



Piezo $d_{33/31}$ Meter



KCF Technologies, Inc.

Part Number PM-3500

Printed in USA

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For safe operation, please read the manual carefully before turning on the meter.

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1. DESCRIPTION

The KCF PM-3500 $d_{33/31}$ Meter is a special instrument for directly measuring the piezoelectric constant $d_{33/31}$ values of piezoelectric ceramics, polymers, and single crystals.

This meter can also measure the d_{33} values in various single crystal directions for crystals such as lithium niobate, quartz, and tourmaline. This meter is capable of measuring the d_{33} and d_{31} values over a very large range, at high resolution, and with a high degree of reliability. The measurement is quick and easily made with a minimum of training required. Specimens of various sizes and shapes can easily be accommodated and measured. For example, the d_{33} or d_{31} value of disks, blocks, rings, tubes and semispherical shells can be easily measured on the KCF PM-3500 $d_{33/31}$ Meter. The direct d_{33} or d_{31} value is displayed on a 3-1/2 inch digital meter. This instrument is valuable as a tool for quality assurance of piezoelectric materials, in-line production inspection, and for research and development applications involving piezoelectric materials.

2. SPECIFICATIONS

d_{33} Range: X1 range: 10 to 2000 pC/N
X0.1 range: 1 to 200 pC/N

d_{31} Range: X1 range: 10 to 2000 pC/N
X0.1 range: 1 to 200 pC/N

Accuracy: X1 range: $\pm 2\%$ of the d_{33} value in 100 to 2000 pC/N
 $\pm 5\%$ of the d_{33} value in 10 to 200 pC/N
X0.1 range: $\pm 2\%$ of the d_{33} value in 10 to 200 pC/N
 $\pm 5\%$ of the d_{33} value in 1 to 20 pC/N

Accuracy: X1 range: $\pm 8\%$ of the d_{31} value in 100 to 2000 pC/N
 $\pm 10\%$ of the d_{31} value in 10 to 200 pC/N
X0.1 range: $\pm 8\%$ of the d_{31} value in 10 to 200 pC/N
 $\pm 10\%$ of the d_{31} value in 1 to 20 pC/N

Resolution: X1 range: 1 pC/N
X0.1 range: 0.1 pC/N

Force: 0.25 N at Frequency: 110Hz

Polarity indication: Indicates polarity on upper face of test element in compression.
(- sign means negative)

Shunt Capacitance: X1 range: 1 pF X0.1 range: 0.1 pF

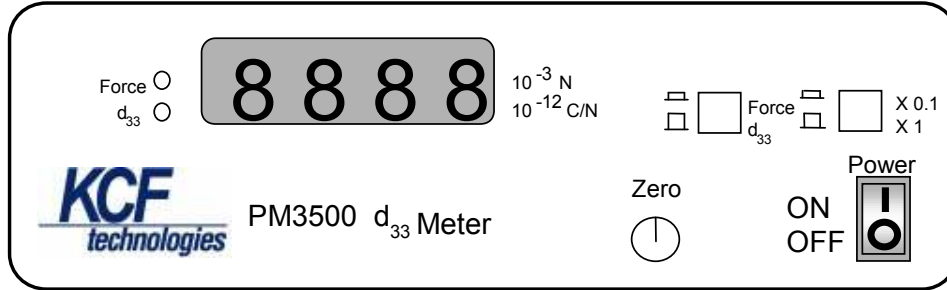
Force Head Dimensions: 110x140mm **Chassis Dimensions:** 280x200x90mm

Force Head Weight: 3 kg **Chassis Weight:** 2 kg

Power: 110/220V, 50/60Hz, 20W

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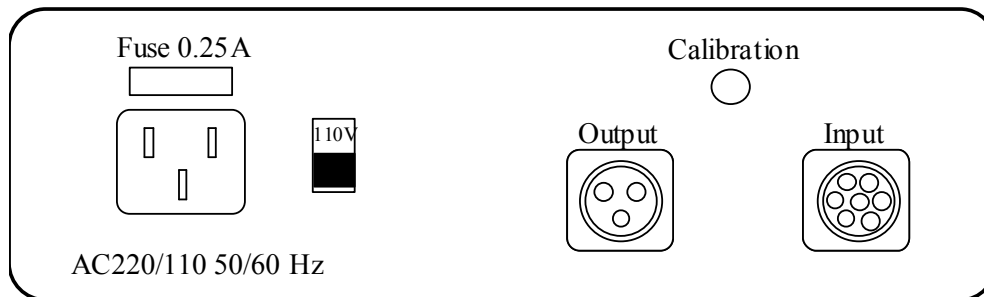
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Front

