



# OPERATION AND SETUP MANUAL

## MODEL 1653



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FOR TECHNICAL ASSISTANCE  
☎ **PHONE: 1 (800) 421-1921**

1653 Manual Rev 1.0 - 040106

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## **Introduction**

This description applies to Series 1653 Surge Testers designed to test the dielectric strength of separators in storage battery cells. These units will give a good resolution of defective separators without false rejects due to moisture in damp process plates.

Output voltage is adjustable to 3000 volts peak and is indicated on a digital peak reading voltmeter. This output voltage is not of a sinusoidal waveform. Series 1653 equipment produces high voltage, high-current pulses of very short time duration. These pulses repeat at the rate of 60 pulses per second on a 60 Hz power source or 50 pulses per second on a 50 Hz power source. Duration of each pulse is approximately 10 microseconds. Though the instantaneous energy in each pulse is high, the short duration of the pulses results in a low average energy level. Therefore, the high voltage stress required to obtain a good test is produced without the problem of providing a high-powered tester and the problem of producing excessive heat within the test object.

The digital quality metering circuit provided essentially monitors the loading of the tester by the work piece cell, which is being tested. This meter indicates quality in arbitrary units, on a scale of 0 to ? 1000. It reads downscale (increasingly larger negative number) with increasing current through the work piece.

A dual range front panel sensitivity switch allows the testing of battery cells with minimum impedance of 250 ohms or 100 ohms. When properly calibrated, the associated circuitry allows switching between impedance ranges without re-balancing.

The Model 1653 Battery Element Tester (BET) is equipped with a filtered Modular Line Cord Assembly and isolation transformer that allows the tester to be configured to operated on a nominal 130 volt input or a nominal 230 volt input at 50 or 60 Hz. The Model 1653 is set for 230 volt input at the factory. Refer to Controls and Indicators section.

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## **Specifications**

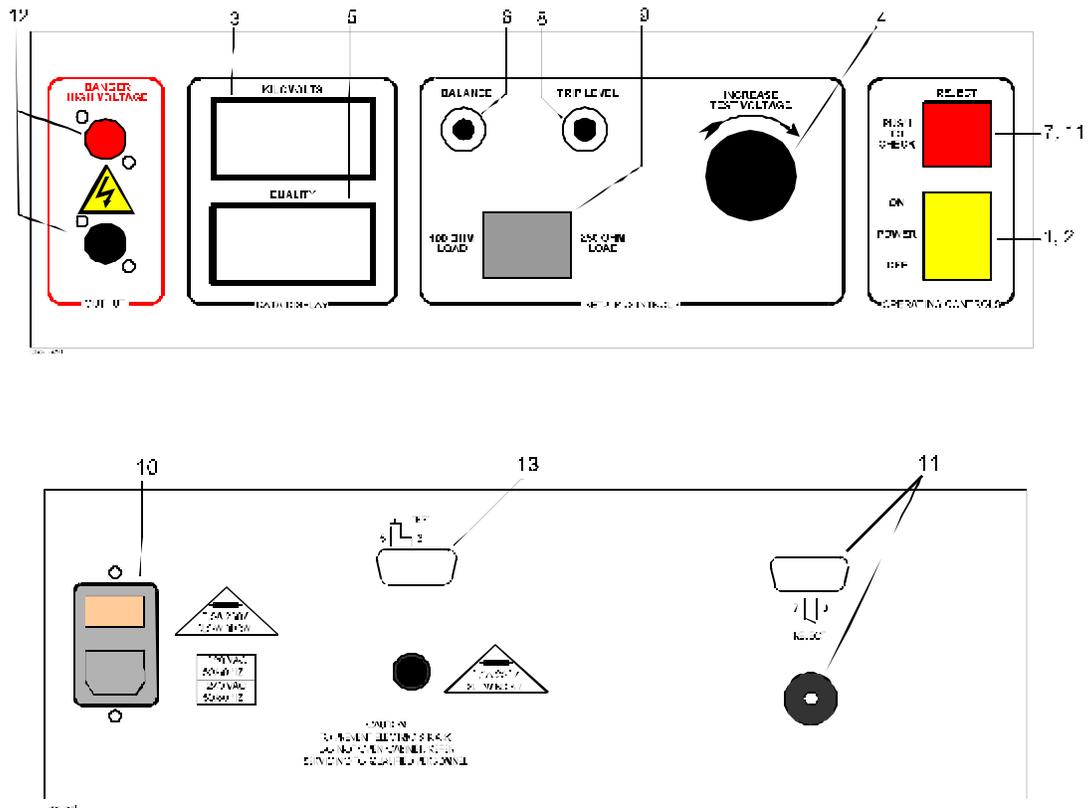
<b>Input Requirements</b>	<b>110 Volts +/- 15%, 50/60 Hz, .6 / .5 A 220 Volts +/- 15%, 50/60 Hz, .4 / .3 A</b>
<b>Output Voltage</b>	<b>400 – 3000 Volts Peak</b>
<b>Minimum Acceptable Cell Resistance Range</b>	<b>100 or 250 Ohms</b>
<b>Maximum Operating Range</b>	<b>Temperature: 0 – 40 deg. C Relative Humidity: 5 – 85 % Non-Condensing Altitude: 0 – 3000 m Vibration: 0 – 2 g</b>
<b>Dimensions (WxHxD)</b>	<b>40.64 cm x 12.7 cm x 34.29 cm</b>
<b>Weight</b>	<b>10.5 kg</b>

