months should it not be used for long periods of time.
- To avoid errors during measuring, do not use high-frequency signal generators like mobile phones etc.
- Pay attention to the label text and symbols on the instrument.
- Do not keep or store the tester in an area with high-temperature, moisture, or condensation, or under direct daylight radiation for a long period of time.
- Pay attention to the measurement range and in use environments specified by this instrument.
- This meter is only to be used, disassembled, adjusted, and repaired by a qualified and authorized personnel.
- If there is any damage to this instrument, it is dangerous to continue operating. Seal up immediately and hand in for repair or disposal by an authorized personnel.
- For the safety warning signs "⚠" on the instrument, the user must strictly follow the contents of this manual for safe operation.

3. STRUCTURE

1 - Screen
2 - Buttons
3 - Wiring Port
4 - USB / Charging Port
5 - Charging Indicator

4. INTERFACE DISPLAY
4.1. Interface Icon and Symbol Description

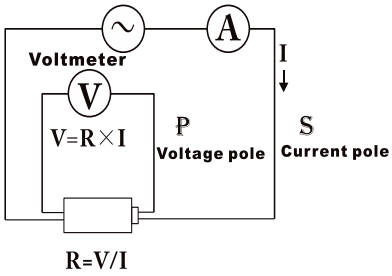
	Indicates the remaining power and charging status of the meter's battery
	Indicates that the tester has turned on the automatic shutdown function, which is turned on by default
	Indicates that the tester has turned on Bluetooth connection, and it is turned off by default
	Indicates that the tester has automatically maintained data
	Indicates that the instrument has manually retained data
A.21	Indicates that the current memory used is A, and there are 21 sets of data in memory A
FULL	If memory is full of 500 groups and continue to measure, the screen will display "FULL" and no more data will be stored
	"FAIL" Indicates that the current measurement result is judged as failed
	"WARNING" Indicates that the current measurement result is judged as a warning
	"PASS" Indicates that the current measurement result is judged as passed
	Indicates that the current measurement result has subtracted the initial line resistance
	Indicates that the software filtering function has been turned on, and the digital change is slower than the normal mode, and is closed by default
	Indicates that the instrument has turned on the automatic shift function, which is turned on by default
	Indicates that the current measured voltage has exceeded the safety voltage. **Please pay attention to safety.**

5. MEASURING PRINCIPALS

5.1. Principle of AC 4-terminal test method

AC Current **(I)** with a frequency of 1KHz flows between the positive and negative electrodes of the battery, and the AC voltage difference V between the positive and negative electrodes of the battery is measured. The internal resistance of the battery is calculated according to the formula **R=V/I (see figure 1)**. In order to ensure the measurement accuracy, the two current electrodes **(S)** and the two voltage poles **(P)** should be in contact with the positive and negative poles of the battery independently, and the correct measurement value can be obtained without wire resistance or contact resistance.

Rated current generator FIGURE 1



5.2. Principle of voltage measurement

After the sampling resistor divides the pressure and the noise is filtered out, the ADC samples and calculates and corrects the measured value through the program.

5.3. Principle of temperature measurement

The voltage divider network composed of NTC temperature sensor and Rx, Rx is a constant, but NTC changes its resistance with temperature changes, and the actual temperature value is obtained by measuring the partial pressure voltage and bringing it into the NTC temperature conversion formula.

6 OPERATION METHOD

6.1. Power Function and Automatic Shutdown

1. Press ⏻ to Power On/Off
2. If the automatic shutdown function is turned on, and no key is pressed within 15 minutes after starting up, the meter will automatically shut down to save power. If any key is pressed during the 15-minute timer, it will be extended by another 15 minutes. This function can be turned off in the settings, the factory default is turned on, and APO will be displayed when turned on.

6.2 Test Interface Operation

In the test interface, you can view the current instrument time, measured value, and instrument status information. The functions of the operation buttons are as follows:

Key Symbol	Short Press	Long Press
HOLD	Hold data	
SET	Enter the settings menu	
Ω	Resistance measurement shift	
V	Voltage measurement shift	Display voltage (+ press enter to return to zero)
▲	Zero set or cancel zero	
▼	Turn automatic gear shift on or off	
◀	Enter data reading mode	
▶	Turn Bluetooth on or off	
↵	Turn software filtering on or off	NOICE / Normal mode switch

6.3. Setting Menu Interface Operation

Press SET on the test interface to enter the setting directory interface. In the setting directory interface, you can select the items to be set and view the basic information of the instrument.