3. FRONT PANEL OVERVIEW (LEFT TO RIGHT)

1. **3 1/2 inch digital display:** The display toggles between showing the force put on the test sample and the d_{33}/d_{31} value of the test sample. The d_{33} sign indicates the polarity on the upper face of test element in compression. (- sign means negative, no sign means positive)
2. **Force/ d_{33} Key:** LED's to the left of the display indicate the operating mode. In Force mode, the digital display show the force put on the sample by the shaker (10^{-3} N). In d_{33} mode, the display shows the d_{33} value (10^{-12} C/N).
3. **d_{33} Range Key:** Chose from X0.1 or X1. In X1 range (for typical piezo materials, piezoceramics, etc.), the measuring range is 10 to 2000 pC/N and the resolution is 1 pC/N. In X0.1 range (for low piezoelectric constant materials such as piezo crystals), the measuring range is 1 to 200 pC/N and the resolution is 0.1pC/N. This mode is indicated by a decimal place on the display.
4. **Zero Adjust:** Use this dial to adjust the zero position with no sample in the device (see calibration).
5. **Power switch:** Turn on the Power and the Force or d_{33} display will turn on.



Back

4. BACK PANEL OVERVIEW (LEFT TO RIGHT)

1. **Output plug:** this three pin plug is connected with the shaker to supply shaker power, the port can output 110 Hz and 0.25 N force.
2. **Input plug:** this seven pin plug is connected with the shaker pick up the signal from shaker.

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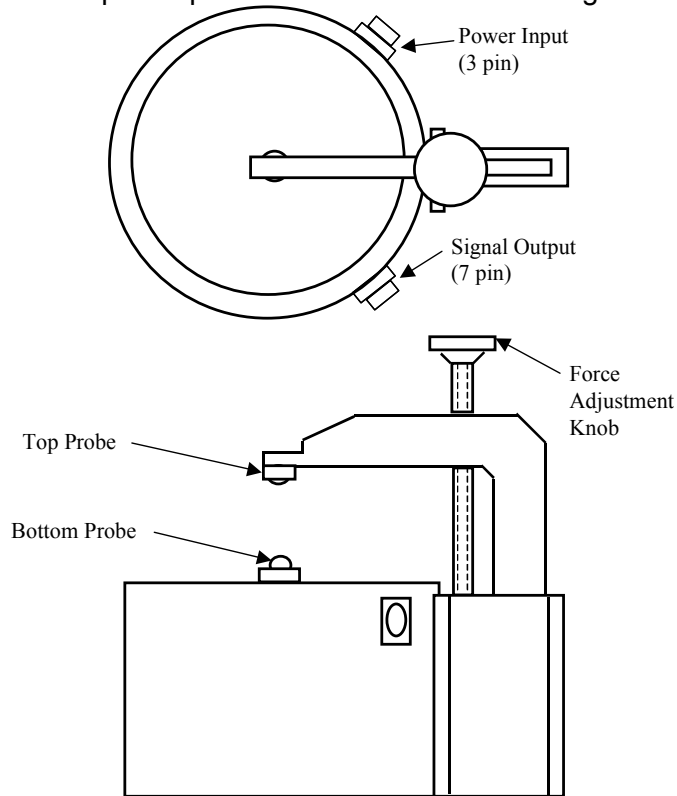
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3. **AC power plug:** AC 60/50 Hz, 110/220 Volt AC plug with 0.5A Fast Fuse for 110V AC power, 0.25A for 220V AC power supply. Before plug in AC power Please check local AC power voltage, and meter AC voltage set up.

5. SHAKER OVERVIEW

(d31 arms not pictured)

1. **Force Adjustment Knob:** Turn the Force Adjustment Knob to position the top probe. The test sample will be clamped between the top probe and bottom probe. Turn $\frac{1}{4}$ turn clockwise beyond the point where sample is captured and stops buzzing.
2. **Top and Bottom Probe:** The probes clamp the sample, supply the shaker vibration, and transfer the signal from the test sample to measuring system.
3. **Output and Input connector:** A three-pin plug is connected with the meter to supply shaker power. A seven-pin output sends the measurement signal to the meter.



6. SETUP AND CALIBRATION

1. Connect the meter input and output plug with the shaker output and input plug using the two cables supplied with the system.
2. Put the standard test sample between the top and bottom probes.
3. Turn on the meter for at least 15 minutes,
4. Turn the Force and D33 switch to Force. The meter readout should be $(250 \pm 10) \times 10^{-3}$ N. If not, check the sample is mounted centrally and that the Force adjustment knob is tensioned correctly.

