

ELECTROSTATIC FIELDMETER

Model 222



Operating Manual

5/09



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1.0 GENERAL

Many applications require the measurement of the electrostatic charge or voltage on surfaces that are either stationary or in motion. The Model 222 is a unique, precision electrostatic fieldmeter that measures the magnitude and polarity of the electrostatic fields produced by charged material and objects. It incorporates a built-in precision voltage source for charge/discharge testing and for calibration of test set-ups to compensate for field distortion, thus providing far more accurate measurements. The accuracy and versatility of the Model 222 makes it a valuable electrostatic measuring and monitoring tool in laboratory, industrial and manufacturing environments.

2.0 DESCRIPTION

The Model 222 Electrostatic Fieldmeter is a precision instrument that operates from either two 9 Volt batteries or a universal switching power module. The instrument features a non-contacting, vibrating reed electrostatic sensor that is available in several configurations. In standard form the sensor is mounted in a 2"x1"x1" (51x.5x.5 mm) aluminum housing and views the object being measured directly. This is the most sensitive configuration and is designed primarily for use in clean or laboratory environments. Optionally, it is available in an enclosed ½" NPT elbow housing where it measures the charge induced onto an 0.875" (22 mm) diameter isolated detector plate. A 1/8" NPT tapped port is provided to purge the housing with air or nitrogen for use in hazardous environments. The user may also use intrinsic safe barriers for these applications. The sensor electronics are incorporated into this sensor housing, enabling it to be mounted up to 100' (30 m) away from the control unit. The sensors are connected to the instrument via a 5' (1.5 m) cable with locking 5-pin DIN connectors on each end. The enclosed sensor can also be hard wired using ½" conduit.

Voltage sensitivities of ± 2000 Volts full scale with 1 Volt resolution at ¼" sensor-to-object spacing and ± 20 kV full scale with 10 Volt resolution at 1" can be obtained with the standard sensor and is selected by a front panel switch. Other ranges can be obtained by changing the distance between the sensor and test object. A zero adjust control is provided to enable the user to compensate for or to introduce voltage offsets.

Voltage levels are displayed on a 3½-digit LCD meter with ½" character display. A recorder output signal of ± 200 mV full scale is available at the BNC connector located on the rear panel.

A unique feature of the Model 222 is the internal 500/1000 Volt regulated power supply. Many measurement set-ups may not include a large, flat test object in free space, which is the condition that all electrostatic fieldmeter calibrations are specified. Rather, measurements may have to be made in proximity to grounded or charged objects, or objects that are smaller than the viewing area of the sensor. This alters the electrostatic field from the object being measured causing the indicated value to be different than the actual value on the target. By applying a known voltage to a conductive surface simulating the test object the system can be calibrated. By altering the sensor-object spacing, adding a correction factor to the measurement, introducing an offset or any combination thereof, will then provide the actual average voltage on the surface being measured.

The voltage output which is current limited can also be used as a charging source for measuring the charge/discharge characteristics of material, objects or personnel plus the performance of ionizers.

Model 222 is housed in a compact, all aluminum instrument case and comes complete with standard sensor and 5' (1.5m) cable plus a plug-in universal voltage power module. Available as options are a Charged Plate Detector Sensor, an AC Sensor, custom sensor configurations and additional cable lengths or extensions. If the 500/1000 charging source is not required the Model 222 may be ordered with it deleted.

2.1 Front Panel

Figure 2-1 shows the front panel controls and display for the Model 222.



Figure 2-1: Model 222 Front Panel

The function of each component is as follows:

Display: This 3½ -digit LCD readout displays in kV the average electrostatic field detected in the field of view of the sensor.

ZERO: This 1-turn potentiometer controls the zero of the meter. Normally, the meter is zeroed when the field is at zero. However, it can also be used to compensate for any offsets that may be caused by extraneous electrostatic fields that may be detected by the sensor.

RANGE: This 2-position switch changes the gain of the system to allow both low and high voltage measurements to be made. When the 2 kV range is selected the sensor is placed ¼ " from the test object and the meter displays the average measured voltage from 0-±1.999 kV with 1 Volt resolution.

CAL: This 3-position switch enables the user to select either 500 V (switch up) or 1000 V (switch down) at the .080 pin V_E output jack. Output current is limited to 50 μ amps at 1000 V. In the center position the voltage is off.