▼ ▲	Select the item to be set
↵	Choose to enter

6.3.1. Threshold Setting

The threshold setting interface can set the thresholds for judging the test results FAIL, WARNING and PASS. Setting an appropriate threshold can improve the efficiency of judgment and test.

▼ ▲	Switch settings
↵	Enter or exit the current setting item
◀ ▶	Digital displacement
▼ ▲	Addition and subtraction value
SET	Return

6.3.2. Alarm Settings

The alarm setting interface can set the buzzer prompt mode when the test is completed.

▼ ▲	Select the alarm function
↵	Save and return
SET	Return

6.3.3. Storage Settings

The storage setting interface can be set to maintain, storage mode, memory selection, there are a total of ABCDEFGHIJ ten storage options, if the current memory is full of 500 sets of data, the memory is full (FULL symbol) when storing data, you need to manually set other memory or Only after deleting the current memory data can the new measurement data be stored.

▼ ▲	Select function
↵	Change settings or select memory
◀ ▶	Choose another storage
SET	Return

6.3.4. Shifting Settings

Shift mode setting interface can choose manual shift or automatic shift measurement mode. The gear shift mode can also be quickly changed by pressing the ▼ button on the test interface. The icon Auto on the test interface indicates that the machine has turned on the automatic gear shift function.

▼ ▲	Select function
↵	Save and return
SET	Return

6.3.5. Clock Settings

The clock setting interface can set the time of the instrument. The time display format of this instrument is **XX (year)-XX (month)-XX (day) XX (hour): XX (minute): XX (second)**. The supporting software is connected to the computer or mobile phone to synchronize the time of the instrument with one button.

Arrow keys	Select the item to be set
↵	Set selection items
▼ ▲	Change the value of the selected value
◀ ▶	Check other values
HOLD	Effective current setting time
SET	Return

6.3.6. Energy Saving Settings

The energy-saving setting interface can set the display brightness of the instrument and turn on and off the automatic shutdown function.

▼ ▲	Set selection items
◀ ▶	Change the backlight brightness
↵	Turn automatic shutdown on or off
SET	Return

6.3.7. About the instrument

You can view the basic information of the current instrument on this page and press the SET key to return to the setup menu interface.

6.4. Measurement procedure

6.4.1. Internal Resistance Measurement

1. Connect the test line to the meter and connect the indication mark **(small arrow)** of the test line and the indication mark **(small arrow)** on the machine according to the corresponding colour.
2. Set the instrument parameters, refer to 6.3.1 and 6.3.2.
3. If you use a test lead other than the standard configuration, short-circuit the four-wire clamp of the test line, and then press the △ key to adjust the zero calibration.
4. Clamp the test lead to the electrode of the battery and start the test.
5. Wait for the value to stabilize to read the test result.

6.4.2. Voltage Measurement

This meter can also be used as a DC voltmeter. Connect the two red and black ports in the middle to measure the DC voltage. Be careful not to measure the AC voltage and that the DC voltage does not exceed 70V. When the resistance shows "——", the voltage must be greater than 0.17 to display the value, otherwise only the "——" symbol will be displayed.

When the short-circuit test lead V+V- has residual voltage or the measurement has deviation, the manual voltage can be adjusted to zero. The operation method is to first short the test lead V+V-, then long press the " **V** " key and hold it, then press the enter button, the buzzer will beep, and the zero adjustment is completed.

6.4.3. Temperature Measurement

Insert the temperature sensor into the TEMP/SENSOR interface, the display interface can display the temperature, and the sensor will not be displayed if it is not connected.

6.5. Data storage

The data storage function needs to turn on the "**Keep Storage**" function in the settings (please refer to section 6.3.3), it is turned on by default at the factory. It will automatically number and store a set of data each time manual HOLD or automatic HOLD is selected. This meter has 10 data memories. Numbers A~J can be selected in the settings. When all memories are full, it can store 5000 data records.

It should be noted that when a memory continues to measure after 500 sets are stored, the HOLD data is no longer saved in the memory, and the user needs to manually switch to another memory or delete the memory data before saving.

Memory number	Store records/items
A	500
B	500
C	500
D	500
E	500
F	500
G	500
H	500
I	500
J	500

6.6. Data Access and Deletion

On the test page, press the ◀ key to enter the reader selection interface, follow the prompts on the page to operate the instrument to select the reader to enter the histogram interface, press the ▲ key on the reader selection interface to delete the current reader data, and you can choose whether to delete it according to the prompts.

