

Keysight Technologies

Characterizing Coils in Wireless Charging Systems Using the Keysight E4980A/AL Precision LCR Meters

Application Note

- Wide impedance range to characterize inductance and quality factor
- High accuracy DCR measurements
- Fast measurement speed for manufacturing
- A wide variety of test fixtures to choose from

Overview

Continually new functionalities are being added to smart terminals and battery life is becoming one of the biggest headaches for users. The wireless charging technique gained a lot of attention due to its convenience and versatility compared to the portable power supply and cable power supply, and thus has become one of the best solutions in the market. Mobile devices, as one of the most popular application of wireless charging technology, requires even higher charging performance due to the long operation time.

This note describes how Keysight’s E4980A/AL precision LCR meters are suitable for characterizing the coils that are the most commonly used component in the wireless charging system.



Figure 1, E4980A Precision LCR meter

Coils in wireless charging systems

Several wireless charging standards are in use today, but generally all of them are using coils to create electromagnetic fields and transfer energy. Typically a wireless charging system consists of two sections: transmitter and receiver, between which the power and energy transfer can be achieved through the inductive coupling (Figure 2). Normally the transmission coil and the driver circuit are installed in a charging block, and the receiving coil and the related circuit is embedded in the devices that need to be charged, such as a smart phone etc. The power transfer efficiency is a key specification of a wireless charging system. It is affected by many factors, including the distance between the coils, parasitic of the inductors, how the coils are aligned and so on. For a single coil, minimal loss (low DCR) and parasitic (high Q) are desired during the design phase in most cases. The typical test parameters for the transmitter and receiver coils are L_s (series inductance), R_s (series resistance) and DCR (DC resistance). The test frequency is typically up to 1 MHz or higher.

The E4980A/AL precision LCR meter is the industry standard solution for LCR component measurements up to 2 MHz. It is well known and accepted by the component manufacturing market because of its most accurate and repeatable measurements, wide impedance range and fast measurement speed.

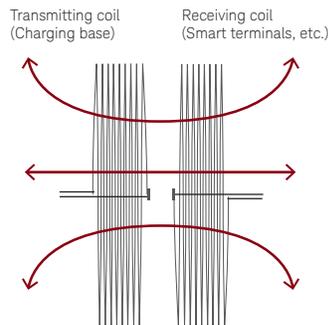


Figure 2. Wireless charging system

Standard DCR measurements with high accuracy

The DC resistance of the transmitter coil and receive coil will directly affect the resistive loss of the energy transfer, therefore low DCR (normally down to mΩ) is desired to ensure high power transfer efficiency.

DCR measurements is a standard function in the E4980A/AL precision LCR meters . DCR values down to mΩ can be measured very accurately. Meanwhile, the E4980A/AL supports low contact resistance fixtures such as 16047E and the fixture compensation function. If the DCR of the coil is 100 mΩ, the DCR accuracy of the E4980A/AL can be as good as 5%, which means the true value is approximately between 95 mΩ to 105 mΩ. This is considered very high accuracy due to the difficulty in low DCR measurements using LCR meters based on the auto balancing bridge method.

Wide impedance range for inductance and stable small ESR measurements

The inductance of transmitter and receiver coils is typically in μH range and tested above several tens of kHz frequency range. Therefore the impedance range is about mΩ to several Ωs. The E4980A/AL LCR meter offers excellent performance for wide impedance range, from 4 mΩ to 100 mΩ within 10% accuracy (Figure 2), which is perfectly suitable for coil measurements in wireless charging systems.

The equivalent series resistance (ESR) of the inductors is also desired to be small and stable to meet the low power consumption needs. The E4980A/AL provides exceptional measurement stability for ESR measurements (Figure 3).

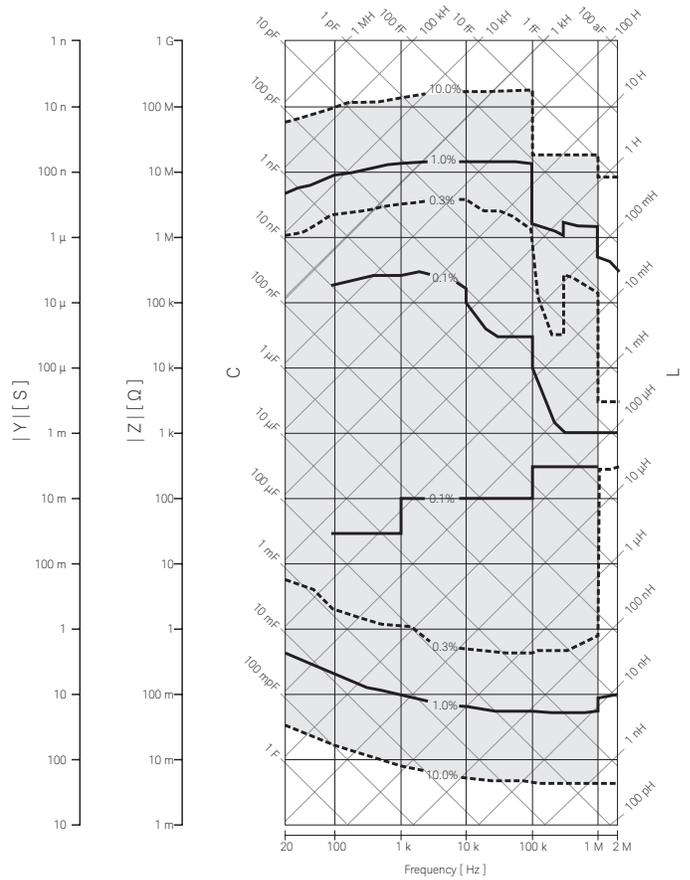


Figure 2. 10% impedance measurement accuracy range (test signal 1 Vrms, MED mode, cable 0 m)

