

1287

Electrochemical Interface

The Solartron Analytical 1287 Electrochemical interface is a high accuracy, wide bandwidth potentiostat/galvanostat which offers a full range of ac/dc test capabilities; when coupled with a frequency response analyzer.

Measurement Integrity

Central to the measurement capability of 1287 are two high resolution digital voltmeters which provide simultaneous voltage and current measurements. Using Solartron Analytical's patented pulse width conversion technique, they have high accuracy, stability and linearity throughout the entire range of the instrument.

The 1287 has excellent measurement resolution and accuracy down to $1\mu\text{V}$ for the reference electrodes and 1pA for the working electrode, which makes it an ideal choice for measurements where signal levels are extremely low.

The 1287 uses floating measurements on all connections: it is equally at home measuring corrosion rates on grounded oil pipelines as it is in the laboratory. For safety reasons, it is often necessary to ground laboratory equipment such as autoclaves, a major problem if your instrumentation is not capable of floating measurements.

The 1287 offers complete flexibility for cell connection: 2-, 3- or 4-terminal measurements can be made with equal ease.

- 2-terminal techniques for general materials/electrochemical testing
- 3-terminal techniques for corrosion/coating applications
- 4-terminal techniques for accurate characterization of batteries/fuelcells, enabling lead resistance and impedance effects to be minimised

Impedance

Electrochemical Impedance Spectroscopy (EIS) is widely used to enhance the information about reaction mechanisms available from dc techniques. Designed with impedance testing very much in mind, the 1287's performance is unsurpassed; no other electrochemical interface matches the flatness and linearity of its frequency response.

Solartron Analytical FRAs use a single sine correlation algorithm which offers excellent noise and harmonic rejection. The technique is particularly powerful for electrochemical applications since signal levels are usually very low (of the order of millivolts), and are inevitably buried in noise. With the 1287/1260 combination it is possible to characterize cells with a very wide range of impedances.

When making high frequency impedance measurements, Solartron Analytical's driven shield technology minimizes the unwanted effects of cable impedance enabling 1287 to be used over a full $10\mu\text{Hz}$ to 1MHz frequency range.

1287 was designed to carry out both dc tests and ac impedance tests: an externally generated waveform from a frequency response analyzer or spectrum analyzer can be added to the polarization signal.

Electrochemistry Software

CorrWare and ZPlot packages are specifically designed to run a wide range of electrochemical tests including:

- Impedance
- Potentiostatic/galvanostatic techniques
- Cyclic voltammetry

CorrWare and ZPlot are an ideal tool for corrosion analysis, battery/fuel cell research, and general electrochemistry. The software provides, real-time analysis, multiple display formats and curve fitting routines.



1287 Electrochemical Interface Specification

Measurement Configuration

Cell connections	2-, 3- or 4-terminal, all floating
Working electrode	current measurement resistor (R_s) range: 0.1 Ω to 1M Ω full scale current ranges: 2A to 200nA limit of error: 0.1% \pm 0.05% of range
Counter electrode	output voltage, wrt LO: $>\pm 30V$ current, subject to thermal protection limits: 2A slew rate, potentiostatic control: $>10V/\mu s$
Reference electrodes	input impedance: $>10G\Omega$, capacitance: 50pF current: $<1nA$ limit of error: 0.1% \pm 100 μV rejection: $f < 10kHz$: 75dB, $f < 1MHz$: 40dB

Measurement Configuration

dc polarization	voltage range: $\pm 14.5V$ limits of error: $V < 3.2V$: 0.2% \pm 200 μV $V > 3.2V$: 0.2% \pm 2mV max. resolution: 100 μV Current range: $\pm 2A$ limit of error: 0.2% \pm 0.1% of range max. resolution: 100pA
dc sweep: analog ramp	ramp rate (voltage): 6mV/min to 6000V/min segment duration: 10ms to 10 ^s
dc sweep: stepped ramp	step height: 5 μV /5pA to 29V/4A step duration: 10ms to 10 ^s
ac input	voltage range: $\pm 10V$, gain: $\times 1$, $\times 0.01$, impedance: 10k Ω
Control loop Bandwidth,	100 Ω resistive load, unity gain potentiostatic mode, type C stability: $>1MHz$ galvanostatic mode, type B stability: $>100kHz$