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## ***Controls and Indicators***

Functions of the various Controls and Indicators are shown in fig. 1 on the next page and described as follows:

1. **Power Switch** – The rocker power switch is used to turn the unit On and Off.
2. **Pilot Light** – Contained within the Power switch is a Pilot Lamp, which lights when the unit is turned On.
3. **Voltmeter** – The digital Voltmeter provided on this unit monitors the actual test voltage at the output terminals of the unit when the test probe is activated. This is a true peak reading meter. Note that when a load is placed on the output terminals, the voltmeter indication may change, depending on the type of load involved. In the case of a short circuit, this voltage may fall practically to zero. However, the tester will still be On, producing test voltage, which is absorbed within the unit.
4. **Voltage control** – Voltage control provided on this unit is used to adjust the actual test voltage. Clockwise rotation increases test voltage.
5. **Quality Meter** – The digital Quality Meter monitors loading produced by the workpiece. It is calibrated in arbitrary units on a scale of 0 to ? 1000. As loading increases, due to defects or moisture, the indication on this meter will read down-scale as an increasingly larger negative number.
6. **Balance Control** – This control is used to balance quality meter circuitry to correspond to the actual operating conditions. Normally, it is adjusted under no-load conditions to provide a 000 reading on the leakage meter.
7. **Check Button** – The Check Button is used to verify that the leakage meter circuitry is operating normally. After the voltmeter has been properly balanced at 2.00KV, operation of the check button under no-load conditions should produce a leakage meter reading of approximately –600. When the button is released, the leakage meter reading should return to the 000 balance condition.
8. **Trip Level** – This control is used to set the desired reject level.
9. **Sensitivity Select Switch** – This rocker switch allows the selection of two levels of sensitivity to match the minimum impedance characteristics of different battery element testing requirements.
10. **Modular Line Cord Assembly** – The Modular Line Cord Assembly is located on the rear of the tester. It consists of the Socket/Filter section, which is black and permanently mounted to the tester, the removable Line Cord, and the removable Fuse Drawer, which is tan.
11. **Reject Indicator(s)** – The Model 1653 has three (3) Reject Indicators; on the front panel, a Red illuminated button, on the rear panel, an Audible Tone and a 9-pin D-sub connector provides a Dry Contact Closure when a reject occurs.
12. **High Voltage Connectors** – Two (2) High Voltage connectors are provided on the front panel. Polarity should be observed when connecting the leads. The black socket is referenced to ground.
13. **Test Probe Connector** – The Test Probe Connector is a D-Sub 9-Pin socket connector located on the rear of the tester. The Push-to-Test probe must be plugged in this connector for proper operation.



