# VOLUMETRIC PIEZOELECTRIC COEFFICIENT (D13/D33) EXPERIMENTAL SET-UP

***MVCA*-Series**

**Introduction:**

MHECS series of piezoelectric volumetric coefficient experimental set-ups are available in more than ten different models to examine and explore the relation between stress and generated electric field statically/dynamically under varied thermo/mechanical condition of piezoelectric. This set-up consist of electromagnetic/pneumatic actuator, capable of applying force to as much as 1.0 mili-newton statically and dynamically with full feature of measuring amplitude, velocity and acceleration desired phase trajectory. Sensitive electrometer measures the generated voltage/charge. All these parameters may be measured and connected to PC at RS-232 to generate desired result. On account it's versatile feature this preferable choice for research and teaching institution, generation, traction, telecom, airlines, railways, electrical utilities, M.E.M.S, organic/inorganic chemical, heavy electrical/mechanical industries, sensors, and many uncountable defense/nuclear applications. Updated design topology ensures better controllability and efficiency with additional integrated power/voltage and frequency control/protection. Company offers tailor made solution to custom requirement.

**Operating Principle:** Piezoelectricity is change in electric polarization with a change in applied stress (direct piezoelectric effect). $D_i = d_{ijk} X_{jk}$ The converse piezoelectric effect is the change of strain or stress in a material due to an applied electric field. This linear relationship between stress *Xik* applied to a piezoelectric material and resulting charge density *Di* is known as the direct piezoelectric effect and may be defined as where *dijk* (C N−1) is a third-rank tensor of piezoelectric coefficients.

Conversely converse piezoelectric effect describes the strain that is developed in a piezoelectric material due to the applied electric field: $x_{ij} = d_{kij} E_k = d^t_{ijk} E_k$ where *t* denotes the transposed matrix. The units of the converse piezoelectric coefficient are *(*m V−1). It is common to call a piezoelectric coefficient measured in the direction of applied field the longitudinal coefficient and that measured in the direction perpendicular to the field the transverse coefficient. Other piezoelectric coefficients are known as shear coefficients. Because the strain and stress are symmetrical tensors, the piezoelectric coefficient tensor is symmetrical with respect to the same indices, accordingly *ijk* = *dikj* .In the absence of external strain, the charge distribution is symmetric and the net electric dipole moment is zero. However when an external stress is applied, the charges are displaced and the charge distribution is no longer symmetric and a net polarization is created.

Piezoelectric materials are characterized by several coefficients:

dij: Strain coefficients [m/V]: strain developed (m/m) per electric field applied (V/m)
or (due to the sensor / actuator properties material.

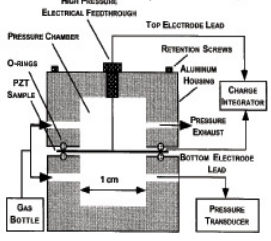
Charge output coefficients [C/N]: charge density developed (C/m²) per given stress (N/m²).

gij: Voltage coefficients or field output coefficients [Vm/N]: open circuit electric field developed (V/m) per applied mechanical stress (N/m²) or (due to the sensor / actuator properties of Piezo material) strain developed (m/m) per applied charge density (C/m²).

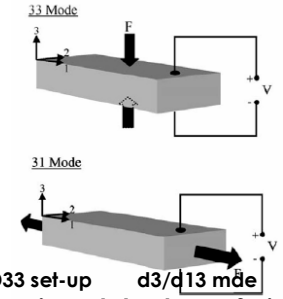
kij: Coupling coefficients [no Dimensions]. ..The coefficients are energy ratios describing the conversion from mechanical to electrical energy or vice versa. k² is the ratio of energy stored (mechanical or electrical) to energy (mechanical or electrical) applied.