POWER: The instrument is powered by either 2 alkaline, 9 Volt batteries or a 16 V universal switching power module. The 2-position ON/OFF switch controls power to the unit. When operating from batteries the BAT LO LED indicator will come on when battery voltage is below 12 V.

(GND): This miniature pushbutton switch is retrofitted to the front panel between the ZERO control and the RANGE switch. It is used to ground the isolated charged plate detector of the optional Charged Plate Detector sensor.

2.2 Rear Panel

Figure 2-2 shows the rear panel that contains the battery compartment plus the following input/output connectors:



Figure 2-2: Model 222 Rear Panel

Battery Compartment: This 2-drawer unit holds the 2 alkaline batteries used to power the unit. To gain access, pry up on the drawer as indicated by the arrow and pull it out. The battery is inserted with the contacts facing the instrument. The drawer has cutouts that allow the batteries to be inserted only one way. Push the drawer back in to complete the installation. It is recommended that both batteries be replaced at the same time.

SENSOR: This 5-pin locking DIN connector is where the sensor cable is connected to the instrument. The standard cable supplied is 5' (1.5m) long, but cable lengths up to 100' (30m) can be provided when the optional charged plate sensor assembly is selected.

REC OUT: This BNC connector provides a linear analog ± 200 mV full-scale signal corresponding to the ± 2000 V or 20kV full scale reading on the LCD display. It enables a chart recorder, oscilloscope or other data acquisition device to be added for recording the measurement.

EXT PWR: This 5mm power jack accepts the 16V DC power from the supplied universal switching power module. When the module is plugged in the batteries are disconnected.

GND: This standard banana jack enables the instrument to be connected to either house ground to establish a common ground reference. It could also be used to connect the unit to the system being measured to establish a common ground if the system is not tied to house ground.

2.3 Sensor

The Model 222 is available with two (2) sensor configurations, both operate using a vibrating reed sensing unit. The standard sensor is for laboratory or clean environments and is best suited for low voltage measurements. A Charged Plate Adapter assembly (optional) enables the standard sensor to measure charge on conductors by direct connection or use with custom detector probes.

The optional Environment Protected Charged Plate sensor incorporates both the sensing unit and the processing electronics in a ½" NPT electrical conduit elbow

housing and is best suited for use in dirty or hazardous environments or when a long cable run is required.

2.3.1 Standard Sensor

The standard sensor, shown in Figure 2-3, is housed in an aluminum housing that measures 2"x1"x1" (52x25x25mm). Two 6-32 tapped holes on the side are used to install the optional charged plate assembly or could be used for mounting the sensor. The top of the sensor contains a 5-pin locking DIN connector. The ¼-20 taped insert accepts standard tripod mounts or any stud that is less than ¼" (6mm) long for installation. The vibrating reed senses the electrostatic field directly and is not affected by ionized air. The processing electronics are located on a separate PC board located inside the instrument. For special applications where a long sensor cable run is required this PC board could be mounted externally at or near the sensor. Contact factory for details.



Figure 2-3: Standard sensor

2.3.2 SENSOR with Charged Plate Detector Assembly (Optional)

The Charged Plate Detector Assembly shown in Figures 2-4 is used to connect to either a conductive isolated object or personnel for a direct reading or to a custom probe that detects the electrostatic field in a remote or sealed location such as vessels, chutes, ducts etc.



Figure 2-4: Charged Plate Detector Assembly

Figure 2-5 shows the sensor with Charged Plate Detector assembly connected to a remote probe.

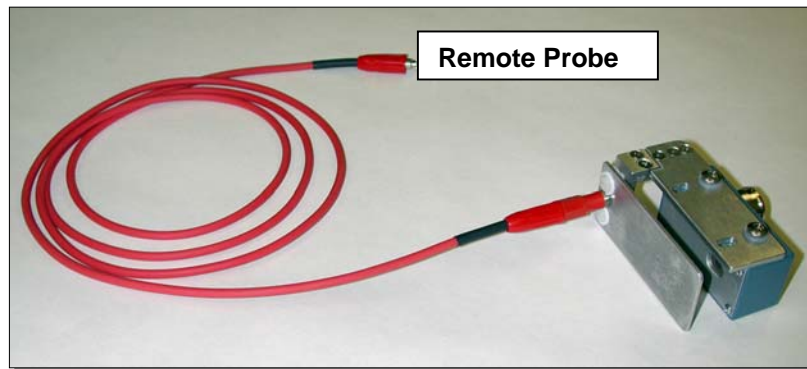


Figure 2-5: Charged Plate Detector Assembly connected to remote probe

If the probe that is connected to the detector assembly is to measure a field then follow the set up described in Section 3.0.

