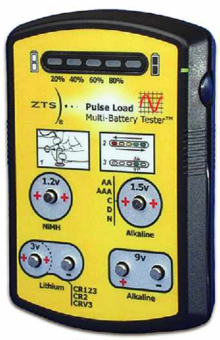
Pulse Load Multi-Battery Testers

Easy to Use • Fully Automatic • High Accuracy

- UPS
- Maintenance
- Institutions
- Safety
- Utilities
- Telecom
- Electronics
- Government
- Security
- Military
- Medical
- Residential
- Emergency Lights
- Scientific
- Industrial



Mini-MBT

MBT-1

MBT-LA

Features & Benefits

- **Fast, easy-to-read test results**
- **Save money - discard only bad batteries**
- **Patented Pulse Load Test**
- **Made in U.S.A.**

Mini Multi-Battery Tester (Mini-MBT)
- Test more than 15 battery types
- Dimensions 4 x 2.5 x 0.75

Multi-Battery Tester (MBT-1)
- Test more than 25 battery types
- Dimensions 7.5 x 4 x 1.5

Lead Acid Multi-Battery Tester (MBT-LA)
- Test 2v, 4v, 6v, 8v, and 12v SLA batteries
- Dimensions 8.75 x 5.5 x 1.75

(all dimensions given in inches)

Product Description

ZTS Multi-Battery Testers provide a comprehensive means of testing the state of charge or state of power for many popular battery types including alkaline, lithium, silver oxide, NiMH and SLA rechargeable. These microprocessor-contolled instruments compute the battery's remaining power capacity using a patented, high accuracy pulse load test.

After a fully automatic test cycle, percentage of remaining battery capacity is indicated on the LED bar display. Battery types are clearly labeled next to appropriate contacts.

Quickly and easily identify weak or failing batteries. Test and replace batteries *before* they let you down.

Please visit our website to see all models.

U.S. Patent 6,823,274.

Advantage of a Pulse Load Test

In today's electronic devices, battery performance is very important. ZTS Multi-Battery Testers compute the battery's actual remaining power capacity using a true pulse load test. This pulse load simulates the real power demand that batteries experience during normal operation. So battery *performance* is measured, not just voltage or internal resistance.

The load is disconnected automatically, so testing will not harm or drain the battery.

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Subject: External SOC testing of LiMnO2 batteries using Pulse Load technology.

Company background: ZTS was established in 1976, we started out making camera test equipment for measuring shutter speed, exposure, and focus. These camera testers were used mainly by camera manufacturers and service facilities. Our first battery tester was developed specifically to determine the remaining power capacity of LiMnO2 photo batteries (such as the 3-volt CR123 and 6-volt 2CR5) . In the photo industry, the need for this new testing technology came about when camera manufacturers began designing cameras that were powered by lithium batteries. And, as the use of these new cameras grew in the marketplace, the manufacturers noticed that an usually high percentage of them being returned as defective. What was happening was that when a consumer's camera would stop working, often times they would return to the store where they purchased it, and one of the first things the retailer would do was check the battery. What the retailer was unaware of at the time was that these lithium batteries would always check good on their conventional battery tester, even if the battery was nearly depleted. At the same time, because lithium batteries are expensive, retailers were reluctant to open up a new battery without knowing for sure that the other was bad. The upshot was that the camera was returned to the manufacturer as defective, when in fact the only problem was a spent battery. Today, we have a U.S. patent on our pulse load technology and we make several different models for various applications and market segments. End users include battery manufacturers, power utilities, medical industry, the U.S. military and others. We manufacture all of our testers in the U.S.A (Cincinnati, OH).

Need: Two primary reasons for testing batteries are reliability and cost reduction. Since you can't ask a battery whether it's good or bad, and since a good battery looks the same as a bad one, it's necessary to use a testing device to make the determination.

1) Reducing costs is straight-forward enough, save money by only discarding bad batteries. There is no need to discard a mission-critical battery after only a single use. Testing allows for effective battery management according to state of charge, and enables you to make the correlation between run time and remaining power capacity. Batteries that are not suitable for a mission could be used in practice or other application.