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5. Switch the Force and D33 switch to D33. The meter read out should be close the D33 value of the standard test sample. Write down the value of meter displayed for D1. Then turn the test sample 180°, measure the sample again. The meter will show opposite polarization and the D33 value for D2. If the two values are different $D1 \neq D2$, calculate the D3 by $(D1 + D2) \times 0.5$. Using the Zero point adjust knob get the meter display show the D3 value. Now the test sample negative and positive value should be same.
6. Adjust back panel calibration screw; let the meter display show same value as the standard test marked.
7. The meter is calibrated before shipment. It should be re-calibrated monthly, or before each intermittent use.

7. OPERATION

1. Put the test sample between the two probes. The probes should be as close to the sample center as possible. Turn the knob to adjust the force upon the sample. Do not tighten clamp too much on the sample. Normally ¼ counter-clockwise turns after noisy vibration stops. When the meter display is stable the value is shown. If the clamp is too tight or too loose, the results will be affected.
2. If you want measure samples of the same thickness, you can just push lightly down the bottom probe plate, then change the test sample. There is no need to adjust the knob.
3. Two different shape probe heads are supplied with the meter. It is recommended to use the hemispherical shaped probe head to measure most samples. When measuring a large flat-surfaced sample, use the flat probe on the bottom of the sample.
4. When measuring a large capacitance samples ($>1\mu\text{F}$), the meter readout value must be modified. Otherwise the uncertainty will be greater than 1%. The following equation can be used to calculate the true value.

$$D_{33}(\text{modified}) = D_{33}(\text{Display}) \times (1 + C_c) \text{ For switch on " x1 "}$$

$$D_{33}(\text{modified}) = D_{33}(\text{Display}) \times (1 + 10C_c) \text{ For switch on " x0.1 "}$$

where: C_c = capacitance of sample (μF)

8. CALCULATE ϵ_{33} AND G_{33}

- The relative dielectric constant $\epsilon_{33} = (T \times C) \div (\epsilon_0 \times S)$
- T = The thickness of the sample (m)
- S = The area of simple electrode (m^2)
- C = The capacitance of the sample (F)
- $\epsilon_0 = 8.85 \times 10^{-12}$ F/m
- Piezo voltage $G_{33} = D_{33} \div \epsilon_{33}$
- The d_{31} values use the same formulas, bearing in mind that the thickness of the sample is in the electrical direction.

9. WARRANTY

KCF Technologies (“KCF”) warrants to the customer (“Customer”) that the PM3500 Piezoelectric d33/d31 Meter (“Product”), including chassis and force head, shall be free from defects in material and workmanship for the duration stated below, which duration begins on the date of purchase by the Customer.

Warranty period: One Year

If KCF receives, during the applicable warranty period, notice of a defect in the Product, KCF shall either repair or replace the defective Product, at KCF’s option. If KCF is unable to repair or replace the Product, as applicable, KCF shall within a reasonable time after notification refund the purchase price for the Product. This warranty covers those defects that arise as a result of a normal use of this product, as outlined in this User’s Manual. Failure to read and follow the User Manual instructions, or failure to follow normal use guidelines will void the warranty.

10. MAINTENANCE

This system is maintenance free. If you need service on the instrument, please contact:

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11. INCLUDED ACCESSORIES

- | | |
|--|----------|
| 1. Cable (3 wire) with connectors | 1 piece |
| 2. Cable (7 wire) with connectors | 1 piece |
| 3. Power cord | 1 piece |
| 4. Hemispherical shape probe head | 2 pieces |
| 5. Flat shape probe head | 2 pieces |
| 6. d ₃₃ Calibrated standard | 1 piece |
| 7. Fuse | 1 piece |
| 8. Operating manual | 1 piece |

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D31 INSTRUCTIONS

1. d_{31} measurement differ from d_{33} measurement only in the test material orientation. Both measurements are similar electrically and mechanically.
2. Calibrate the system with the calibrated d_{33} sample following the directions above.
3. Exchange the metal probes for the plastic tipped ones.
4. One D31 sample (for example only, not calibrated) is included with the meter. Find a black dot on the side of this sample. The two metallized sides $\pm 90^\circ$ to this side are the measuring faces. Adjust the d31 arms vertically and horizontally so that the pins on the arms will make electrical contact while the sample is clamped.
5. As in D33, put the test material between the top and bottom clamps to hold it in place. Ensure that the material's D31 direction is oriented towards the side probes and that they make light electrical contact.
6. The rest of the measurement procedure follows that of D33.



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Piezo d_{33}/d_{31} Meter Instruction Addendum

Caution:

Probe heads should be tightened only finger tight!

If a probe head cannot be exchanged without use of tools, be certain that the hex shaped base of the shaker (shown below) is held immobile relative to the shaker unit. Permanent damage to the shaker unit and meter may result if the hex base is twisted.



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