If the probe is connected directly to the object or personnel being measured (must be conductive or dissipative) then no further calibration is necessary. **The maximum voltage build up on the detector plate is limited to approximately 10kV.**

2.3.3 Environment Protected Charged Plate Detector Sensor (Optional)

This optional sensor shown in Figure 2.6 consists of the above chopper stabilized sensing unit mounted on the processing electronics PC board and housed in a cast aluminum ½" NPT electrical conduit elbow housing. A charged plate detection system is used to isolate the sensing unit from outside contaminants found in most industrial environments. The standard detector is a 1" (25mm) stainless steel disc mounted in a Teflon™ housing having a capacitance of 16pf. Other detector configurations are available to adapt the sensor to virtually any application. A 5-pin DIN connector enables the sensor to be connected to the instrument using the standard 5' (1.5m), cable or optional lengths up to 100' (30m). The sensor can also be connected using conduit. Contact the factory for this configuration. The sensor is mounted using a 1" (25mm) long, ¼-20 threaded stud with a vibration-proof locking nut. Custom mounting configurations are available.

The sensor assembly is fitted with a 1/8" NPT tapped hole for those applications requiring an air purge for use in dirty or hazardous environments.

This sensor also requires a RESET button to be fitted to the front panel of the Model 222. When depressed the isolated detector plate of the sensor is grounded. This is necessary when beginning a new measurement.



Figure 2-6: Environment Protected Charged Plate sensor

3.0 SET-UP

3.1 Standard Field Sensor

Connect the sensor cable to the sensor and the connector on the rear panel of the Model 222. If a chart recorder or other data acquisition device is to be used connect it to the BNC connector also on the rear panel. The instrument may be operated from the batteries or the external power module. When possible it is recommended that the power module be used. It connects to the 5mm EXT PWR jack. To establish a common ground reference, connect the instrument to either house ground or system ground via the GND banana jack.

Turn on the power and allow approximately 1 minute for the instrument to warm up. Select the desired range. Shield the sensor with a grounded plate or foil. Zero the meter.

The Model 222 is calibrated at the factory using a 12"x12" (305x305mm) plate charged to a known voltage. The sensor is placed exactly $\frac{1}{4}$ " (6.35mm) and 1.0" (25.4mm) away from the plate for calibration of the system at each range. This is known as a free space calibration. If any object, grounded or ungrounded or extraneous electrostatic field is close to the test object the measurement will be altered. To compensate for this the Model 222 incorporates a manual zero adjust and a built-in 500/1000 V calibration reference source.

Mount the sensor at or as close to the calibrated measuring distance (d) from the object being measured as possible. If the test object is conductive or dissipative and is isolated from ground connect the V_E output directly to the test object. Zero the meter. Then apply the reference voltage and observe the reading on the LCD

display. Ideally it should read approximately the applied voltage. Adjust the sensor/object distance to obtain the same reading. If this is not possible then develop a correction factor by dividing the applied voltage by the meter reading. For example if the meter reads .750 kV when 1 kV is applied to the object then multiply all measurements by $1 \div .75 = 1.33$ to obtain the actual voltage on the test object. Disconnect the reference voltage from the object prior to taking measurements.

If the test object is insulative then place a layer of aluminum foil over the surface that faces the sensor. Apply the reference voltage to the foil and follow the above procedure.

The same procedure applies if voltage levels greater than 20kV are to be measured. Placing the sensor $d=2"$ (51mm) will double the range of the meter to 40kV and tripling the distance will extend it to 60 kV.

Figure 3-1 shows a typical calibration set-up on a moving web measurement.