As shown in Figure 8-1, each page of the histogram interface can display 10 measurement records, which can visually analyze the internal resistance of the batch of batteries. You can use the ◀ or ▶ to move the reading cursor left and right. The item selected by the cursor can read the specific information of battery internal resistance, voltage, temperature, and test time. You can also use the ▲ or ▼ to scroll through pages.

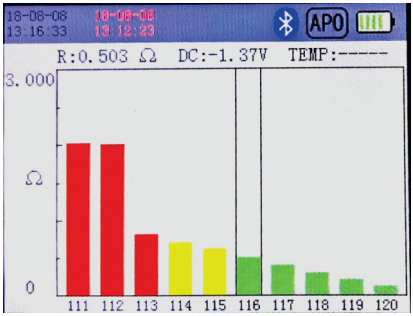


Figure 8-1 Histogram interface

6.7. Communication with PC

Please confirm before use:

1. The USB driver has been installed.
2. EXCEL software is installed on the computer.
3. The host computer software on the USB has been installed.

Use the attached USB cable to connect the instrument to the computer. After opening the software, it will automatically search for the COM port and automatically connect, it can take up to ten seconds. After the connection is successful, it can read real-time measurement values, read historical measurement records, synchronize the computer time to the meter and other functions.

6.8. Communicate with Smartphone or Tablet.

Please confirm before use:

1. The phone or tablet system version is Android 5.0 or higher
2. The "Battery Internal Resistance Tester APP" is installed in the smart device.

In the measurement interface of the meter, press ▶ to turn on the Bluetooth function on the tester. The smart phone's Bluetooth must be switched on, then open the APP. Search for "**BRT**" (Abbreviation of Battery Resistance Tester) and connect. After the connection is successful, functions such as wireless measurement and data browsing can be realized.

7. NOISE FREQUENCY AVOIDANCE FUNCTION

7.1. Applicable Occasions

When measuring the battery of the UPS (uninterruptible power supply) and the battery uninterruptible power supply, the noise frequency generated by the load at or near 1000Hz overlaps with the measurement frequency of the UPS, resulting in measurement instability. Enable this function to automatically avoid the noise frequency.

7.2. Turn On/Off

In normal mode, hold down the key ↵ to open, and hold down the key again to exit.

After turning on, the display icon NOISE indicates that the current mode is noise avoidance frequency; FREQ blinking indicates that the frequency is being converted and the interference frequency is being identified; FREQ stopping blinking and disappearing indicates that the noise frequency is being avoided and the internal resistance is being tested; the progress of a complete test is indicated by the red progress bar at the bottom of the screen.

The longest time to measure a round: 1.5s*3*18+1=82s the longest time to measure a round is about 82 seconds, when there is no interference.

The shortest time to measure a round: 1.5s*2+1=4s the shortest time to measure a round is about 4 seconds, which is when the interference is close to 1000Hz.

NOTE: This mode takes a long time to test. If there is no noise frequency, please do not use this function.

After completing a measurement, there are four frequency test displays below the icon, which are shown in sequence:

1. The difference between the output frequency of the first round and the noise frequency.
2. Difference between the output frequency of the second round and the noise frequency.
3. The calculated noise frequency.
4. Frequency of this test.

Sometimes, it may be impossible to avoid all the noise frequencies due to the specific situation of noise. When the identification of noise frequencies fails, item 1/2/3 above shows Fail and the progress bar turns yellow. In this case, you can manually select the measurement frequency by long press ◀ or ▶ key and select a more stable value as the result.

7.3. Single/Cyclic Identification of Noise Frequency

After turning on the noise avoidance frequency mode, press the ↵ key to

turn on or off rolling measurement, that is, to identify the interference frequency cycle, to avoid the interference frequency test, and display the icon after turning on; If it is not enabled, it will only identify the interference frequency for the first time, and then avoid the interference frequency test all the time. It will be turned off by default.