Digital meters

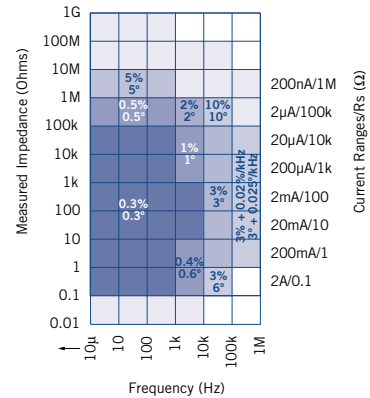
Resolution	3 ^{1/2} , 4 ^{1/2} , 5 ^{1/2} digits
Maximum resolution	1 μV /1pA

Bias Rejection

Voltage	range: $\pm 14.5V$ limit of error: 0.2% \pm 10mV resolution: 5mV
Current	ranges (full scale): 200nA to 2A limit of error: 0.2% \pm 1% of range resolution: 1% of range
Power supply	90 to 110V, 108 to 132V, 198 to 242V, 216 to 264V, 48Hz to 65Hz
Power consumption	150VA
Dimensions (w x h x d)	432mm x 108mm x 472mm (17in x 4.25in x 18.5in)
Weight	11kg (24lb)
Operating temp. range	0 to 50 $^{\circ}C$ (32 to 122 $^{\circ}F$)

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Impedance Measurement Limits of error (for a unity gain cell $Z_C=R_s$, measured with LO grounded) and no error due to reference electrode bandwidth. RE1 and RE2 input capacitance must be corrected to obtain accuracy at high frequency and impedance.



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.



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



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1255B

LF Frequency Response Analyzer

The 1255B Frequency Response Analyzer is one of a range of instruments that will meet your needs today and in the future.

Using the single sine technique the 1255B provides precise measurement of gain and phase between any two points in a system. This fully digital technique is used to assess the performance of both simple and complex systems - mechanical, electronic and electrochemical.

For over 30 years Solartron Analytical have produced frequency response analyzers, instruments which are regarded throughout the world as industry standards. This unsurpassed knowledge and experience has been used to produce the 1255B, with its outstanding 1MHz frequency range and 1 in 65 million frequency resolution.

The 1255B Frequency Response Analyzer applies the power and sophistication of modern measurement technology; simple in concept, fast and precise in performance, and so easy to use, even by non-technical personnel.

The 1255B Frequency Response Analyzer's key features include:-

- Measures gain, phase and group delay
- Unbeatable accuracy - 0.2%, 0.02dB, 0.2°
- Deep dynamic range - 130 dB with autoranging
- Wide frequency range - 10µHz to 1MHz
- Ultrafine frequency resolution up to 1 in 65 million
- Automatic sweeps of frequency, amplitude or dc bias
- Automatic rejection of noise and harmonics
- Blind front panel software control only

Electrochemistry

Measurement of impedance has become an important tool in the study of electrochemical/biological phenomena and material properties. The 1255B together with a potentiostat such as 1287, can be used in a wide range of applications, including:-

- Corrosion and corrosion protection
- Properties of organic and inorganic coatings and films
- Development of solid electrolytes for oxygen sensors
- Development of novel anode/cathode materials and electrolytes
- Studies of animal and plant tissue properties
- Photoelectric effects

Materials Testing

When combined with a 1296 Dielectric Interface and temperature test equipment the 1255B can be used to test a wide range of materials, such as:-

- Supercapacitor/fuelcell electrochemistry
- 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
- Novel gas and liquid sensors
- Characterization of insulating and semiconductor materials
- Quality control in the production of insulators, printed circuit boards, etc.

Electronic Testing

1255B is ideally suited to a wide variety of applications in the field of electronics - from fundamental aspects, such as the characterization of the electrical and mechanical properties of materials, to the development and testing of components and complete circuits.

Generally these applications require the measurement of transfer functions and group delay over a wide frequency range. In the case of filters, a wide dynamic range coupled with high frequency resolution are also needed to enable the attenuation characteristics to be fully defined.