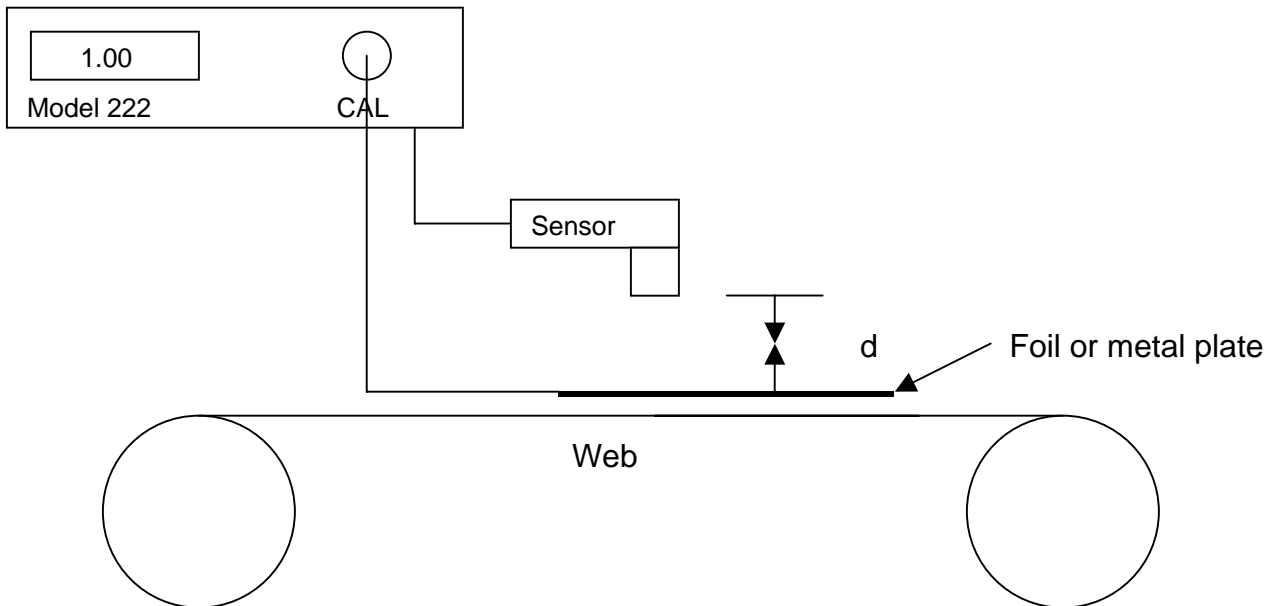


Figure 3-1: Calibration set-up for a moving web installation

3.2 Sensor with Optional Charged Plate Detector Assembly

Install the Assembly onto the sensor using the 6-32 mounting screws provided as shown in Figure 2-4. Select either the 2kV [0.25" plate to sensor spacing] or 20kV (0.75" [18mm]) spacing). Tighten the screws enough so the plate assembly can be moved. **Under no circumstances should screws having exposed tread longer than ¼" (6mm) be used. Longer screws may contact the sensor unit circuit board and damage it. This will void the warranty.**

Mount the sensor assembly so that the detector plate is in free space. Connect the 5' (1.5m) to the RED V_{out} connector on the Model 222 front panel and the other end to the RED banana jack on the detector plate as shown in Figure 3-2.

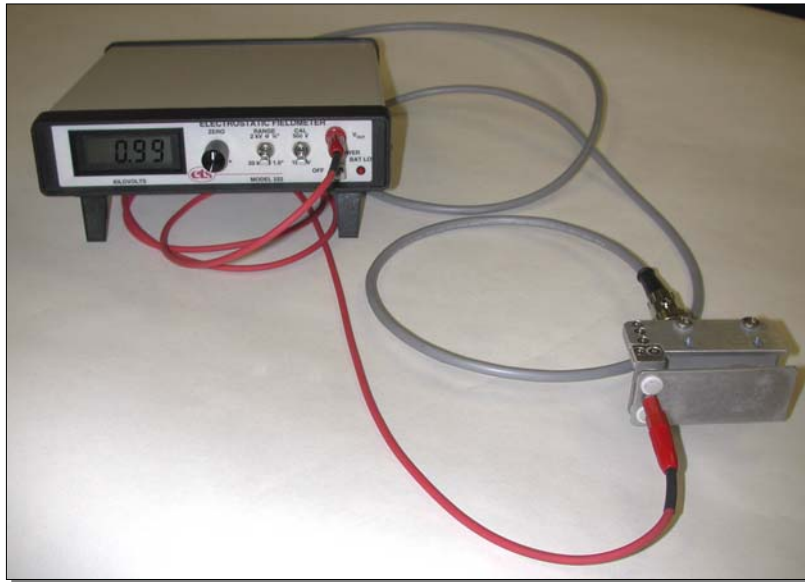


Figure 3-2: Calibration set up of Charged Plate Assembly

Ground the detector plate and adjust the ZERO control for a zero reading on the meter. Move the 3-position CAL toggle switch to either the 500 or 1000Volt position. Wait several seconds for the meter reading to stabilize. Move the Detector Plate Assembly forward or backward until the 500 or 1000 Volt reading is indicated on the meter within ± 5 or 10 V. Tighten the screws.