8. MAINTENANCE AND SERVICE

8.1. Battery

1. When the battery voltage is too low, the battery symbol " " will flash, and it will be forced to shut down after one minute to protect the battery. Please charge timeously to ensure measurement accuracy.
2. Charging is about 5 hours from to fully charge. Whether the battery is fully charged depends on the charging indicator. The red light means charging, and the green light means it is fully charged.
3. When the battery is fully charged, it can be continuously used for 4 to 8 hours. The screen brightness and different load power consumption are also different; assuming that the 3Ω range is used all the time and the screen brightness is adjusted to the lowest level, the maximum output current is about 8 hours.
4. When the boot screen flashes and the screen goes black, it may be that the battery power is not enough to switch on. Please charge it fully before starting the measurement.
5. The battery life of the new meter can be charged and discharged about 500 times. When the battery is not durable, you can contact Major Tech to replace it. **Do not replace it yourself.**

8.2 Repair, Inspection, and Cleaning

> ⚠ **WARNING:** Please do not modify, disassemble, or repair. Otherwise, it may cause fire, electric shock, or personal injury. If you disassemble or remodel it yourself, you will be deemed to have given up the one-year free warranty service.

8.2.1. Calibration

The calibration cycle varies depending on the customer's usage conditions or environment. It is recommended to determine the calibration cycle according to the customer's use condition or environment and entrust our company to perform calibration on a regular basis.

8.2.2. Cleaning of the Tester

When cleaning the instrument, please use a soft cloth dipped in a small amount of water or neutral detergent, and then wipe it gently. Please gently wipe the display area with a dry soft cloth**. Please do not use** gasoline, alcohol, acetone, ether, methyl ketone, thinner and detergent containing gasoline, it will cause the instrument to be deformed or discolored.

8.2.3. Transport

In order to avoid secondary injury caused by impact during transportation, double packaging must be carried out. We do not guarantee the damage caused by transportation. When returning for repair, please write down the fault content and the return address, contact person, telephone and other necessary information on paper with the instrument and send it back to us.

8.3 Common problems

Question	Answer
Why is the time of the meter inaccurate?	The internal clock system is powered by the battery of the meter, not a button battery. Therefore, the clock system needs to be fully charged to work normally. If it is not used for a long time, it should be charged once every 3 months.
Why does it keep displaying "-----" during measurement?	Please check whether the test lead is well connected, and whether the interface is fully plugged in. Generally, "-----" will be displayed when the loop is not connected.
What does it mean to show OL?	The measurement is out of range
What capacity (Ah) battery internal resistance and voltage can be measured?	This meter uses AC signals for measurement, and DC current does not flow into the meter. Therefore, there is no restriction on the capacity (Ah) of the battery under test.

9. SPECIFICATIONS

9.1. Range and Accuracy

9.1.1. Accuracy Conditions

Accuracy guarantee conditions	**Accuracy guarantee period:** 1 year. **Accuracy guarantee period after calibration:** 1 year. **Accuracy guaranteed temperature and humidity range:** 23°C ± 5°C, below 80%RH. **Warm-up time:** not required
Temperature Characteristics	Add test accuracy *0.1/°C within the operating temperature range (except 18°C ~ 28°C)
Excitation Signal Accuracy	**Measuring current accuracy:** ±25% **Normal mode:** 1000Hz ± 5Hz **Avoid noise frequency mode:** 920Hz~1080Hz. (Using multi-stage noise reduction technology to effectively filter out noise interference of different frequencies or near the same frequency)

9.1.2. Resistance Measurement Accuracy

Range	Maximum Display	Resolution	Test accuracy	Measuring Current
3mΩ	3.100mΩ	1uΩ	±1% fs. ± 20 dgt.	200mA
30mΩ	31.00mΩ	10uΩ	±0.5% fs. ± 15 dgt.	200mA
300mΩ	310.0mΩ	100uΩ		20mA
3Ω	3.100Ω	1mΩ		2mA

9.1.3. DC Voltage Measurement Accuracy

Range	Maximum Display	Resolution	Test accuracy
7V	±7.100V	1mV	±0.2% fs. ±10 dgt
70V	±71.00V	10mV	

9.1.4. Temperature

Range	Maximum Display	Resolution	Test accuracy
-10.0°C~60.0°C	60.0°C	0.1°C	±1.0°C

Note: The above accuracy guarantee is limited to the factory standard test leads. When using non-standard test leads or extension cables, this accuracy table is also applicable after zero adjustment.