1255B LF Frequency Response Analyzer Specification

Generator

Waveform	Sine
Frequency	range: 10 μ Hz to 1MHz, max resolution: 10 μ Hz error: \pm 100ppm, stability (24hrs, \pm 1 $^{\circ}$ C): 10ppm
Amplitude	\leq 10MHz: 0 to 3V rms, >10MHz: 0 to 1V rms
Resolution	5mV
Error	
(driving open circuit)	\pm (5% + 1% / MHz + 5mV)
Distortion	<2%
Sweep types	frequency (logarithmic and linear), amplitude (linear) dc bias (linear)
Resolution	frequency: >10000points, amplitude: >200points

dc Bias

Range	-40.95V to +40.95V
Resolution	10mV
Error	
(driving open circuit)	\pm 1% \pm 10mV
Max. Current	\pm 100mA
Max. Voltage	
(lo to ground)	\pm 0.4V
Impedance	output: 50 Ω \pm 1%, lo to ground: 100 Ω , <10nf
Connection	single BNC, outer floating to \pm 0.4V
Output is short circuit proof	

Analyzers

Two independent analyzers operating in parallel.

Range	Sensitivity (dynamic range)	Full scale peak input	Com. Mode rejected
30mV	1 μ V (90dB)	45mV	5V
300mV	10 μ V (90dB)	500mV	5V
3V	100 μ V (90dB)	5V	5V

Input protected to	\pm 46V peak
Coupling	dc or ac (-3dB at 1Hz)
Impedance	Hi to outer: 1M Ω \pm 2%, <35pF Outer to ground (floating): 10k Ω , <330pF
Common mode rejection (at 1MHz)	>50dB
Cross-channel isolation (at 1MHz)	>100dB
Integration time	0.01s to 10 ^s , or auto
Measurement delay	0 to 10 ^s

This is a remotely controlled instrument which can only be configured via software

Power supply	90 to 126V, 198 to 252V, ac, 48 to 65Hz
Consumption	200VA
Dimensions (w x h x d)	432mm x 176mm x 573mm (17in x 6.93in x 22.56in)
Weight	18kg (40lbs)
Operating temp. range	0 to 50 $^{\circ}$ C (32 to 122 $^{\circ}$ F)

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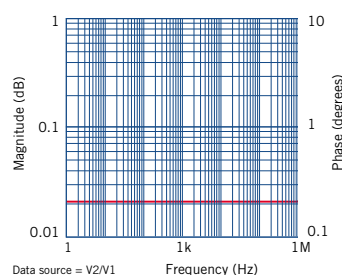
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Gain-Phase measurements

Applies to all ranges at >10% full scale



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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.

Stretching the limits of impedance testing



1260

Impedance/gain-phase Analyzer

The 1260 Impedance/gain-phase Analyzer is - without doubt - the most powerful, accurate and flexible Frequency Response Analyzer available today.

In daily use by leading researchers wherever measurement integrity and experimental reliability are of paramount importance, 1260's solid reputation is frequently endorsed in published research papers in fields such as:-

- Corrosion studies
- Battery research and fuel cells
- Solar cells
- LCDs
- Bio-materials
- Ceramics / composites
- Electronic component development
- Civil engineering

Part of Solartron Analytical's extensive range of precision products designed to provide cost effective solutions for dc and ac analysis in electrochemical and materials research, 1260 offers an outstanding measurement specification for impedance spectroscopy:

Huge frequency range

Spanning 10 μ Hz to 32MHz with 0.015ppm resolution, 1260 provides excellent coverage for virtually all chemical and molecular mechanisms - all in a single instrument.

Unbeatable accuracy

With an accuracy of 0.1%, 0.1 $^\circ$, measurements can be made with complete confidence, and even the most subtle changes in sample behavior detected and quantized.

Noise free analysis

1260 uses Solartron Analytical's patented single-sine correlation technique, which inherently removes the noise and harmonic distortion which plagues lesser instruments.

- Frequency resolution: 1 in 65 million (0.015ppm)
- 0.1%, 0.1 $^\circ$ accuracy - unsurpassed by any similar instrument
- Resolution to 0.001dB, 0.01 $^\circ$ - capturing every detail
- Measures impedances >100M Ω
- 2-, 3- and 4-terminal measurement configurations
- Polarization voltage up to \pm 40.95V
- Renowned ZPlot software package simplifies experiments and optimises throughput

Systems

When combined with other products from Solartron Analytical's range, including well-proven application software, 1260 can form the heart of an advanced electrochemical and materials measurement system, to provide superb accuracy, flexibility and reliability - even for the most complex research problems.