2) Reliability is one of the most important aspects of any battery. Will the battery be able to deliver power when needed? Today, most battery operated electronic devices are microprocessor based, and therefore have a programmed cutoff voltage at which they will cease to operate. When the battery voltage falls to this level under operating load, the unit will shut down. That's why it's good to know, starting out, that a battery is able to delivery steady current and maintain its voltage under load, in other words, deliver power. It's not good policy to assume that because a battery is new out-of-the-package that it is always a good battery. As you know, batteries are mass produced, and even with a high level of quality assurance, occasional manufacturing defects are a reality. We've seen this problem on a regular basis on medical device manufacturing lines where our testers are

used to check new batteries prior to installation into the device. It's a fact that a certain percentage of new batteries test as low as 60% remaining power capacity due to a manufacturing defect in the battery. In some cases the battery's chemistry may be out of spec., in others it may be a mechanical connection within the battery that causes reduced performance. This is true whether the battery is a single cell, or several cells within a battery, such as the BA-5390. In the case of the BA-5390, where there are 10 separate cells within the same battery, all wired together, along with some other electronics components, it's logical that because of the complexity there is more opportunity for a problem. If any one of the 10 cells is weak, or if there is a bad connection between the cells, or a marginal component, the battery's power output is going to suffer. So, for reliability purposes, it's important to be able to make a fast, accurate test of remaining battery capacity.

Idea/Approach: One of the characteristics of $LiMnO_2$ batteries is that they have a relatively flat discharge curve. This means that the battery's voltage is nearly the same at 90% capacity or 40% capacity, compared to other chemistries such as alkaline or lead-acid whose voltage decreases steadily with discharge. So, simply measuring the battery's voltage or even voltage under a small load, like a conventional battery tester does, is not a reliable method to test this type of battery. On the other hand, measuring and recording the amount of current that is discharged from the battery, or coulomb counting, has its drawbacks because it assumes that the battery begins with full capacity, which is not always the case because a battery's initial capacity is affected by age and other factors. It also assumes that the battery will be able to actually *deliver* its capacity at the necessary rate. I remember one example, when a battery manufacturer that we make testers for was concerned that occasionally some of their batteries were not testing 100% capacity new out-of-the-pack. So, what the battery company did was carefully discharge these batteries and they found that the batteries did have nearly all of their rated current capacity. Next, to rule out a mechanical defect, they decided to examine the batteries by x-ray, and it turns out that each of the cells that tested low had a small crack in the cathode inside the battery. The cracked cathode was causing the battery's voltage to fall lower than normal under pulse load - which means reduced run time when used in a high drain electronic device because it will reach the cutoff voltage sooner. The bottom line is that you can't know for sure that a battery will be able to deliver power until you make it deliver power.

Our approach was to design a method to accurately determine remaining battery capacity, or State of Charge, and at the same time measure the battery's ability to deliver power. To do this, the battery is placed under a relatively large load for a specific period of time, usually ranging from 2 to 15 seconds, and its voltage levels are precisely measured while under load. We call this a pulse load test, and this pulse load simulates the real power demand that a battery experiences in the field – under normal operating conditions. In the case of the $LiMnO_2$ chemistry, we found that using a relatively large test load actually increases the slope of the discharge curve. More slope means there is a greater voltage difference between levels of discharge. This enhances the ability to make an accurate measurement of the voltage changes throughout the battery's discharge curve.

So, during the pulse load test, we are able to evaluate two important parameters about the battery, which are:

1) Its ability to deliver the necessary current

2) Its ability to maintain a certain voltage level under load

In other words, it's a measure of battery performance, not just voltage or internal resistance. The load is automatically disconnected so testing will not harm or drain the battery. For example, a typical pulse load test consumes less than 3/100 of 1 percent (0.03%) of the battery's total capacity.

The factors that influence the size and duration of the pulse load are battery design, that is, high-rate or low-rate, and the battery's typical application. This ensures that the power demand on the battery during the pulse load test will be comparable to what the battery experiences under normal operation conditions.