## **Input Power Adjustment**

The input power setting is visible in a small window in the fuse drawer.

To change the input voltage setting, proceed as outlined below.

1. Switch tester off and unplug the line cord from the utility mains and remove it from the socket-filter.
2. Remove the fuse drawer.
3. One half of the fuse drawer contains a voltage selector insert with 110 and 220 written on the bottom. Remove, rotate and re-install the voltage selector insert so that the desired input voltage is visible in the window of the fuse drawer.
4. Re-install the fuse drawer.
5. Re-install the line cord with the appropriate plug properly installed.

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## **Theory of Operation**

Pulses produced at the output terminals of the unit result from the discharge of capacitors that have been charged to a high voltage. Discharge capacitors are charged by means of a half-wave rectifier power supply operating from a high voltage transformer that is controlled on the primary side by means of the front panel voltage control.

The discharge capacitors are charged on the negative half cycles of the 60-cycle input. On the alternate half cycles, the SCR is triggered so that the capacitor is discharged into the load while the main charging circuit is in a non-conducting condition. The voltmeter is a peak reading type connected across the output terminals of the unit.

A bleed load-switching coil is connected across the output terminals of the unit to produce a fixed load condition if the unit is operated with no load connected.

Under normal conditions, discharge of the capacitors into the bleed load creates a strong magnetic field in the core of the bleed load. When the forward pulse dies off, this magnetic field collapses producing a back EMF which is applied to the quality meter circuits where it is compared with a reference voltage which is proportional to the original forward pulse. By means of the balance control, conditions are established, so a 000 reading appears on the quality meter when the probe is activated under normal operating conditions.

Any external load, such as a work piece under test, is effectively in shunt with the bleed load and therefore, will reduce the back EMF signal, resulting in a down-scale reading on the quality meter. The amount of the down-scale reading will, of course, depend on the amount of reduction existing.



**Caution: To allow for sufficient voltage levels to be available for tests, a certain amount of over-voltage is to be expected during idle conditions (no load). The test probe activation switch prevents this voltage from being applied until a test is performed. It is important not to attempt to defeat this feature so that voltage is present during idle conditions for extended periods of time such as breaks, lunch hour, or etc. The high over-voltage levels may damage the switching coil or the SCR.**

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## **Installation and Safety**



### **CAUTION!**

- ? **This unit is equipped with a three-prong grounding type line plug. It is essential that it be utilized only with a mating three-terminal receptacle, properly grounded in accordance with electrical codes.**
- ? **This unit is designed for indoor use.**

When first received, unpack the equipment carefully and inspect for any hidden damage. If damage is evident, keep the carton and file a claim with the carrier.

Packed with all Slaughter equipment is a certificate of conformance, operator's manual, test leads and any required interface connectors.

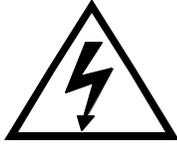
To check the unit quickly, set the trip level knob to 10.0, the balance control at 5.0, the voltage control to full counter clockwise, connect the D-sub connector from the test probe to the TEST connector on the back panel, and plug the unit into the appropriate single phase voltage source. Turn unit ON and with the test probe button activated, slowly rotate the voltage control clockwise. A reading should appear on the digital voltmeter, which will increase, as voltage control is turned further clockwise. Continue to rotate voltage control until voltage is approximately 1.00KV.

Depending on the setting of the balance control, a reading may appear on the Quality meter, and this reading may be positive or negative. Rotate balance control, as necessary, to obtain a 000 reading on the Quality meter.

Increase voltage control setting to obtain a 2.00KV-voltmeter reading. When necessary re-adjust balance control to obtain a reading of 000 on the Quality meter. Operate the check button. The Quality meter indication should be approximately -600. Release the button. The Quality meter reading should return to 000.

Repeat the above, and while holding the Check Button In, adjust the trip level until the tester registers a rejection. this will be an intermittent type signal and will automatically clear when the check button is released.