Impedance measurement

Virtually every liquid and solid is able to pass current when a voltage is applied to it. If a variable (ac) voltage is applied to the material, the ratio of voltage to current is known as the impedance. The measured impedance varies with the frequency of the applied voltage in a way that is related to the properties of the liquid or solid. This may be due to the physical structure of the material, to chemical processes within it or a combination of both.

The advantages of impedance measurement over other techniques include:-

- Rapid acquisition of data
- Accurate, repeatable measurements
- Non-destructive
- Highly adaptable to a wide variety of different applications.
- Ability to differentiate effects due to electrodes, diffusion, mass/charge transfer by analysis over different frequency ranges
- Equivalent circuit/modelling techniques for detailed analysis of results



1260 Impedance/gain-phase Analyzer Specification

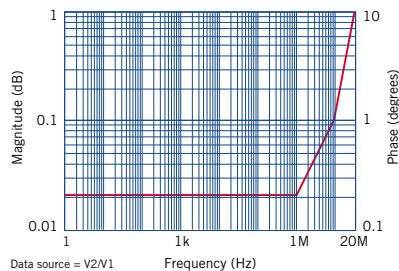
Generator	Voltage mode	Current mode
ac Amplitude $\leq 10\text{MHz}$ $>10\text{MHz}$	0 to 3V rms 0 to 1V rms	0 to 60mA rms 0 to 20mA rms
Maximum ac resolution	5mV	100 μA
dc bias range	$\pm 40.95\text{V}$	$\pm 100\text{mA}$
Maximum dc resolution	10mV	200 μA
Output impedance	50 $\Omega \pm 1\%$	$>200\text{k}\Omega$ at $<1\text{kHz}$
Frequency	range: 10 μHz to 32MHz, max resolution: 10 μHz error: $\pm 100\text{ppm}$, stability, 24hrs $\pm 1^\circ\text{C}$: $\pm 10\text{ppm}$	
Sweep types	frequency (log or lin), ac/dc voltage, ac/dc current	
Maximum voltage	hi to lo: $\pm 46\text{V}$ peak, lo to ground: $\pm 0.4\text{V}$ peak	
Maximum current	$\pm 100\text{mA}$ peak	
Impedance	lo to ground: 100k Ω , $<10\text{nF}$	
Connection	single BNC, floating shield	
Output disable	contact closure or TTL logic 0	
Input System	Voltage (2x)	Current
3 independent analyzers operating in parallel		
Ranges	30mV, 300mV, 3V	6 μA , 60 μA , 600 μA , 6mA, 60mA
Maximum resolution	1 μV	200pA
Full scale peak	$\pm 5\text{V}$	$\pm 100\text{mA}$
Inputs protected to	$\pm 46\text{V}$	$\pm 250\text{mA}$
Connections	single/differential BNC	single BNC
Shields	floating/grounded	-
Coupling	dc or ac (-3dB at 1Hz)	dc or ac (-3dB at Hz)
Input impedance		
Hi to shield	1Mohm, $<35\text{pF}$	$\geq 600\mu\text{A}$ range, 1 Ω
Shield to ground	10kohm, 330pF	$<600\mu\text{A}$ range, 50 Ω
Limits of error	Ambient temperature $20 \pm 10^\circ\text{C}$, integration time $>200\text{ms}$. Data valid for one year after calibration.	

Results

Variable	frequency, ac amplitude, dc bias
Measured parameters	voltage gain, phase, real, imaginary, Z, R, X, Y, G, B, V, I group delay, C, L, Q, D
Power supply	90 to 126V, 198 to 252V, 48 to 65Hz
Power consumption	230VA
Dimensions (w x h x d)	432mm x 176mm x 573mm (17in x 6.93in x 22.56in)
Weight	18kg (40lbs)
Operating temp. range	0 to 50 $^\circ\text{C}$ (32 to 122 $^\circ\text{F}$)

Limit of error

Gain-phase measurements
Applies to all ranges at $>10\%$ full scale



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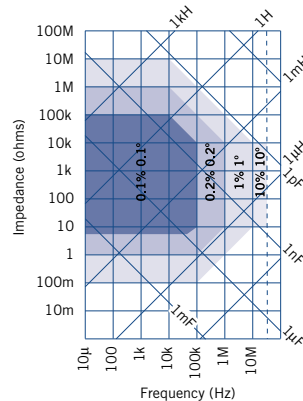
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Impedance Measurements

Applies for stimulation level of 1V for impedances $>50\Omega$ or 20mA for impedances $<50\Omega$



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