There are two practical coupling modes exist; the −31 mode and the −33 mode. In the −31 mode, a force is applied in the direction perpendicular to the poling direction, an example of which is a bending beam that is poled on its top and bottom surfaces. In the −33 mode, a force is applied in the same direction as the poling direction, such as the compression of a piezoelectric block that is poled on its top and bottom surfaces

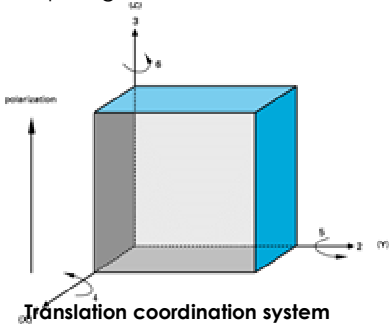
MLCA-00999901




Schematic presentation of D33 set-up




d3/d13 mode




Translation coordination system

## General specification of Volumetric coefficient experimental set-up of piezoelectric material

| Model | D13/D33 Range/L.C. | Applied stress(M-Pa)/ stress-frequency(Hz) | Poling field K.Volt/cm | Charge(nC/voltage | Poling field k.v./m.m. |
|---|---|---|---|---|---|
| MLCA-00999901 | +/-009999 /0.000001 | 999.999/(0-09.99999) | 99.9999 to -999.999 | +/-009999 /0.000001 | Upto 20.0 |
| MLCA-00999901 | +/-009999 /0.000001 | 999.999/(0-09.99999) | 99.9999 to -999.999 | +/-009999 /0.000001 | Upto 20.0 |
| MLCA-09999901 | +/-099999 /0.000001 | 999.999/(0-09.99999) | 99.9999 to -999.999 | +/-099999 /0.000001 | Upto 20.0 |
| MLCA-09999901 | +/-099999 /0.000001 | 999.999/(0-09.99999) | 99.9999 to -999.999 | +/-099999 /0.000001 | Upto 20.0 |
| MLCA-99999901 | +/-999999 /0.000001 | 999.999/(0-09.99999) | 99.9999 to -999.999 | +/-999999 /0.000001 | Upto 20.0 |
| MLCA-99999901 | +/-999999 /0.000001 | 999.999/(0-09.99999) | 99.9999 to -999.999 | +/-999999 /0.000001 | Upto 20.0 |

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# VOLUMETRIC PIEZOELECTRIC COEFFICIENT EXPERIMENTAL SET-UP

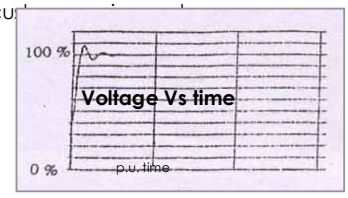
***Programmable/Non-programmable*** **MHVLC-Series**

## Introduction:

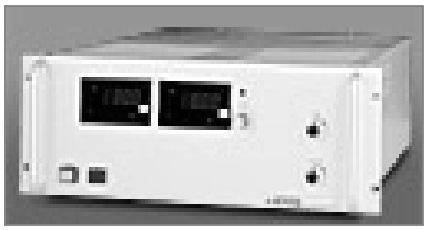
MHVLC series of high voltage /low current supplies are available upto 20,000 kv/(15.0 to 100,000 watts), in more than 50 different models working in constant voltage/current mode virtually offering solutions to electrical insulation, pollution control, electrostatic precipitators, Capillary zone electrophoresis, Petrochemical industry, organic/inorganic chemical, heavy electrical/mechanical industries, high voltage testing, electron microscope supplies, smart sensors and actuators, electrorheology, biotechnology, capacitor energy storage, solids state physics application and many uncountable defense/nuclear applications. Updated design topology ensures better controllability and efficiency with additional integrated power/voltage and frequency control/protection. These power supplies may operate in parallel to make it more redundant. Company offers tailor made solution to cu

## Operating Principle:

These high voltage supply current/low voltage are line commutated S.C.R. or force commutated high frequency I.G.B.T. controlled converters working in feedback cascade mode. Set voltage/ current immediately settles to set point with consistent regulation over wide load range with fail proof protection against over/under voltage. These power supplies may be operated in parallel along with facility of parallel Port/serial port to enable it to interface with computer to achieve any real time Voltage /current profile.

