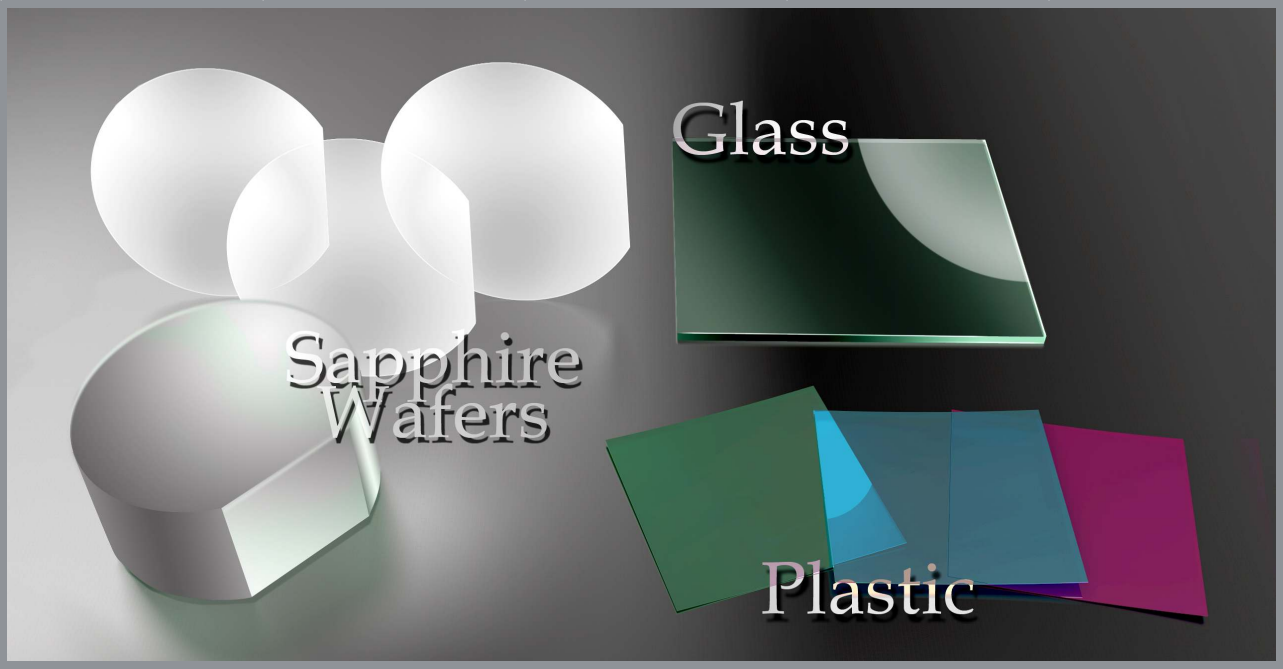
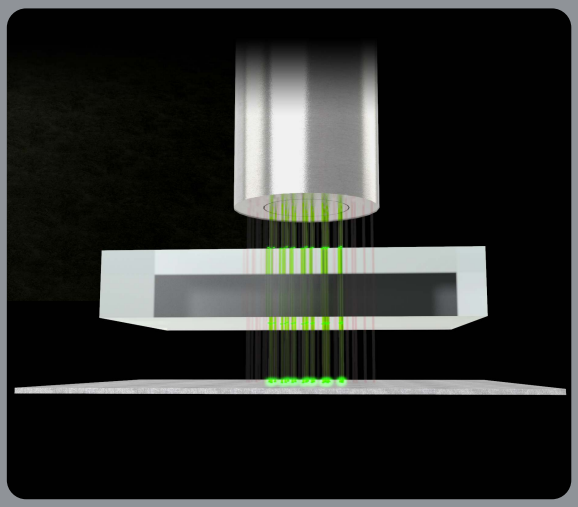
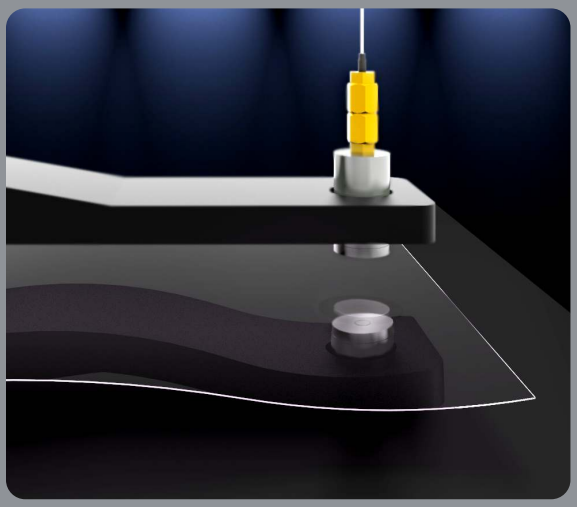
HOW-TO GUIDE