CAUTION:

DO NOT TOUCH THE DETECTOR PLATE HIGH VOLTAGE IS PRESENT. ALSO DO NOT USE THIS CONFIGURATION IN HAZARDOUS LOCATIONS.

The system is now calibrated. Any voltage generated on a conductive or dissipative object or detected by a remote probe will be transferred to the isolated detector plate and the resulting voltage will be displayed on the meter directly.

3.3 Custom Test and Measurement Fixtures

The measurement of static charge build-up in certain unique applications may require specially designed Charged Plate Adapter test fixtures. If the Model 222 is provided with a Custom Test Fixture, refer to the Appendix for installation and operating instructions.

4.0 OPERATION

Basically, once the measurement set-up has been calibrated, taking measurements follow in a similar manner. Make sure the wire connecting the V_{out} output is disconnected from the measurement set-up and the CAL switch is in the center (off) position. After approximately 1 minute warm up period the zero setting will remain stable. If the standard sensor is used the electrostatic field is viewed directly. If the optional Charged Plate Detector sensor is used the field from the test object is induced onto the 1" (25mm) isolated detector plate. The secondary electrostatic field is then detected by the sensor.

Select the desired range using both the RANGE switch and setting the sensor-object spacing. The 2kV range is for low voltage measurements requiring 1 Volt resolution. Otherwise, use the 20kV range (10 Volt resolution).

4.1 Standard Sensor

The standard sensor views the electrostatic field directly. Therefore, any reading displayed on the meter is from the electrostatic field within the viewing area of the sensor.

4.2 Environment Protected Charged Plate Detector Sensor

The Environment Protected Charged Plate Detector sensor views the charge induced on the isolated detector plate. When the test object is removed from the field of view of the sensor a residual charge may remain on this plate. A small **RESET** pushbutton switch is added to the front panel to discharge this residual charge. The detector plate should only be discharged when a completely new measurement is to be taken where the initial charge on the test object is zero.

4.3 Charged Plate Detector Assembly

The Charged Plate Detector Assembly functions similarly to the Environment Protected Charged Plate Detector sensor described in Section 4.2. However, a reset function is not supplied with this configuration so the **charge must be removed from the detector manually by touching it with a grounded lead.**

5.0 TAKING MEASUREMENTS

To measure voltage on an insulator directly place a piece of aluminum onto the surface being measured and connect using the RED cable and clip provided. Voltage on the insulator will be induced onto the foil and this voltage is read directly by the meter.

If the detector plate is grounded during a measurement such as measuring the voltage on a moving web the measured voltage at that moment will become the new zero reference. Any voltage displayed on the meter will be relative to this voltage. For example, the meter is reading 5 kV on a moving web when the detector is grounded. The meter will then read zero even though there is still 5kV on the web. If the voltage on the web drops to 3 kV the meter will then read -2kV.

If a recorder or other data acquisition device is connected to the REC OUT BNC connector its input impedance must be greater than 20 kOhms, otherwise it may load down the amplifier output.

6.0 REPAIR & CALIBRATION

The Model 222 Electrostatic Fieldmeter should require very little attention if it is used properly and is protected from excessive contamination (dust, dirt, harmful vapors, solvents, etc.) The sensor electronics are surface mount and cannot be serviced by the user. The zero/gain amplifier and the power converter in the instrument are plug-in DIP devices and can be field replaced if the problem is traced to them. The most vulnerable part of the system is the sensor. The vibrating reed sensing element is susceptible to

damage when exposed to excessive shock or vibration. A sensor failure is usually indicated by the LCD display locked onto a reading with no static field present, or not responding to a static field.

If the unit fails it should be returned to the factory for repair and recalibration.