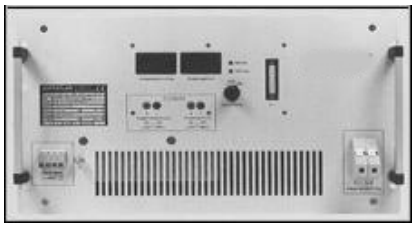



**Transient time response of power supply**



**MHVLC-020010**


**MHVLC-050020**



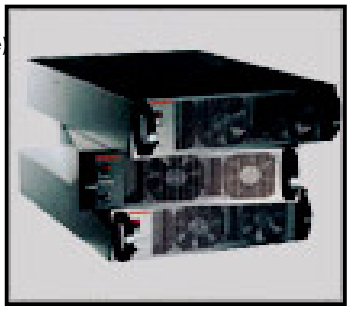
**MHVLC-100100**

| Model | Power watts | Volts K.V./ option | Current m.a./ option | Repetition rate pulse/sec maximum | coolin g | Model | Power watts | Volts K.V. | Current m.a. | Repition rate Pulse/sec maximum | Cooling |
|---|---|---|---|---|---|---|---|---|---|---|---|
| MHVLC-0500103 | 0050.0 | 0.5 | 010.0 | 100/option | Air/oil | MHVLC-0300103 | 500.0 | 30.0 | 010.0 | 100/option | Air/oil |
| MHVLC-0502503 | 0250.0 | 05.0 | 50.0 | 100/option | Air/oil | MHVLC-0300203 | 500.0 | 30.0 | 020.0 | 100/option | Air/oil |
| MHVLC-0505003 | 0500.0 | 05.0 | 100.0 | 100/option | Air/oil | MHVLC-0500103 | 500.0 | 50.0 | 010.0 | 100/option | Air/oil |
| MHVLC-0510003 | 1000.0 | 05.0 | 200.0 | 100/option | Air/oil | MHVLC-0500203 | 1000.0 | 50.0 | 020.0 | 100/option | Air/oil |
| MHVLC-0100103 | 100.0 | 10.0 | 010.0 | 100/option | Air/oil | MHVLC-0500403 | 2000.0 | 50.0 | 040.0 | 100/option | Air/oil |
| MHVLC-0100203 | 200.0 | 10.0 | 020.0 | 100/option | Air/oil | MHVLC-0501403 | 5000.0 | 50.0 | 100.0 | 100/option | Air/oil |
| MHVLC-0100503 | 500.0 | 10.0 | 050.0 | 100/option | Air/oil | MHVLC-0502003 | 5000.0 | 50.0 | 100.0 | 100/option | Air/oil |
| MHVLC-0101003 | 1000.0 | 10.0 | 100.0 | 100/option | Air/oil | MHVLC-1000103 | 1000.0 | 100.0 | 10.0 | 100/option | Air/oil |
| MHVLC-0105003 | 5000.0 | 10.0 | 500.0 | 100/option | Air/oil | MHVLC-1000203 | 2000.0 | 100.0 | 020.0 | 100/option | Air/oil |
| MHVLC-0109993 | 10,000.0 | 10.0 | 1000.0 | 100/option | Air/oil | MHVLC-1000503 | 5000.0 | 100.0 | 050.0 | 100/option | Air/oil |
| MHVLC-0200203 | 1000.0 | 20.0 | 020.0 | 100/option | Air/oil | MHVLC-1001003 | 10000.0 | 100.0 | 100.0 | 100/option | Air/oil |
| MHVLC-0200503 | 1000.0 | 20.0 | 050.0 | 100/option | Air/oil | MHVLC-1002003 | 10000.0 | 100.0 | 200.0 | 100/option | Air/oil |
| MHVLC-0201003 | 2000.0 | 20.0 | 100.0 | 100/option | Air/oil | MHVLC-2002003 | 10000.0 | 200.0 | 050.0 | 100/option | Air/oil |
| MHVLC-0205003 | 10000.0 | 20.0 | 500.0 | 100/option | Air/oil | MHVLC-2002003 | 20000.0 | 200.0 | 100.0 | 100/option | Air/oil |
| MHVLC-0209993 | 20,000.0 | 20.0 | 1000.0 | 100/option | Air/oil | MHVLC-4000503 | 20,000.0 | 400.0 | 050.0 | 100/option | Air/oil |
| MHVLC-0320003 | 20,000.0 | 20.0 | 2000.0 | 100/option | Air/oil | MHVLC-0500053 | 20,000.0 | 500.0 | 010.0 | 100/option | Air/oil |

Voltage/current specs of above power supplies are of regular production, however company is regularly manufacturing power supplies of higher voltage/current options.