NON-CONTACT THICKNESS MEASUREMENT OF MOST INSULATING MATERIALS



How to achieve accurate thickness measurements of thin, non-conductive materials such as, Glass, Sapphire, Plastic and other Polymers using MTI capacitance amplifiers and capacitance probes.



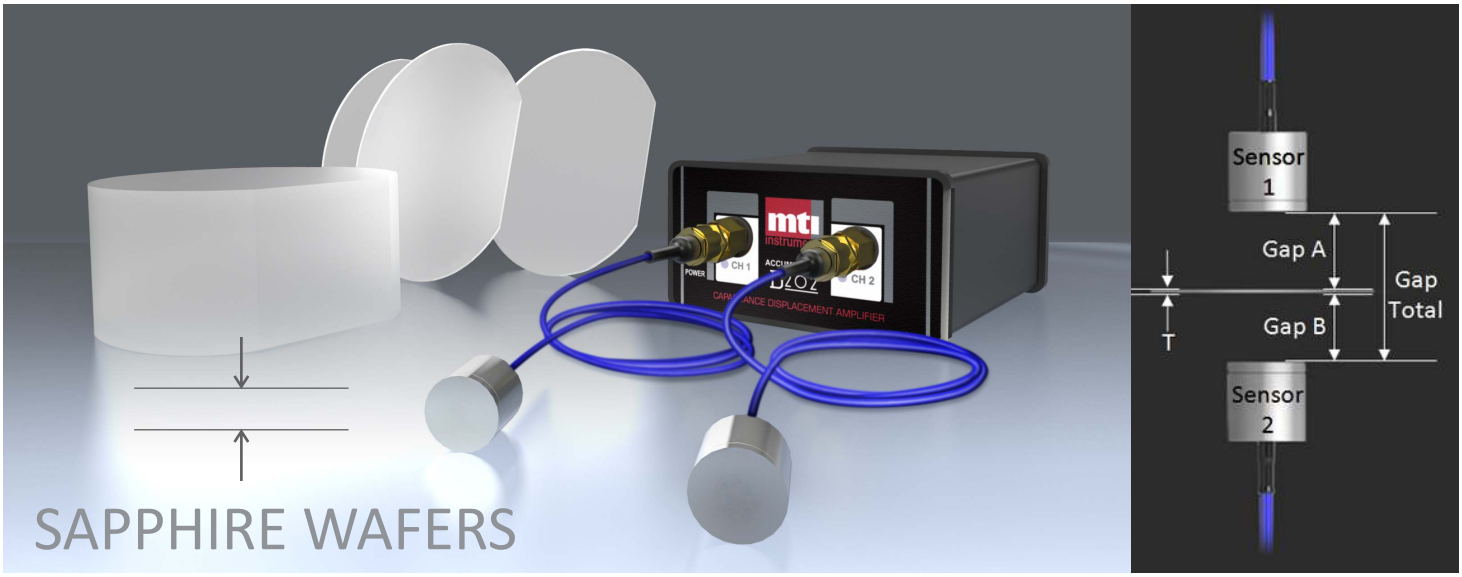


mtiinstruments

A worldwide leader in precision measurement solutions

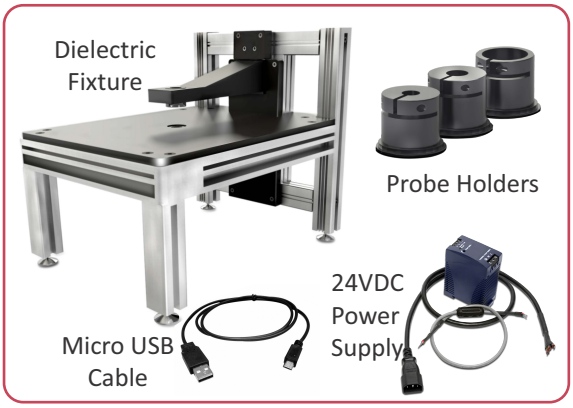
WHAT IS NEEDED for up to 1µm accuracy - Opaque, Translucent or Clear Materials

Forms a complete thickness measuring system. System calibration made easy with built in calibration software. Thickness data can be viewed on a PC or stream data directly to a file.



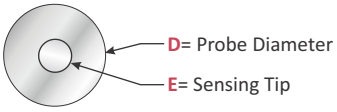
WHAT YOU NEED:

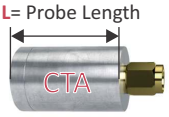
	Unit	Product Model	Product #
OR	1	Digital Accumeasure D202	8000-6234-202
OR	1	Digital Accumeasure D402	8000-6234-402
	1 pair	Dielectric Probes	*Selections Below*
	1	Optional Dielectric Fixture	7500-6811
	1	Optional 24VDC Power Supply	8000-6925
	1	Optional Micro USB Cable	8000-6929

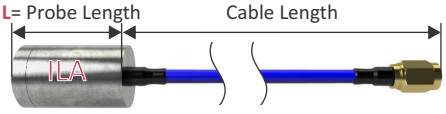


2 same probes (selection below)

