

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 milli-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 X_{ik} applied to a piezoelectric material and resulting charge density D_i is known as the direct piezoelectric effect and may be defined as where d_{ijk} (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: $x_{ij} = d_{kij} E_k = d_{ijk}^t E_k$ 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:

d_{ij} : 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).

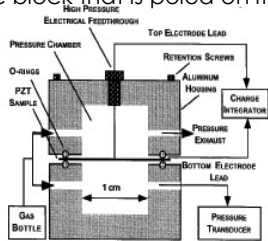
g_{ij} : Voltage coefficients or field output coefficients [Vm/N]: open circuit electric field developed (V/m) per applied mechanical stress (N/m²) or (due to the sensor / actuator properties of Piezo material) strain developed (m/m) per applied charge density (C/m²).

k_{ij} : Coupling coefficients [no Dimensions]. ..The coefficients are energy ratios describing the conversion from mechanical to electrical energy or vice versa. k^2 is the ratio of energy stored (mechanical or electrical) to energy (mechanical or electrical) applied.

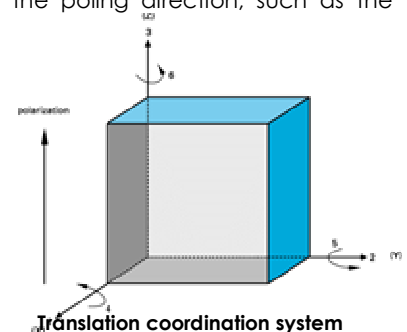
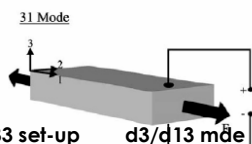
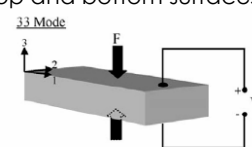
There are two practical coupling modes exist; the -31 mode and the -33 mode. In the -31 mode, a force is applied in the direction perpendicular to the poling direction, an example of which is a bending beam that is poled on its top and bottom surfaces. In the -33 mode, a force is applied in the same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



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	+/-0.009999 /0.000001	999.999/(0-09.99999)	99.9999 to -999.999	+/-0.009999 /0.000001	Upto 20.0
MLCA-00999901	+/-0.009999 /0.000001	999.999/(0-09.99999)	99.9999 to -999.999	+/-0.009999 /0.000001	Upto 20.0
MLCA-09999901	+/-0.999999 /0.000001	999.999/(0-09.99999)	99.9999 to -999.999	+/-0.999999 /0.000001	Upto 20.0
MLCA-09999901	+/-0.999999 /0.000001	999.999/(0-09.99999)	99.9999 to -999.999	+/-0.999999 /0.000001	Upto 20.0
MLCA-99999901	+/-9.999999 /0.000001	999.999/(0-09.99999)	99.9999 to -999.999	+/-9.999999 /0.000001	Upto 20.0
MLCA-99999901	+/-9.999999 /0.000001	999.999/(0-09.99999)	99.9999 to -999.999	+/-9.999999 /0.000001	Upto 20.0

MOTORON SEMICONDUCTORS CORPORATION

VOLUMETRIC PIEZOELECTRIC COEFFICIENT EXPERIMENTAL SET-UP

Programmable/Non-programmable

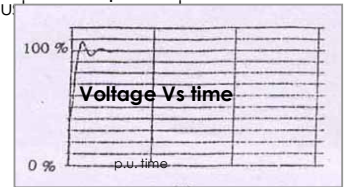
MHVLC-Series

Introduction:

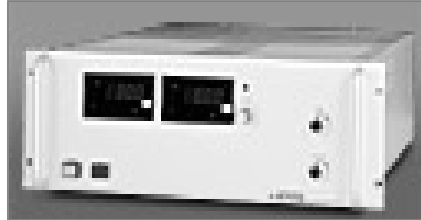
MHVLC series of high voltage /low current supplies are available upto 20,000 kv/(15.0 to 100,000 watts), in more than 50 different models working in constant voltage/current mode virtually offering solutions to electrical insulation, pollution control, electrostatic precipitators, Capillary zone electrophoresis, 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 customer's requirements.

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.



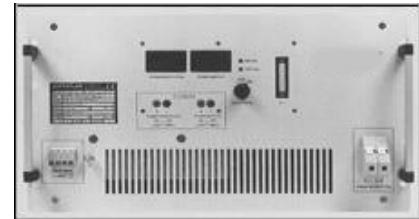
Transient time response of power supply



MHVLC-020010



MHVLC-050020



MHVLC-100100

Model	Power watts	Volts K.V./option	Current m.a./option	Repetition rate pulse/sec maximum	cooling	Model	Power watts	Volts K.V.	Current m.a.	Repetition 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 : $\pm 0.005\%$ (for $\pm 10\%$ of input change)/ Load: 0.005% (for 10 to 100% of load change)

Current regulation: Line : $\pm 0.005\%$ (For $\pm 10\%$ 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 3 1/2 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 impedance/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-232/USB
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 mA-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 mA-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 mA-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

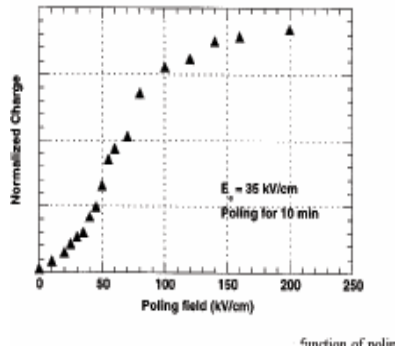
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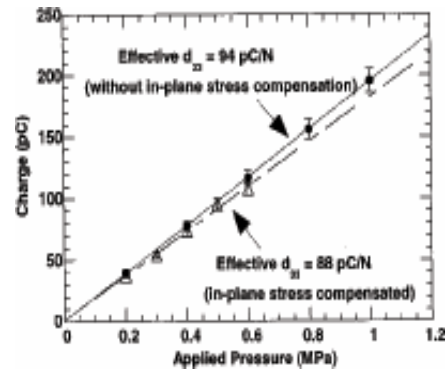
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VOLUMETRIC PIEZOELECTRIC COEFFICIENT (D13/D33) EXPERIMENTAL SET-UP

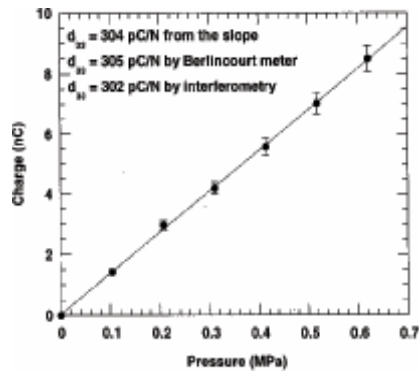
MVCA-Series



Charge induced vs poling level of sample



induced charge vs applied pressure



Charge induce vs applied preesure

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