Again, rotate voltage control full CCW. Wait until the voltmeter returns to zero. Then, insert test leads into Output connectors.



**WARNING: (RISK OF ELECTIC SHOCK)**

**With the test leads connected, voltage is present at the test probes whenever the probe button is depressed.**

After connecting test leads, return voltage control to a voltmeter indication of approximately 1.00KV. With unit operating at this voltage, short circuit test leads. A rejection should be indicated.

If the unit does not operate, contact the factory for instructions.

Insure the unit is operated within the following environmental specifications:

Temperature:	0 – 40 Degrees C.
Relative Humidity:	0 – 85%, Non-condensing
Vibration:	2 g. maximum
Ventilation:	No special requirements

Of prime consideration and importance in the layout and installation of a test station is to insure the safety both of the operator and any visitors or casual bystanders, invited or otherwise. As a general rule it is suggested that each test area be in a location with minimum distractions.

One of the more important ways to promote safety is through operator training. Benefits of training are twofold. First, thorough training promotes safety, which may significantly reduce injuries on the job. Second, it ensures adequate testing of the product which helps increase product reliability. Both of these can have a positive impact on profits.

An additional consideration in any test station is operator comfort. This is affected by the operator's position, which includes the chair, table, test equipment, the object under test and the test procedure itself. The chair and work bench or table should be nonconductive and the table as large as possible to allow sufficient room for the test equipment and the object under test. Studies should be made of the test requirements and work habits and steps taken to ensure that any unusual or unnatural motion is not required and to eliminate any repetitive motions that may produce injuries such as carpal tunnel syndrome.

After the equipment has been installed, a careful study should be made of the test station to determine what, if any, safeguards are needed. It is suggested that any electrical test station involving voltages in excess of 42.4 volts peak (approximately 30 volts RMS) should be equipped with safeguards. These should operate both for the protection of the operating

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personnel and for the protection of casual bystanders. At the minimum, safeguards should prevent the operating personnel or casual bystanders from coming into contact with the test circuit. In the event electrical interlocks of any sort are required, either to insure that guards are in place, or to insure that the operator's hands are in a safe location, we will be happy to provide suggestions and schematics for safety interlocking our test equipment.

The test procedure should be well thought out to ensure that it adequately tests the product to the desired criteria but that the procedure does not require the operator to perform tasks that are unsafe. The product should never be touched during a test.

Good safety practice dictates labeling of hazards properly. Since high voltage testing can be hazardous, the work station should be labeled. Naturally, the location of the label should be carefully selected so that it can be placed in a location that will do the most good.

In some cases, this may be on the test instrument itself, and in others, it may be in a location directly in front of the operator, somewhat removed from the instrument.

A final word about high voltage testers. Generally, commercial high voltage test equipment is not in itself hazardous. The hazards come about when the equipment is improperly used. These testers, when used properly and in a safe manner, can be a check on the quality and reliability of your product. If used incorrectly and without proper consideration for safety, they represent a hazard for both operating personnel and casual bystanders. We strongly recommend proper training for all personnel involved in testing.

#### Technical Notes

1. This unit is solid state High-Voltage Pulse type leakage and breakdown Tester with digital meters. Essentially, it subjects the battery elements to a high peak voltage that appears between all plates and across all separators.
2. If everything is normal – if there are no defects in the separators, no runs, trees, et cetera, the battery element will withstand the test voltage, and the instrument will register a “normal” quality meter reading.
3. This normal quality meter reading is due to the electrostatic capacity between the plates, and should not vary except in relation to the moisture content of the separators.
4. If separators are defective, or if for any reason opposite polarity spacing within the battery element are abnormally close, the high voltage applied will jump this gap, and a rejection will be indicated.
5. The user best establishes exact test voltage for any particular battery element. It is suggested that a representative group be checked at successively higher voltages until the voltage that will reject good assemblies is established. The voltage should then be “backed off” 200 to 500 volts for routine testing of high quality assemblies, and somewhat more for lower grade elements.