PRODUCT MODEL	PRODUCT #	Min. Range to Target at x1 Range		Normal Range at x1		Max Range Extension[1]	E		D		L	
		µm	*mils*	µm	*mils*		mm	*Inch*	mm	*Inch*	mm	*Inch*
ASP-250M-ILA	8100-2013-410	12.5	*0.49*	*250*	9.8	4x	3.53	*0.139*	5.59	*0.220*	11.79	*0.464*
ASP-300M-CTA	8100-0013-000	15	*0.59*	*300*	11.8	4x	3.81	*0.150*	12.00	*0.472*	36.00	*1.4*
ASP-400M-ILA	8100-2012-410	20	*0.78*	*400*	15.7	4x	4.29	*0.169*	13.59	*0.535*	10.84	*0.427*
ASP-2500M-CTA	8100-0009-000	125	*4.9*	*2500*	98.5	3x	11.25	*0.443*	25	*0.984*	63.5	*2.5*
ASP-5000M-CTA	8100-0010-000	250	*9.8*	*5000*	*197*	2x	15.93	*0.627*	38.00	*0.149*	63.50	*2.5*





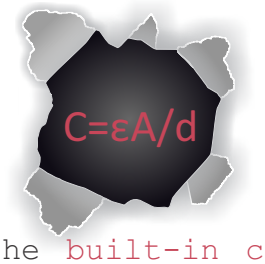


Electronic Range is allowed. Consult your Quick Start Guide included when you purchased any Digital Accumeasure Amplifiers on how to install hardware and how to install and configure the software.

Capacitance sensors are well known for being able to precisely measure thickness and position of conductive targets.

MTI capacitance sensors can also measure the thickness of insulating materials such as sapphire, glass, many plastics and even semi- insulating semiconductors material such as GaAs and silicon nitride with thickness <10mm and uniform dielectric constant.