9.2. Technical Specifications

Function	Range
Function	Battery internal resistance measurement, battery voltage measurement, temperature measurement
Accuracy guaranteed temperature and humidity	23°C ± 5°C below 75% RH.
Power supply	DC 3.7V lithium battery
Resistance resolution	1uΩ
Voltage resolution	1mV Temperature resolution 0.1°C
Measuring range	**Internal resistance measurement:** 0.000mΩ~3.100Ω (4 range configuration)
	Voltage measurement: 0.000V~±71.00V (2 range configuration)
	Temperature measurement: -10.0°C~60.0°C (Single range configuration)
Maximum input voltage	DC 70V (between + measurement terminal and - measurement terminal), no AC input

9.2. Technical Specifications continued

Function	Range
Measurement method	**Internal resistance measurement:** 1KHz (AC 4-terminal test method, open-circuit terminal voltage 3V max) **Measuring current:** 2.0mA~200mA (different measuring currents in different ranges) **Temperature measurement:** NTC temperature sensor (10KΩ at 26°C) **A/D conversion method:** Successive approximation type **Display update frequency:** 5 times/second
Response time	200ms
Measure time	About 2 seconds
LCD Size	70.1mm x 52.6mm /3.5 inches (320x240 resolution 16-bit true color screen)
Instrument size	190mm x 121mm x 51mm
USB interface	With a USB interface, the stored data can be uploaded to the computer, saved, and printed
Bluetooth connection	Yes
Hold and store function	Manual retention and storage, automatic retention, and storage
Measurement judgment function	Pre-set PASS, WARNING, FAIL judgment thresholds
Battery voltage	The battery level is displayed in 5 bars, reminding to charge timeously when the battery voltage is low
Automatic shut-down	No operation when power on, it will power off automatically after about 15 minutes (can be turned off in the settings)
Power consumption	300mA MIN / 500mA MAX
Weight	80g (with battery)
Working temperature and humidity	-10°C ~ 40°C below 80% RH
Storage temperature and humidity	-20°C ~ 60°C below 70%RH
Insulation resistance	Above 20MΩ (500V between circuit and case)
Withstand voltage	AC 3700V/RMS (between circuit and case)
External magnetic field	<40A/m
External electric field	<1V/m
Suitable for safety regulations	IEC 61010

10. ACCESSORIES

Meter	1 pcs
Test line	1 set
USB	1 pcs
charger	1 pcs
Instructions, warranty	1 set
Instrument box	1 pcs

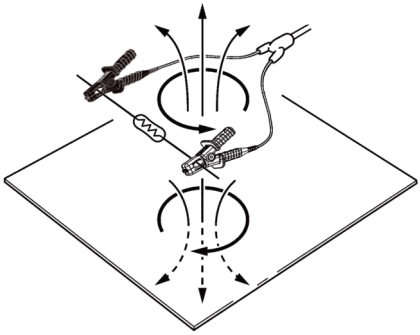
11. APPENDIX

11.1. Appendix 1 Influence of Eddy Current

The AC current generated by this instrument induces eddy currents on nearby metal plates. Affected by this eddy current, an induced voltage will be induced on the test line.

Since the induced voltage and the AC current (reference signal) differ by 180 degrees in phase angle, it cannot be eliminated by synchronous detection, which leads to measurement errors.

The influence of eddy current is a phenomenon unique to resistance meters for AC measurement. In order to avoid this effect, do not place metal plates near the test line (where it splits into two strands), and avoid closing metal plates.



11.2. Appendix 2 Influence of extension cord and induced voltage

The quality and structure of the test leads has a certain impact on the measurement results. If you need to extend the test leads, please use the test leads recommended by Major Tech.

11.3. How to reduce Voltage.

Since this meter uses AC to measure small resistance, it is susceptible to the influence of induced voltage. The induced voltage mentioned here refers to the voltage that the current generated by this instrument affects the signal system through the electromagnetic coupling formed inside the wire. Since the induced voltage and the AC current (reference signal) have a 90-degree phase angle, when the level is small, it can be completely eliminated by the synchronous detection circuit, but when the level is large, it will cause signal distortion and fail to perform correct synchronous detection. The extension of the test lead will increase the induced voltage. Therefore, to reduce the level of the induced voltage, the length of the test leads must be shortened as much as possible. Especially shortening the junction into two parts, the effect is better. Even if a standard test lead is used, in the 3mΩ range, if the wire configuration changes significantly during the zero adjustment and the range, the measured value will be affected by the induced voltage and produce approximately 20dgt. fluctuations.

The content of this user manual cannot be used as a reason for using the product for special purposes.
Major Tech is not responsible for other losses caused by use.
Major Tech reserves the right to modify the contents of the user manual. If there are changes, no further notice will be given.

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