When a capacitive load (the battery) is coupled to an inductor (internal load of the

- tester) the voltage developed across the inductor and the capacitor will be higher at resonance. The outgoing voltage pulse of the battery tester is composed of an extremely wide range of frequencies so resonance can occur. The battery's capacitance will determine the resonance frequency for a particular battery line. The difference in firing characteristics of the Thyatron tube and the SCR produce different output wave shapes that affect the frequency of the output and consequently resonance.
6. The most difficult defects to detect are pinholes and splits or tears in separators. With present day separators a voltage in the 2000 to 2500 volt range may be required. If some defects are acceptable, the test voltage can be dropped as low as 1500, and practically all defects except pinholes, hairline splits, and tears will be detected. Holes in the insulation are normally detected by arcing. The suggested procedure is to use sufficient voltage to initiate an arc if the insulation has a hole or is missing. The insulation will prevent arcing. If there is a hole or the insulation is missing, the tester will arc across and find the fault (no insulation).
  7. These units have dual sensitivity ranges and may be operated with the limits set to accept external loads having effective impedance in excess of 250 ohms or in excess of 100 ohms. With the 250 ohm sensitivity selected, these units are normally operated with the limit set to accept external loads having an effective resistance in excess of 260 ohms. If the effective resistance of the load is less than 240 ohms, the work piece will be rejected. Effective resistances between 240 and 280 ohms are marginal and may or may not be rejected. Switching to the 100 ohm sensitivity setting, the work piece will be rejected if the effective resistance is less than 90 ohms. Effective resistances between 90 and 110 ohms are marginal and may or may not be rejected.
  8. Battery elements are sometimes tested in a "formed" (the paste in the lattice is conductive) or an "un-formed" (the paste in the lattice is non-conductive) condition. If the battery element is un-formed when the test is performed, faults are much harder to detect because a fault must be located in an area between the conductive lead lattices of the positive and negative plates. If the fault is located in a non-conductive area, an arc will generally not occur and the fault will be un-detected.
  9. The tester does not determine that an element is reversed in a cell. The tester sees only the potential between the positive and the negative plate.
  10. We have constructed a STANDARD BATTERY. This is a .002 microfarad capacitor in parallel with two ½ inch steel balls separated by gap of .013 inch. This 'standard' can be constructed by anyone and allows a repeatable comparison of testers.

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## **Setup and Operation**

Setup adjustments should be made with no load connected to the test prods. Proceed as follows:

1. Turn the unit ON.
2. Activate the test probe and adjust voltage to desired Peak Kilovolts reading. One (1.00) kilovolt = 1000 volts.
3. Adjust Balance to make quality meter read 000. Set the trip level to 10.0.
4. Battery impedance is complex in nature and composed mainly of Capacitive leakage with Resistive and Inductive leakage. Because the open circuit reading on the Quality Meter is 'balanced' to '0' against an internal load that is primarily Inductive and Resistive, we do not assign a scalar value to the Quality meter reading. It is used to indicate a change from this balance condition and to allow you to determine your product's relative impedance.

To determine your product's relative impedance:

Adjust the test voltage to the desired level.

Adjust the Balance to make the Quality Meter read 000.

Adjust the Trip level to 10.0.

Test 10 to 12 known good batteries.

Note the Quality Meter reading of each.

For example:

You test 10 known good batteries and record readings of -650, -595, -680, -675, -701, -620, -665, -625, -688, and -617. Since your 'largest' reading is -701, you would set your Trip Level limit larger than -701 to say -725. Actual settings can be as "tight" as you like but, you should allow for normal product variation and the effect of humidity on the moisture content of the plates. If you perform your setup under low humidity conditions you would expect the readings to do down-scale (larger negative number) during high humidity conditions.

