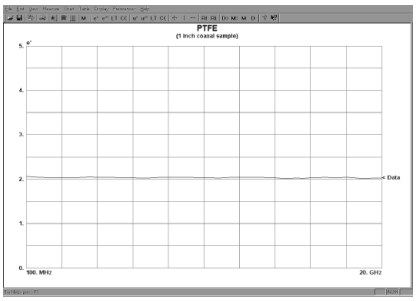
product overview

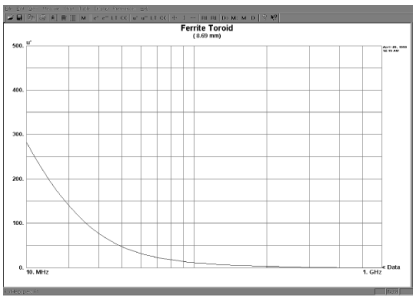
HEWLETT® PACKARD

HP 85071C Materials Measurement Software

Measure ε_r* and μ_r* over a wide frequency range

The HP 85071C materials measurement software determines the intrinsic electromagnetic properties of many dielectric and magnetic materials. The complete system is based on a versatile network analyzer which measures the material's response to RF or microwave energy.





Examine the properties of materials across the RF and microwave frequency spectrum.

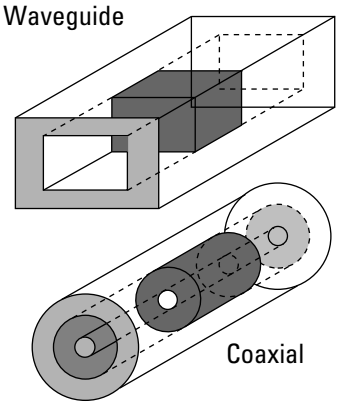
Small samples of the material under test (MUT) are machined to fill the cross section of coaxial or waveguide transmission lines and measured within the fixture. Or large, flat samples are placed between antennas and measured under free space conditions.

The HP 85071C software controls the network analyzer and calculates the complex permittivity ε_r* (or dielectric constant) and permeability μ_r*, including the loss factor or loss tangent. Results are displayed as a function of frequency, with 1 to 2% accuracy (typical). Depending on the HP network analyzer and fixture used, measurement frequencies can extend to 110 GHz.

The HP 85071C software requires a PC running Windows® 95, 98 or NT 4.0.

New features of HP 85071C

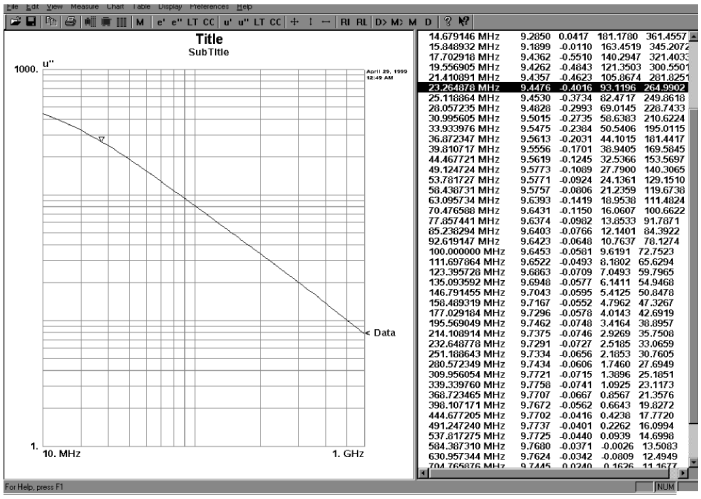
- Compatible with Windows 95, 98, or NT 4.0
- Compatible with HP economy network analyzers, HP 8712ET/ES, 8714ET/ES
- Addition of markers
- Split screen view showing simul taneous plot and listing of data
- Ability to copy/paste measure ment data to other applications in plot or list format
- Support of additional IEEE-488 interface cards: HP 82340, 82341, 82350
- On-line manual



Simple coaxial or waveguide transmission lines hold the samples of material under test.

Measurement attributes

- Nicolson-Ross model provides sample position invariance.
- One-port arbitrary backed model measures thin samples accurately.
- Air gap correction improves the accuracy of transmission line methods.
- Compatibility with free space measurements.



Split screen window and marker aids in data analysis. Simply click on a point on the chart or list to activate the marker.

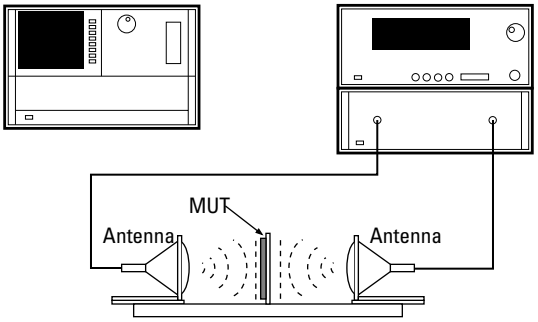
Transmission line method

Coaxial airlines or rectangular waveguide transmission lines can be used as sample holders. Solid samples that can be precisely machined to fit inside the fixture give the best results.