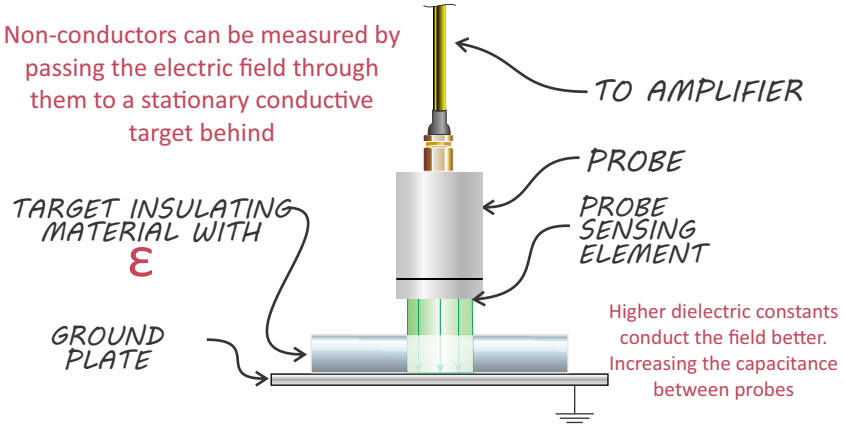
The Digital Accumeasure takes all the guess work out of what used to be a complex measurement.



where

- C is capacitance
- ε is the dielectric constant
- A is the area of the probe sensing element
- d is the gap between the probe and the ground plate or gap between opposing probes

The built-in computing capability can measure and compensate for the probe to plate (or probe to probe) gap and the dielectric constant after performing a simple auto calibration routine with two different samples with two different known thicknesses.



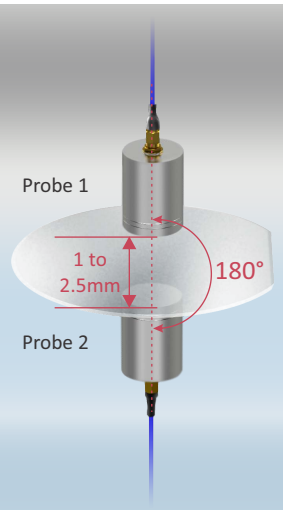
MTI's capacitance probes emit an electric field that passes through the insulating material, and the dielectric constant of the insulating material conducts that field. In order for the capacitive system to measure thickness it must account for different dielectric constants by going through a calibration with the material to be tested. As long as the dielectric constant of the material doesn't change then the calibration will remain consistent.

Dielectric Constant of Common Materials

Material	ε
Acrylic (Plexiglass)	2.7 to 4.5
Acrylonitrile Butadiene Styrene (ABS)	2.87
Acetal resin (Delrin)	3.6
Air	1.000585
Alumina	9.3 to 11.5
Asbestos	3.0 to 4.8
Bakelite	3.5 to 5.0
Beeswax	2.6 to 3.0
Celluloid	3.3 to 11
Epoxy Resin (Cast)	3.6
Formica	3.6 to 6
FR-4	4.3 to 5.0
Mica	5.4
Micarta	3.2 to 5.5
Neoprene	6 to 9
Nylon	4.0 to 5.0
Paper (clean)	3
Paraffin Wax	2.1 to 2.5
Phenol resin	4.9
Polyamide	2.5 to 2.6
Polycarbonate (Lexan®)	2.9 to 3.0
Polyester film (Mylar)	2.8 to 4.5
Polyethylene	2.27to2.5
Polypropylene	2.25
Polystyrene	2.4 to 2.6
Polyvinyl Chloride (PVC)	2.8 to 3.4
Porcelain	5.1 to 6.0
Pyrex Glass	4.3 to 5.0
Quartz	4.2
Rubber Cement	2.7 to 2.9
Silicon	11.0 to 12
Silicone Oil	2.2 to 2.9
Silicone Rubber	3.2 to 9.8
Silk	2.5 to 3.5
Styrene (ABS)	2.8
Teflon (PTFE)	2.1
Teflon (glass weave)	2.2 to 2.8
Water (Distilled)	76.5 to 80
Wax	2.4 to 6.5
Wood, Dry	2 to 6
Wood, Wet	10 to 30

If the target material's dielectric constant is different from previous calibration, recalibrate the system and adjust the slope factor.

MEASUREMENT PRINCIPLES for up to 1µm accuracy - Opaque, Translucent or Clear Materials



MTI Digital Accumeasure amplifier is a multichannel digital capacitance gauge that is capable of measuring thickness of semi-insulating wafers such as high bulk resistivity GaAS.