5. Set the Trip level as required. This is determined by your product's relative impedance as outlined above.
6. Apply the test probes to battery to be tested and activate probe test switch. The reject visual and audible signals operate if quality meter reaches the trip level setting. The reject signals cancel automatically when the probe test switch is released.
7. Even on good parts, a slight spark will be noticed when the tester probe is touched to the part under test with the probe test switch activated. This is normal, since a charging current flows as a result of the inherent capacity of the part under test.

8. When replacing the Model A648/018 (018) tube type battery element tester with a Model 1653 solid state tester, it is usually necessary to increase the test voltage by 100 to 200 volts depending upon cell capacitance. This apparent difference in test voltage is caused by the different trigger characteristics of the thyatron tube and SCR and the solid state metering circuit.

We determined that the wave shape of the 018 contained a previously unnoticed very sharp leading spike on the output wave. Due to the spike's extremely high frequency, it does not register on the analog metering circuit of the 018. Its resonance only occurs After the battery (capacitance) is connected. Depending upon the capacitance of the battery, this spike may grow from an initial 50 volts to more than 500 volts above the metered voltage level. It is this spike that detects most separator holes found by the 018.

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## **Maintenance**



**WARNING: (RISK OF ELECTRIC SHOCK)  
DO NOT REMOVE COVER. NO USER SERVICEABLE PARTS  
INSIDE, PLEASE REFER SERVICIING TO QUALIFIED  
SERVICE PERSONNEL.**

Routine maintenance should include the following:

### **1. Function Check**

At least once per shift verify calibration by the methods described in the “Installation and Safety” on page 7.

### **2. Safety Inspection**

- A. **Daily** – Check test leads for damage. Retracting probes should be inspected for contamination or burning inside barrel. Leads should be inspected for cracks or deterioration. Front panel receptacle should be inspected for excessive wear, cracks or loose components.
- B. **Monthly** – Check line cord on tester for damage, deterioration and ground lead integrity. Check line receptacle for ground integrity.

### **3. Annual Service**

All testers should be returned to the factory at least once per year for calibration and certification.

Individual fuses are used to protect the different sections of the equipment. Failure of any of the fuses is evidence either of fuse aging, abnormal line surges, or trouble in the unit.

Two fuses, one in high voltage circuitry and the other to protect the entire unit protect this unit. The high voltage fuse and the main fuse are on the rear panel. If any fuse blows, replace with one of the same type and rating. If the replacement holds, the original failure is probably due to aging or line surges. If the replacement immediately blows, something is wrong and repairs are indicated. Under no circumstances should oversize fuses be used in this equipment.

Replacement test probe assemblies can be obtained by ordering the following:

<b>102-078-912</b>	Red Test Probe Assembly
<b>102-050-915</b>	Black Test Probe Assembly

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## **Repairs**



**WARNING: Field repairs, other than routine replacement test probe assemblies and fuses are not recommended due to the risk of high voltage shock. It is recommended that defective equipment be returned to the factory for repair.**

Complete calibration and repair services are offered at our Ardmore, Oklahoma manufacturing facility. Calibrations are to original factory specifications and are traceable to National Standards. A certificate of conformance accompanies each repaired tester.

A Return Authorization (RA) number must be obtained from Slaughter Test Systems before returning any instrument for repair. Please contact Slaughter at 1-800-421-1921, 580-223-4773 or Email us at [info@slauthertest.com](mailto:info@slauthertest.com) for assistance and instructions. Transportation costs (including insurance) for the return of the instrument to Slaughter must be prepaid by the customer.

Tester sent for repair should be shipped prepaid and insured to:

Slaughter Test Systems  
Attn: Repair Dept.  
801 Hailey Street  
Ardmore, OK 73401 USA

Inside the container with the tester, put the name and telephone number of someone to contact if the Service Department has any questions regarding the repair and someone to advise of billing. Please indicate your 'ship to' address – no PO boxes, please.

Subject to weight restrictions, testers are normally returned to the customer via UPS ground with the actual shipping charges prepaid and added to the invoice. Premium shipping and alternate carriers can be provided upon customer request. Freight charges will vary according to the method/carrier specified.