The HP 85071C features an algorithm that corrects for the effects of air gap between the sample and fixture, which can be the largest source of error with a transmission line technique.

Free space method

Large, flat samples of materials can be placed between antennas to measure their properties in a non-contacting fashion. Because the sample is not contained in a fixture, the error from air gap is not a concern. Free space is best when measuring materials that must be heated to very high temperatures or when measuring a large area of a material which is non-uniform (i.e., honeycomb, composite). A TRL or TRM (Thru-Reflect-Line or Match) calibration is ideal under free space conditions with a full S-parameter test set configuration. Time domain gating can also be used to remove mismatch effects.



Antennas direct beams of microwave energy at or through a material, without enclosing it in a fixture.

Wide range of models

The HP 85071C has five different algorithms to choose from, each with specific benefits:

The traditional method has been described by Nicolson-Ross, Weir and HP product note 8510-3. It is best for magnetic materials such as ferrites and absorbers. It calculates both ε_r* and μ_r*, including loss, from a two-port measurement of a single sample. You get results quickly and easily.

The HP 85071C also includes two other two-port algorithms for non-magnetic materials (μr*=1). These models do not suffer from discontinuities at frequencies where the sample length is a multiple of half-wavelengths. These models are used to measure long, low-loss materials with greater accuracy.

While the two-port algorithms are best for most solid materials, one-port algorithms provide a simple calibration and measurement and are better suited to measurements of liquids and powders. A shorted waveguide can be turned on end and filled with a material. One-port fixtures are also better suited for high-temperature measurements where one end of the fixture can be heated, while cooling mechanisms at the other end protect the network analyzer.

Although one-port fixtures are usually terminated with a short circuit, the HP 85071C also accommodates an arbitrary termination which produces more reliable results for thin samples.

Performance characteristics

Specifications describe the warranted performance over the temperature range 0° to 55°C. **Supplemental characteristics** are intended to provide information useful in applying the instrument, by giving typical but non-warranted performance parameters. These are denoted as "typical," "nominal," or "approximate."

Frequency range (typical)
100 MHz to 110 GHz depending on network analyzer, fixture and material.[1]
Accuracy (typical)
1 to 2%
Transmission line fixtures
Coaxial fixtures (beadless airlines) are broadband but require a sample shaped into a flat-faced torus. Waveguide fixtures are band-limited but operate at higher frequencies and accept a simpler rectangular shape.

Samples must completely fill the cross section of the transmission line without gaps at the fixture walls. Faces at either end must be flat, smooth and perpendicular to the long axis.
Free space systems
Large, flat, thin, parallel-faced samples are placed between antennas and measured under free space conditions. Antennas should maintain a planar "far-field" wavefront to the sample[2].
Material under test assumptions
Material is homogeneous (uniform composition) with no layers[3]. Non-isotropic (uniform orientation) materials can be measured in waveguide.

Software Menu Items

File
Save or recall measurement setups or previous measurement results. Print copies of the measurement results in a tabular or graphical format.
Edit
Copy the measurement results to the clipboard. Either graph or the tabular listing can be copied. This allows your measurements results to be pasted into other application.
View
Select what you want to view. Selections include the toolbar, status bar, table of the measurement data and chart of the measurement data.
Measure
Trigger a measurement; recalculate without re-measuring the MUT; set measurement model, define sample holder and set measurement attributes.
Chart
Select the format to be displayed on the chart. Choices include ε_r', ε_r'', tan δ , u_r', u_r'', tan δ_m and Cole-Cole. Set scale factors or "autoscale". Select from linear, semi-log or log-log representations.
Table
Choose between a tabular formatting of real and imaginary or real and tan δ.
Display
Display current measurement data; save/display up to 3 memory traces; compaire data to reference trace with trace math. Turn the marker on or off.
Preferences
Select your preferences of fonts, colors and annotations used to plot and list the measurement data.
Help
On line help including the product manual.
ToolBar
Provides single click access to the most important menu items.

1. Minimum frequency is set by the maximum practical sample length (L): f (in GHz) $> \frac{1}{\sqrt{\varepsilon_r' \mu_r'}} \frac{30\text{ cm}}{\text{L (in cm)}} \frac{20}{360}$
2. Antenna should be placed $\approx 2d^2/\lambda$ from the sample, where d is the larger of the antenna or sample diameter.
3. If the material is not homogeneous through the length of the sample (i.e., layers), the reflection from the front (S_{11}) and back (S_{22}) face will be different and will lead to a potentially erroneous result. If the material is not homogeneous across the face of the sample, the result is an average value over the cross section that is exposed to the EM field (weighted by the intensity).