How the technology/process works: So how does the technology work, how do we make the correlation between voltage under pulse load and remaining power capacity? Well, for any given battery that we plan to test, the first step in programming the tester is to acquire battery discharge data. To do this, we begin with a representative set of the identical of batteries - from different manufacturers when available. Then we incrementally discharge them, and at certain levels of discharge, we measure and record the battery's voltage under pulse load. For example, we start with a 100% capacity battery and measure and record its voltage under pulse load, then we carefully remove 5% of the battery's capacity and measure and record the its under pulse load, and then we remove an additional 5% of the battery's capacity and measure and record its voltage under pulse load, and we repeat this process until the battery is discharged to its specified EDV (End-Of-Discharge Voltage). This EDV is usually specified by the battery manufacturer as an end-of-life point for that particular battery. Each time we measure and record the battery's voltage under pulse load, it provides a data point on the battery's discharge curve – for that particular load. What we normally find during this discharge process is that there are measurable differences from one battery to the next and from brand to brand. For example, certain batteries have more capacity than others, or some batteries discharge at a higher average voltage. Therefore, it's necessary to repeat this process on an entire representative set of batteries so that an average discharge curve under pulse load can be established. The resulting data points form a discharge curve which shows the direct relationship between remaining battery capacity, or state of charge, and voltage under pulse load. This discharge curve data is then programmed into the tester's operating software, so that when a battery is tested, the tester measures the battery's voltage under load, and then compares that voltage to the discharge data and is able to accurately determine remaining battery capacity.

A typical pulse load test cycle is comprised of the following sequence of events:

1) The tester detects and initiates a pulse load test when a battery is placed in contact with a test terminal.

2) The tester measures and records the battery's voltage level under pulse load, then automatically disconnects the load.

3) The recorded battery voltage under load is then compared to the discharge curve data that is programmed into the tester′s memory, and the test result is indicated on the LED display as percentage of remaining battery capacity (10 - 100%). So, a test result of 60% for example, means that there is 60% remaining power capacity in the battery.

SIDE NOTE It′s worth mentioning that in order to measure voltage, any microprocessor-based device must use an analog-to-digital converter, or A/D. The A/D′s sole purpose is to convert analog signals such as voltage to a binary equivalent which can be recognized by the microprocessor. In order to make the conversion, the A/D must have a reference point upon which to base its measurements. This is analogous to measuring height based on the rungs of a ladder. For example, the height measurement depends on whether the base is the reference point, or say, the second rung. In most cases, this reference voltage is the A/D′s supply voltage. So changes in the A/D′s supply voltage can cause erroneous voltage measurements. To eliminate this possibility, we process the measured battery voltage under load with a patented scaling algorithm that compensates for any change in the A/D′s reference voltage. Which means that when the A/D converts a given voltage measurement, the binary result will be the same regardless of the reference or supply voltage.

Note: Pulse load technology provides an accurate method for determining remaining battery capacity for many battery chemistries, but not all.

Advantage & Benefits: There are several benefits to this technology.

1) It′s fast and accurate – within seconds you have a test result. It′s also easy to use and the test results are easy to understand. It doesn′t take any special training to understand 80% capacity, 60% capacity and so on.

2) It provides a true load test for the battery. A pulse load actually makes the battery perform, so it verifies the battery′s ability to deliver the power. The test is accurate whether the battery is brand new or has been in storage for 5 years.

3) The tester can be configured or programmed for different battery voltages and chemistries, depending on the end user. Each test terminal can be programmed separately, so a single tester can be used to test several different batteries. There′s no need to have a different tester for each battery type.

4) Upgradeable. As battery technology changes or improves, the tester′s software can be upgraded accordingly.

5) It′s proven technology in the field. There are tens of thousands of testers in the field using this technology for the last 10 years.

Conclusion: To summarize, we talked about the two primary reasons for testing batteries, those are reliability and cost reduction.

Reliability is fundamental because it's necessary to know in advance that a mission-critical battery is going to be able to provide the power required for the job. Remember, that just because a battery is new or unused, doesn't guarantee that it always has full capacity and can deliver power.

Cost savings can be significant. Batteries are widely used, and more and more devices are power by batteries each day. Prematurely discarding batteries simply because of not knowing their remaining capacity is expensive and not good policy.

There are a number of battery testing concepts, of which Pulse Load testing is one. The advantage to this type of tester is that it measures battery *performance*, is easy to use, and is flexible – can be programmed for different battery types.

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