## General High voltage/low current power supply Specification:

Operating voltage: 1.0-200.0 kV D.C. / 100.0 kilo watts
Output current: 0.0-40,000 m.a (max)
Voltage/current control accuracy: 99.9% of set point
Voltage regulation: Line : ±0.005% (for ±10% of input change)/ Load: 0.005% (for 10 to 100% of load change)
Current regulation: Line : ±0.005% (For ±10% of input change)/Load: 0.005% (for 10 to 100% of load change)
Resolution: 0.1 volts/amps D.C.
Repeatability: 100 percent
Response time: 0.5 –1.1 mill-seconds
Interface Signal: 0.0-12.0 volts D.C. proportional to output voltage
Voltage control ranges: 0.0-400 K.V.
Step down ratio: 0-100%
Control options: 1. Reverse polarity control 2. 1. Cascade feedback control with Soft start 2.Ratio control (option) 2. Contant voltage/current with external adjustment.
Display: 3-1/2,4-1/2,5-1/2 Voltage/current/charge/kilowatt/option in 3½ red glow LED display
Protection: over voltage/short ckt.
Additional: Local: Constant voltage mode, by 10-turn potentiometer Constant current mode, by 10-turn potentiometer
Remote: Constant voltage mode, by external voltage of 0 to 10Vdc*/*NOTE: These power supplies are also offered in pulse mode.*



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# PRECISION NANO VOLT METER/PICO-COULOMB ANALYZER

**(A.C./.C./D.C./PULSE)**

## Introduction:

Precision nanovoltmeters/coulomb are available in 8 different regular models apart from tailor made solutions virtually covering all industrial and research applications meeting all electrical, thermal, mechanical, and environmental specifications. These indicators are first choice for online monitoring of ultra low volt signal or allied measurement.These finds defense, electrical/mechanical m/c testing instrument, industrial electronics, railway, and avionics and solid state physical application like dielectrics characterization, switch gears, MEMS and many research and development activities. These precision instruments are compatible to any standard or hall/shunt/thermocouple sensor and display with very high degree of accuracy/repeatability/reliability and are available in different constructional material like ceramic-coated MS, poly carbonate cabinets.

## Benefits:

- Ultra high input impedence/negligible biased current /higher accuracy.
- 4-1/2, 5-1/2 & 6-1/2 digit display /consistent performance
- stable over large temperature/humidity range (70°C and 80 % RH)
- Scaled directly in nanovolt or allied measurement with repeatable accuracy.
- Auto/manual zero offset without drift.
- Auto drift tracking
- RS-32 interface/high sample rate – 10,000 sample/second.
- Feed back current measurement technique.