The calibration of the Model 222 can be checked using the built-in regulated 500/1000 Volt reference power supply as follows. Secure a 12"x12" (305x305mm) plate to a good insulator such as Teflon™, acrylic, polypropylene, etc. Mount the sensor so that the outside surface of the viewing port is exactly the specified ¼" (6.35mm) or 1.0" (25.4mm) from the plate. Connect the plate to the V_E output jack. With the REF switch in the center off position ground the plate and zero the meter. Apply 500 Volts and check the meter reading. Repeat for 1000 Volts. The meter should read the applied voltage within ±4% (2% for the power supply accuracy and 2% for the measuring accuracy). Allow approximately 10% variation in the spacing. Moving the sensor back or forward slightly will generally bring the instrument into calibration.

If it is necessary to recalibrate the instrument it will be necessary to remove the bezels and top cover. Remove the 4 screws holding the bezels in place. The bezels will come right off. Remove the top cover. R1 and R2 are the gain control pots for calibrating the 2 and 20 kV ranges respectively.

6.0 SPECIFICATIONS

ELECTRICAL:

Sensor: Vibrating reed

Range: ±2 kV @ ¼": (0.6 cm)

±20 kV @ 1.0" (2.5 cm)

Resolution: 1V @ 2 kV/10V @ 20 kV

Display: 3 ½-Digit LCD

±2%

Linearity: ±2%

HVPS: 500/1000 ±2%, Regulated

Current: 50 µa @ 1000V

Power: 2 x 9V Batteries

Bat Low: LED On

AC Adapter: 90-260VAC/50/60 Hz

MECHANICAL:

GND: Std 0.162" Banana jack

REC OUT: NC (±1.0V FS)

DIMENSIONS:

Control Unit: 7.5"Wx8.25"Dx2.0"H
(19x21x5.1cm)

Accuracy:

Sensor (Std): 2"Wx1D"x1"H

(5.1x2.5x2.5 cm)

(Opt): 5"Lx1.4"Wx3"H

(12.7x3.6x7.6 cm)

Weight: 2.5 lbs (1.1 kg)

WARRANTY: One (1) Year

7.0 WARRANTY

Electro-Tech Systems, Inc. warrants its equipment, accessories and parts of its manufacture to be and remain free from defects in material and workmanship for a period of one (1) year from date of invoice. The Seller will, at its discretion will either replace or repair without charge, F.O.B. Glenside, similar equipment or a similar part to replace any equipment or part of its manufacture which, within the above stated time, is proved to have been defective at the time it was sold. All equipment claimed defective must be returned properly identified to the Seller (or presented to one of its agents for inspection). This warranty only applies to equipment operated in accordance with Seller's operating instructions.

Seller's warranty with respect to those parts of the equipment that are purchased from other manufacturers shall be subject only to that manufacturer's warranty.

The Seller's liability hereunder is expressly limited to repairing or replacing any parts of the equipment manufactured by the manufacturer and found to have been defective. The Seller shall not be liable for damage resulting or claimed to result from any cause whatsoever.

This warranty becomes null and void should the equipment, or any part thereof, be abused or modified by the customer or if used in any application other than that for which it was intended. This warranty to replace or repair is the only warranty, either expressed or implied or provided by law, and is in lieu of all other warranties and the Seller denies any other promise, guarantee, or warranty with respect to the equipment or accessories and, in particular, as to its or their suitability for the purposes of the buyer or its or their performance, either quantitatively or qualitatively or as to the products which it may produce and the buyer is expected to expressly waive rights to any warranty other than that stated herein.

ETS must be notified before any equipment is returned for repair. ETS will issue an RMA (Return Material Authorization) number for return of equipment.

Equipment should be shipped prepaid and insured in the original packaging. If the original packaging is not available, the equipment must be packed in a sufficiently large box (or boxes if applicable) of double wall construction with substantial packing around all sides. The RMA number, description of the problem along with the contact name and telephone number must be included in formal paperwork and enclosed with the instrument. Round trip freight and related charges are the owner's responsibility.

NOTE:

ELECTRO-TECH SYSTEMS, INC. WILL NOT ASSUME RESPONSIBILITY FOR ADDITIONAL COST OF REPAIR DUE TO DAMAGE INCURRED DURING SHIPMENT AS A RESULT OF POOR PACKAGING