This also includes measuring the thickness of dielectric material such as Sapphire, glass, SiC and other high bulk resistivity materials that exhibit a uniform dielectric constant.

$$T = \frac{K\,[GapTotal-(GapA + GapB)]}{(1-K)}$$

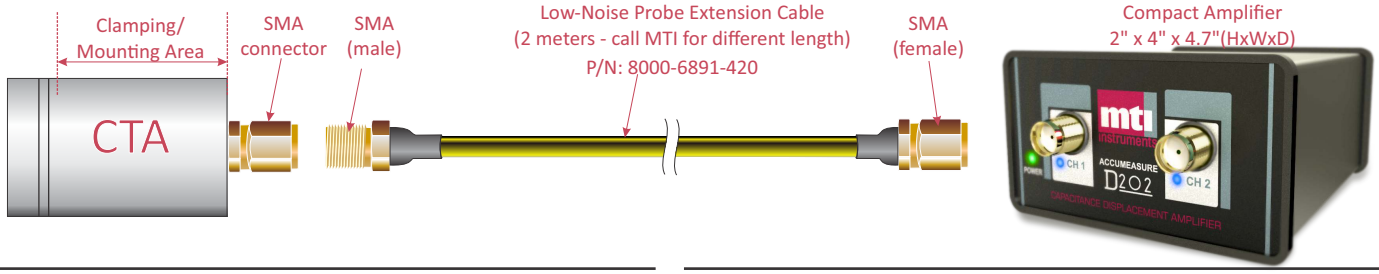
*K= dielectric constant

Placing a dielectric (non-conducting) material between two capacitance probes creates a three capacitor equivalent circuit.

*The greater the dielectric constant the more easily the field passes through the material and the thinner it looks to the probes. This is described by the equation C=εA/d. You can measure the thickness of the insulating material by placing it between two dielectric probes or between a probe and a ground plate that is grounded back at the capacitance amplifier. Using two probes doubles the gap distance and gives some immunity to common mode noise.

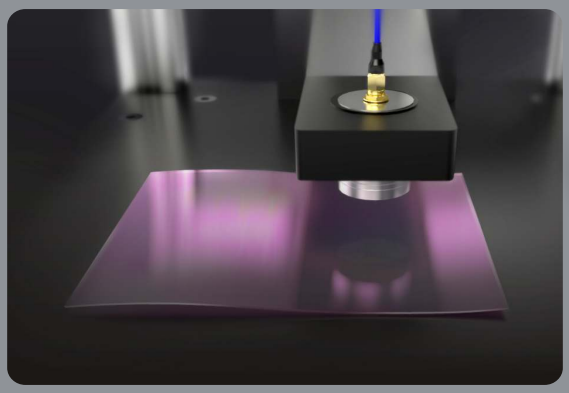
*NOTE: Not recommended for targets that absorb moisture such as paper.

Do not let the insulating material get too close to the probe face. 1/4 gap distance from probe face is recommended.



Target material should NOT be thicker than the probe range *(select probe from previous page)*

- Includes software development kit (SDK), DLL, .NET, C++ and LabView
- Quadrature encoder inputs to synchronize probe position with thickness reading
- Custom probes can be manufactured by MTI for specific applications



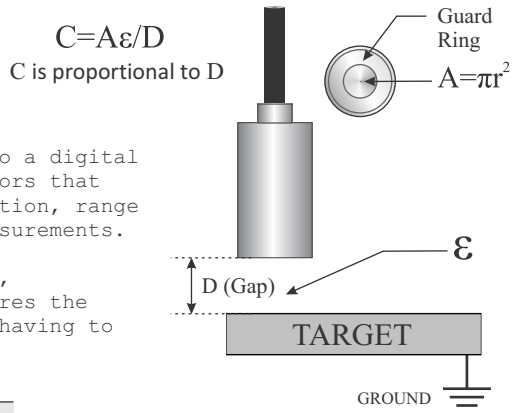
Capable of measuring both displacement and thickness of semiconductor wafers such as silicon, and GaAs.

Do not mount the probes flush with a grounded fixture as it will warp the electric field and introduce some error in the measurement.

Dielectric thickness measurement works best with materials that have good control over their dielectric content. If batch to batch variation exists, recalibrate the probes with two samples of known thickness to teach the system the dielectric constant and probe to gap separation.