**MLCHVEM-0009991**

NANOVOLTMETER D.C./A.C. Range<999999 nano volt meter / 999999 pico amperemeter

| Model | Range $10^{-9}/10^{-12}/10^{-15}$ Volt | Range $10^{-9}/10^{-12}/10^{-15}$ Ampere | Pulse/D.C./Pulse Frequency Range | Burdon | Accuracy Restricted to Resolution level | Resolution Quantified/ optional | Voltage/current source Volt/current/optional As demanded | INTERFACE |
|---|---|---|---|---|---|---|---|---|
| MLCHVEM-9999990101 | 10.0/5.0 -999999Nv 1.0 mV-10.0Volts | 05.0/01.0 -999999nA 1.0 mA-10.0Amp | 0-50K.Hz | < 100 micro-volts | 99.99999% | 5 nV/5nA | 015 VOLTS/001.0 A | RS-232USB |
| MLCHVEM-9999990401 | 10.0/5.0 -999999Nv 1.0 mV-20.0Volts | 05.0/01.0 -999999nA 1.0 mA-20.0Amp | 0-50 k.Hz | < 100 micro volts | 99.99999% | 5 nV/5nA | 040 VOLTS/001.0 A | RS-232/USB |
| MLCHVEM-9999990102 | 05.0/1.0 -999999Nv 1.0 mV-10.0Volts | 10.0/05.0 -999999pA 0.001 m.A-1.00Amp | 0-50K.Hz | < 100 micro volts | 99.99999% | 5 nV/5pA | 015 VOLTS/001.0 A | RS-232/USB |
| MLCHVEM-9999990402 | 05.0/1.0 -999999Nv 1.0 mV-20.0Volts | 10.0/05.0 -999999pA 0.001 m.A-2.00Amp | 0-50 k.Hz | < 100 micro volts | 99.99999% | 5 nV/5pA | 040 VOLTS/001.0 A | RS-232/USB |
| MLCHVEM-9999991002 | 05.0/1.0 -999999Nv 1.0 mV-99.9Volts | 10.0/05.0 -999999pA 0.001 m.A-10.0Amp | 0-50k..Hz | < 100 micro volts | 99.99999% | 5 nV/5pA | 100 VOLTS/001.0 A | RS-232/USB |
| MLCHVEM-9999992002 | 05.0/1.0 -999999Nv 1.0 mV-199Volts | 10.0/05.0 -999999pA 1.0 mA-199Amp | 0-50 k.Hz | < 100 micro volts | 99.99999% | 5 nV/5pA | 200 VOLTS/001.0 A | RS-232/USB |
| MLCHVEM-9999992003 | 05.0/1.0 -999999Nv 1.0 mV-199Volts | 10.0/05.0 -999999fA 0.0001mA-10.0 mA | 0-50 k.Hz | < 100 micro volts | 99.99999% | 5 nV/5fA | 200 VOLTS/010.0m A | RS-232/USB |

Six digit after product code indicate count, next, Two digit indicate voltage and last digit indicate
01- nano amp/02-pico amp/03-femto amp.

## General electrical/mechanical specifications:

Operating voltage: 220 volt A.C. (50-20,000 Hz)/ 12 volts D.C.
Measurement range (full scale): as above in different model.
Measurement Range (V/C -A.C./D.C):$10^{-09}$-$10^{-04}$ /$10^{-4}$-$10^{+1}$ /$10^{+1}$-$10^{+3}$ volt least count- 5.0 nano volt
$10^{-12}$-$10^{-07}$ C/$10^{-7}$-$10^{-2}$ /$10^{-02}$-$10^{+2}$ C/least count- 5.0 pico.C
Input capacitance: 10 nF
Response time: 1000 sample/sec
Burden: less than 100 micro volt/full scales current or better
Accuracyerror : 0.5/1.0/2.0 % reading
Repeatability: 100 of reading
Resolution: 1/5 nV & 1/5 nano/pico coulomb/ optional and may be altered based on time behaviour of signal
Linearity adjustment: upto 100 nano volt
Input imedence: ultra high(<100 giga ohm),
Filtering: low pass( adjustable)
Offset: variable upto 10,000 nano volts (manual/auto)
CMMR: >80 db at 50-60 Hz
Isolation: > 100 giga ohm
Connector: BNC-9 pinx2 and BNC-25 pinx2
Size: 8X8x12 inches/rack mounted or portable
Interface: RS-232
Option : ADDITIONAL SOFTWARE to plot D33/T, D33/Epoling etc
THESE SPECIFICATIONS OR PART THERE OF MAY BE MODIFIED TO MEET ANY TAILOR MADE SOLUTIONS.
NOTES: The numeral after product code indicates the ( ampere meter) range and last digit corresponds to size (5x5x8, 8x8x12)

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# DYNAMIC PRESSURE ANALYZER

**Introduction:**

MDPA range of dynamic pressure analyzer / conditioner( AC/DC) conditioner are available in 8 different regular models apart from tailor made solutions virtually covering all industrial and research applications meeting all electrical, thermal, mechanical, and environmental specifications. These conditioners are first choice for online monitoring of piezoresistive based pressure/force/level/acceleration/torque/flow and many other inferential variable. These conditioners also find application in heavy electrical engineering industries, structure,automobile, vibration, defense, and electrical/mechanical m/c testing instrument, industrial electronics, railway, and avionics and many research and development activities. These conditioners are compatible to any standard or hall/shunt sensor and display with very high degree of accuracy/repeatability/reliability. These conditioners are available in different constructional material like ceramic-coated ms/poly carbonate.