Factory service is based upon an hourly rate with a one hour minimum charge per tester. Parts needed to bring the tester back to factory specifications are extra.

Altered testers cannot be certified. All non-Slaughter parts will be removed and the customer charged to bring the tester back to original factory specifications before calibration will be attempted.

Non-warranty repairs carry a limited warranty of 90 days on services and replacement parts only. Defects in our repair work or any parts replaced will be corrected at no charge if the defect occurs within 90 days from shipment from our factory.

If difficulty arises during the 90-day period that is due to a secondary defect, which could not normally be detected during the original service procedure, it will be repaired and a charge made only for parts used.

## **1 YEAR LIMITED WARRANTY POLICY**

All products are covered by our standard limited warranty: Your new instrument is warranted to be free from defects in workmanship and material for a period of (1) year from date of shipment and we will repair or replace any such product we find to be so defective upon its prepaid return to us. This warranty is void if the product has been tampered with, or subjected to gross misuse, and is exclusive of all others, expressed or implied. In case products of other manufacturers are specified as a part of the above quotation, the warranty of that manufacturer will apply to such items, and our responsibility is limited to assisting the customer in filing warranty claims with the manufacturer responsible. In the event that the prepaid return of a system to our Ardmore, Oklahoma plant is impractical and the customer desires on-site warranty, we expect payment for the actual incurred travel and out-of-factory expense of our factory representative.

Please contact Slaughter Test Systems at 1-800-421-1921, (580) 223-4773 or Email us at [info@slaughtertest.com](mailto:info@slaughtertest.com) for assistance and instructions. The customer must prepay transportation costs for the return of instrument for warranty service. The return method will be at the discretion of Slaughter Test Systems.

Except as provided herein, Slaughter Test Systems makes no warranties to the purchaser of this instrument and all other warranties, expressed or implied (including, without limitation, merchantability or fitness for a particular purpose) are hereby excluded, disclaimed and waived.

Any non-authorized modifications, tampering or physical damage will void your warranty. Elimination of any connections in the earth grounding system or bypassing any safety systems will void this warranty. This warranty does not cover batteries or accessories not of Slaughter Test Systems manufacture. Parts used must be parts that are recommended by Slaughter Test Systems as an acceptable specified part. Use of non-authorized parts in the repair of this instrument will void the warranty.

Slaughter Test Systems, certifies that this instrument was calibrated using standards that are traceable to the National Institute of Standards and Technology (NIST). Most safety compliance agencies such as UL recommend that your instrument be calibrated on a twelve-month cycle.

## DECLARATION OF CONFORMITY

**Manufacturers Name:**

Slaughter Test Systems

**Manufacturers Address:**

801 Hailey Street  
Ardmore, Oklahoma 73401  
USA

**Declares that the product:**

Battery Element Tester

**Model Name:**

Model 1653

Conforms to the directives and standards identified in this declaration

**EU Directives:****89/336/EEC**

Electromagnetic Compatibility Directive, amended by 93/68/EEC

**73/23/EEC**

Low Voltage Directive

**Standards:**

- EMC:** EN 61000-4-2: 1995 “Electromagnetic Discharge immunity test”  
EN 61000-4-3: 1998 “Radiated, radio frequency, electromagnetic field immunity test”  
EN 61000-4-4: 1995 “Electrical Fast Transient/burst immunity test”  
EN 61000-4-5: 1995 “Surge immunity test:  
EN 61000-4-6: 1996 (Incorporating Amendment No. 1) “Immunity to Conducted disturbances, inducted by radio-frequency fields”  
EN 61000-4-11: 1994 “Voltage dips, short interruptions and voltage variations immunity test”  
EN 61326 (CISPR 16: 1993 “Specification for radio disturbance and immunity measuring apparatus and methods”)

- Safety:** EN 61010-1: 2001 “Safety requirements for electrical equipment for measurement, control, and laboratory use”

The technical documentation required to demonstrate that the product meets the requirements of the directives listed in this declaration is available for inspection by the relevant enforcement authorities.

**CE mark first applied:**

2004

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