The Accumeasure D series amplifier is a true revolutionary design that uses the latest technology to convert a highly reliable capacitive electric field measurement (displacement) directly into a highly precise 24 bit displacement or thickness reading.

Where:
C=Capacitance
ε= Dielectric constant of the gap medium, typically air
D= Gap distance between the probe and grounded target
A= Probe sensing area



Our new capacitance amplifier converts the gap capacitance directly to a digital target gap (distance). This direct conversion approach eliminates errors that traditional analog amplifiers have due to analog filtering, linearization, range extension and the summing of channels to obtain thickness or step measurements.

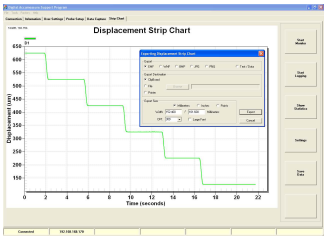
With the Accumeasure D series, filter frequency response, sample rate, linearization and probe range are all digitally controlled. This ensures the most accurate data capture, lossless processing and the freedom from having to purchase additional acquisition hardware.

Measurement Range	0 to 12.5mm[1]
Noise	0.0006% FSR at 50Hz[3]
Repeatability	0.000085% FSR (at a fixed point, 1 Hz bandwith[2])
Minimum System Resolution	0.100 nm[2]
Long Term Stability/Drift	20ppm /month *or better at (±1 ° C)*
Linearity Accuracy	±0.01% FSR[2]
Frequency Response	5kHz
Output Data Rate	100 min. to 20,000 max. (samples per second)
Temperature Stability	100 ppm digital (over 0 to 40°C)
Butterworth Filter	50, 100, 500, 1kHz, or 5kHz
Range Extension	1x and 2x Default. *Up to 10X max. optional (see probe charts for max probe range extension permissable)*
ADC Bit Count	24-bits
Exponential Filter	No Filtering, 0.1 , 1 or 10 Hz
Basic Interface	Command-Response , ASCII commands
Digital Output	Micro USB or RJ-45 Ethernet 10/100/1000
Analog Output Span	0-5V (14 bit resolution), 0-10V(15 bit resolution), -10V to +10V (16 bit resolution), -5V to +5V (15 bit resolution)
Analog Output Impedance	50 Ω, 5kHz, 5 pole Butterworth Low Pass Filter Limited
Encoder input	0-24VDC max, Threshold ~1.2 V, 32 bit, Z input/ reset input
Included Software	MTI Basic Software, LabVIEW, .NET, and DLL Drivers
Operating Temperature	0 – 40°C, 95% non-condensing (designed) 20°C, 100kPa, 50%RH (nominal)
Operating Environment	IP40 *(particles to 1mm/ no water protection)*
Power Requirements	24VDC±1V 50mV ripple, switching speed >60kHz. <8W estimated
Target Ground Return	Integrated with Power Connector
Input Protection	Reverse Polarity (Over Volt to 35VDC)
ESD Protection	±4kV Contact and ±8kV Air
Case Dimensions	2" (53mm) H *x* 4" (103mm) W *x* 4.7" (120mm) D
Case Mount	DIN Mount Kit
Probe Connectors	SMA Female

[1]Measurement range is determined by probe selected and amplifier gain (Range Extension)
[2]actual resolution is a function of measurement range and frequency response
please refer to probe brochures for specifications
[3]0.00000180 x Frequency Response √Hz x FSR

Basic Measurement Software

(Includes DLL, .NET and NI LabVIEW™ Driver)



Easy user interface allows exporting data to image files or Excel® CSV files or data logging for data analysis and reports. The user settings tab allows adjustment of range, filter, data rate and other items.

Optional Accessories

Description	Product Number
Special Low Noise Probe Extension Cables - SMA male to SMA female	
1 meter	8000-6891-410
2 meters	8000-6891-420
4 meters	8000-6891-440
24 VDC Power Supply	8000-6925
KD-CH-4D Calibration Fixture	8000-6952
Ethernet Cable (2.1 meters)	8000-6887
USB-A to Micro USB-B (1 meter)	8000-6929
DIN rail (to mount amplifier)	8000-6882

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