Benefits:

- Simple installation and operational compatibility.
- Consistent performance over large temperature range (70◦C)
- Scaled directly in desired protocol with repeatable accuracy.
- Auto zero offset without drift.
- All standards din sizes and custom sizes.
- Bridge configuration selector

**MDPA-99999.9**
**range: +/- 9999999 Mpa**

**Dynamic Pressure Analyzer**

| **Model** | Pressure M.Pa/L.C. | Lease count PRESSURE | Linearization | Excitation AC/DC | Display | Interface option |
|---|---|---|---|---|---|---|
| MDPA-00099.9- | 999999/000001 | 1/10 of lbs. | Optional | Optional | LCD/LED | RS-232 |
| MDPA-00999.9- | 999999/000001 | 1/10 of lbs. | optional | Optional | LCD/LED | RS-232 |
| MDPA-09999.9- | 999999/000001 | 1/10 of lbs. | Optional | Optional | LCD/LED | RS-232 |
| MDPA-99999.9- | 999999/000001 | 1/10 of lbs. | Optional | Optional | LCD/LED | RS-232 |

**General electrical/mechanical specifications:**

Operating voltage: 220 volt A.C. (50-20,000 Hz)/ 12 volts D.C.
Measurement of Dynamic/static Pressure:range (full scale): as above in different model.
Input capacitance: 10 nF
Response time: 1000 sample/sec
nano ampere meter signal: 100 micro ampere AC/DC (optional)
Burden: less than 100 micro volt/full scale current
Accuracy: 0.5/1.0/2.0 % reading
Repeatability: 100 of reading
Resolution: 1/10 of least significant bit
Linearity adjustment: upto 100 nano volt
Input imedence: 100 mega ohm (<1000 nano volt), 1000 mega ohm (<1000 mili volt)
Filtering: low pass
Offset: variable upto 10,000 nano ampere (manual/auto)
CMMR: >80 db at 50-60 Hz
Isolation: > 100 giga ohm
CHANNEL: 4/8/20/40 Channels
Connector: BNC-9 pinx2 and BNC-25 pinx2
Size: 5X8X8 inches/rack mounted or portable
Interface: RS-232

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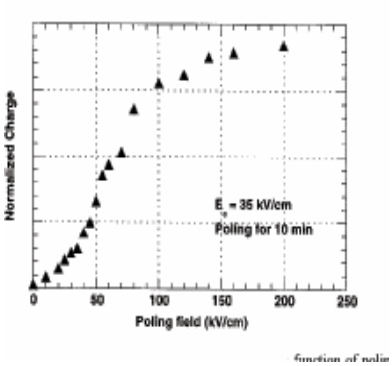
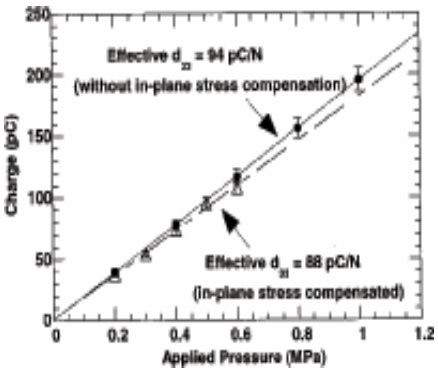
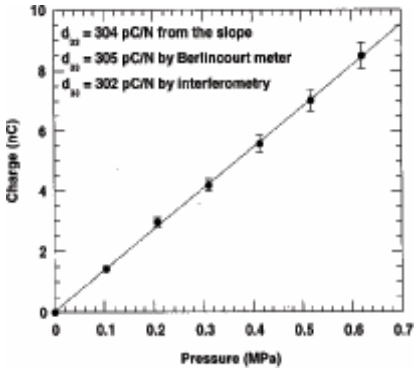
*MVCA-Series*




**Charge induced vs poling level of sample**




**induced charge vs applied pressure**




**Charge induce vs applied preesure**

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