Stretching the limits of materials testing

1296

Dielectric Interface

Analyzing low conductivity, low loss materials stretches the capabilities of even the best frequency response analyzers (FRAs). Used alone, they lack the sensitivity required for accurate measurements, especially at low frequencies.

The 1296 Dielectric Interface overcomes these limitations to give you fast, accurate and repeatable impedance measurements over 12 decades of frequency, yielding valuable insights into the characteristics of a wide range of materials, including polymers, rubber, wood, adhesives, electronic components, waxes and oils, etc. Coupled with easy-to-use software, a 1296-based system takes care of experimental technique and lets you concentrate on interpreting the results.

1296 enhances the capabilities of Solartron Analytical's renowned 1260 and 1255 FRAs to cope with ultra-low current and capacitance levels experienced in testing dielectric materials, enabling:-

- Impedance measurements to exceed 100TΩ ($10^{14}\Omega$)
- Accurate tan delta measurements down to $<10^{4}$
- Frequency range from 10μHz up to 10MHz
- ac signal and dc bias voltages up to 1000V (with external psu or amplifier)

revealing essential data in areas previously inaccessible.

Highly accurate reference capacitors are built in to 1296, or you can choose to use an external reference, offering unrivalled flexibility to meet almost every measurement need. Support for temperature and dc controllers is integral to the measurement software, further increasing the scope for materials analysis.

Defining Dielectrics

Many materials have the properties of low conductance (high impedance) and low loss. They are often referred to as dielectrics, although many materials not normally considered as dielectrics exhibit these properties.

One popular technique for analyzing such materials is Impedance Spectroscopy - measuring the electrical impedance over a range of frequencies. The impedance is related to the conductivity and capacitance of the material, and these parameters can in turn be related to the molecular activity of the material.

When an alternating voltage is applied to a dielectric sample, some energy is stored by the capacitance, and some is dissipated by the resistance effects. The resulting current in the sample will exhibit a phase lag, δ. In materials research, the capacitance effect is known as the permittivity (or dielectric constant) ε', and the resistive effect as dielectric loss, ε''. Tan δ, the dissipation factor equals $\varepsilon''/\varepsilon'$.

In materials where ε'' is very small and ε' large, the resolution of tan δ becomes critical if an accurate measurement is to be made. The 1296 overcomes this by taking a reference measurement on a precision capacitor which is automatically substituted for the sample; a second measurement is made, this time on the sample itself. The two results are used to derive a very accurate estimate of the permittivity of the material - in effect, the first measurement is used to eliminate the effects of extraneous capacitance.

Temperature Options

- Cryostat System covering 77K to 500K, complete with solid and liquid sample holder for testing polymers, rubber, pharmaceuticals etc.
- Furnace system covering 400-1000ºC, complete with sample holder for testing ceramics, composites, glasses etc.
- Room temperature sample holder for solids and liquids

1296 Dielectric Interface Specification

	1296+1260/1255	1296+1250	1296+1253
Frequency Range	10µHz to 10MHz	10µHz to 65kHz	1mHz to 20kHz
Signal Amplitude	up to 7Vrms*	up to 10Vrms	up to 10Vrms
DC Bias	up to ±40V	up to ±10V	up to ±10V

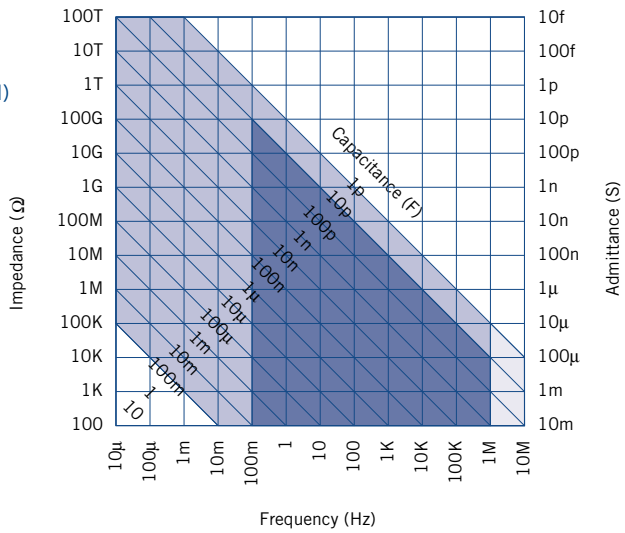
*For signals >3Vrms, an internal amplifier is used, and signal amplitude + dc bias must not exceed 10V peak

Current measurement	1fA to 100mA
Tan delta range	$<10^{-4}$ to 10^{3} (reference mode)
Impedance range	100Ω to >100TΩ (10^{14}Ω)
Capacitance range	1pF to >0.1F

Typical accuracy (reference mode)

Capacitance (real)

<0.2%
<2%
<5%



Software	Provides control of FRA, 1296 and optional temperature controller, dc bias and ac signal amplifiers
Result parameters	Z*, Y*, ε*, C* (real, imaginary, magnitude, phase, tan δ)
plotted vs	frequency, time, temperature, bias, ac level
on	Bode, complex plane
Power supply	85Vac to 264Vac (47 to 440Hz)
Power consumption	30VA max.
Dimensions (w x h x d)	340mm x 120mm x 300mm (13.39in x 4.72in x 11.81in)
Weight	5.5kg (12.13lb)
Operating temp. range	10 to 30ºC (50 to 80ºF)

Applications

The range of applications for a 1296 system is huge, and includes the investigation of:-

- Relaxation processes in the molecular dynamics of liquid crystals, polymers and liquids
- Charge transport in semiconductors, organic crystals, ceramics etc.
- Analysis of chemical reactions, polymerization and curing processes
- Non-linear electrical and optical effects
- Novel gas and liquid sensors
- Characterization of insulating and semiconductor materials
- Quality control in the production of insulators, printed circuit boards, etc.
- Fuel cell/battery materials

Solartron Analytical is a world leader in instrumentation and software for the characterization of materials and electrochemical systems using precision electrical measurement techniques.

These techniques find particular use in the fields of corrosion, battery and fuel cell research, dielectric analysis and electrochemistry. The product portfolio includes industry standard frequency response analyzers, potentiostats, electrochemical software (Zplot and CorrWare) and battery test equipment.

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Solartron Analytical's Quality System is approved to BS EN ISO 9001:2008

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