Software models

Model Name	Measured S-parameters	Number of Samples	Optimum Sample Thickness[1]	Results	Comments
Refl/Tran μ **&** ε (Nicolson-Ross)	S_{11}, S_{21}, S_{12}, S_{22} (or S_{11}, S_{21})	1	$\lambda_g/4$	ε_r* & μ_r*	Fast, but has nλ/2 discontinuities. Best for magnetic, short or lossy MUTs.
Refl/Tran ε (NIST Precision)	S_{11}, S_{21}, S_{12}, S_{22}	1	$n\lambda_g/2$	ε_r*	Accurate, no discontinuities. Best for long, low-loss MUTs.
Refl/Tran ε (Fast)	S_{11}, S_{21}, S_{12}, S_{22} (or S_{11}, S_{21})	1	$n\lambda_g/2$	ε_r*	Similar to precision but faster and better for lossy MUTs. Best for long, low-loss MUTs.
Refl ε (Short-backed)	S_{11}	1	$\lambda_g/2$	ε_r*	Best for liquids or powders.
Refl ε (Arbitrary-backed)	S_{11}	1	$\lambda_g/2$	ε_r*	Best for thin films.
Refl μ_r **&** ε_r (Single/Double)	S_{11}	1[2]	$\lambda_g/4$[3]	ε_r*and μ_r*	Best for liquids or powders.

1. Where: $\lg = \dfrac{1}{\sqrt{\dfrac{\varepsilon_r'\mu_r'}{\lambda_o} - \dfrac{1}{\lambda_c}}}$ λ_c = cutoff frequency (omit for coaxial) and λ_o (in cm) $= \dfrac{30}{\text{frequency (in GHz)}}$
2. This model requires two measurements of one sample in different positions backed by a short, or two samples backed by a short, each measured once.
3. $\lambda_g/2$ for lower loss materials.

Ordering information

HP 85071C Materials measurement software
Windows 95, 98 or NT 4.0 compatible software, supplied on CD-ROM.
Not included, but required is a computer, network analyzer and fixtures or antennas to complete the system.

Option 071 Upgrade any HP 85071 to Windows 95, 98 or NT 4.0 HP 85071C.
Upgrade from any version of HP 85071 software.

Option 300 Substitutes HP 85071B HP Basic software.
This option is EXACTLY THE SAME as HP 85071B Option 300.
This option supplies the software in HP Basic language (revision 1.05), instead of Windows.

Option 371 HP Basic software upgrade to HP 85071B
This option is EXACTLY THE SAME as HP 85079B Option 371.
This option upgrades the HP Basic software to the latest revision available in HP Basic (revision 1.05).

Note on HP Basic version of software:

We will continue to offer the software in the HP Basic language, as Option 300, or Option 371. However, the HP Basic software does not have the full functionality of the new Windows version. Furthermore, the HP Basic software was not upgraded from the B to the C models. So even though you may order HP 85071C Option 300 or 371, you will receive HP 85071B software.

The difference between Options 300 and 371:

Option 300 supplies the software in HP Basic language.
Option 371 upgrades the previous HP Basic revision to the latest HP BASIC revision.

Compatible network analyzers

HP 8752A/C	300 kHz to 1.3 or 3 GHz
HP 8753A/B/C/D/E	30 kHz to 3 or 6 GHz
HP 8719A/C/D	50 or 130 MHz to 13.5 GHz
HP 8720A/B/C/D	50 or 130 MHz to 20 GHz
HP 8722A/C/D	50 MHz to 40 GHz
HP 8712B/C	300 kHz to 1.3 GHz
HP 8714B/C	300 kHz to 3 GHz
HP 8712ET/ES	300 kHz to 1.3 GHz
HP 8714ET/ES	300 kHz to 3 GHz
HP 8510B/C	45 MHz to 110 GHz

PC requirements

Windows 95, 98 or NT 4.0 or higher
Compatible IEEE-488 interface cards:
HP 82335, 82340, 82341, 82350,
National Instrument Cards,
CD-Rom drive

Transmission line fixtures and accessories

Waveguide airlines
HP 11644A series waveguide calibration kits contain a 1/4 wavelength line and a straight section which can also be used as sample holders. Contact HP for information on third party suppliers of other waveguide transmission lines.

Coaxial airlines
HP 8505X series coaxial verification kits contain airlines that can also be used as sample holders. Contact HP for information on third party suppliers of other coaxial transmission lines.

Accessories
Test port cables to connect fixture to network analyzer; adapters (as needed) to adapt cables to fixture; calibration kit to match connectors on fixture.

Free space antennas and accessories

Antennas
Contact HP for information on third party suppliers of free space antennas.

Accessories
Cables to connect antennas to network analyzer; adapters (as needed) to adapt cables to antennas; free space calibration standards

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For more information about Hewlett-Packard test and measurement products, applications, services, and for a current sales office listing, visit our web site, http://www.hp.com/go/tmdir. You can also contact one of the following centers and ask for a test and measurement sales representative.

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