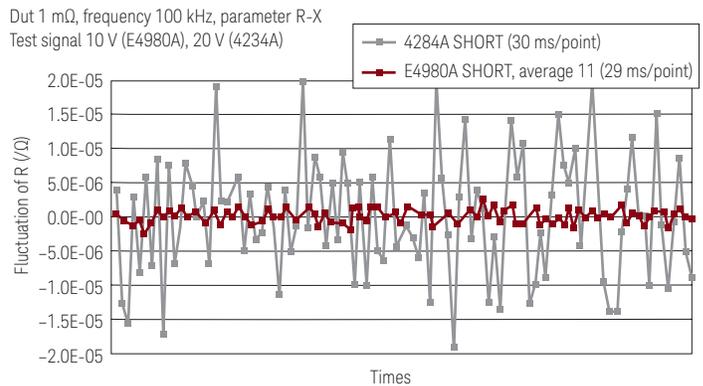


Figure 3. Low impedance evaluation (E4980A, 1 mΩ at 100 kHz)

Fast measurement speed increases production yields

A major concern for manufacturing is to improve throughput and reduce cost of test. The E4980A/AL features fast measurement speed that improves test productivity in both design and manufacturing. For E4980A, the measurement speed is as follows:

- 5.6 ms per point at 1 MHz with SHORT mode
- 88 ms per point at 1 MHz with MED mode
- 220 ms per point at 1 MHz with LONG mode

A wide variety of test fixtures to meet your needs

The E4980A/AL can be used with over twenty fixtures to meet a variety of evaluation needs; from materials to SMD components. The 16047 series lead type fixtures are the best fixtures to measure lead-type coils of low DCR and ESR. Also, built-in compensation functions in the E4980A/AL minimize the influence of test fixtures.

E4980A and E4980AL product comparison

Keysight offers multiple frequency options based on the E4980 platform to fit your application needs and budget. The key product specifications for the E4980A and E4980AL are listed in the table below.

	E4980AL	E4980A
Frequency	20 Hz to 300 kHz /500 kHz / 1 MHz	20 Hz to 2 MHz
Test signal level	0 to 2 Vrms /0 to 20 mArms	0 to 2 Vrms or 20 Vrms (Option 001) / 0 to 20 mArms or 100 mArms (Option 001)
Auto level control (ALC)	Yes	Yes
DC bias capability	Built-in 1.5 V, 2 V	1.5 V, 2 V or ± 40 V (Option 001)
Programmable list sweep	201 points	201 points
Remote control	GPIB, LAN, USB	GPIB, LAN, USB
Interface option	None	Handler (Option 201)/ Scanner (Option 301)
Parameters	Impedance, DCR	Impedance, DCR
Control commands	E4980A/4284A compatible	E4980A/4284A compatible
Basic accuracy	0.1% at Short 0.05% at MED/LONG	0.1% at Short 0.05% at MED/LONG
Measurement time mode	149 ms at 100 Hz 26 ms at 1 kHz 12 ms at 1 MHz Short mode	100 ms at 100 Hz 20 ms at 1 kHz 5.6 ms at 1 MHz Short mode
Storage devices	Internal/USB memory	Internal/USB memory
Cable length	0, 1, 2, 4 m	0, 1, 2, 4 m
Cabinet dimensions (mm)	370 (W) x 105 (H) x 390 (D)	370 (W) x 105 (H) x 390 (D)
Weight	5.3 kg	5.3 kg

Summary

The Keysight E4980A/AL precision LCR Meter is the industry standard LCR meter that provides highly accurate, repeatable high-speed measurements. It is the ideal measurement platform to test coils in wireless charging systems. The DC resistance measurement function with high DCR accuracy and low ESR measurement capabilities can improve test quality and productivity in both design and manufacturing.

Related literature

Keysight E4980A Brochure, 5989-4235EN

Keysight E4980AL Brochure, 5991-2305EN

Keysight E4980A/AL Data Sheet, 5989-4435EN

Keysight LCR Meters, Impedance Analyzers and Test Fixtures Selection Guide, 5952-1430

Keysight Technologies Impedance Measurement Handbook, 5950-3000

Web resources

www.keysight.com/find/e4980a

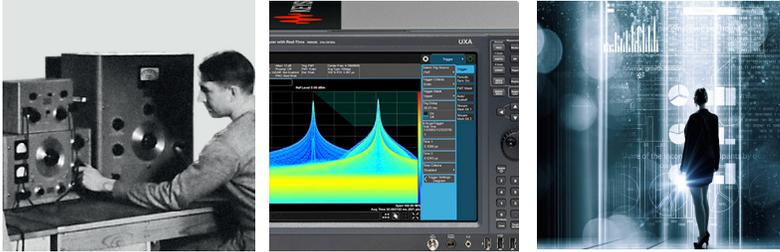
www.keysight.com/find/e4980al

www.keysight.com/find/impedance

Evolving Since 1939

Our unique combination of hardware, software, services, and people can help you reach your next breakthrough. We are unlocking the future of technology.

From Hewlett-Packard to Agilent to Keysight.



myKeysight

myKeysight

www.keysight.com/find/mykeysight

A personalized view into the information most relevant to you.

www.keysight.com/find/emt_product_registration

Register your products to get up-to-date product information and find warranty information.

KEYSIGHT SERVICES

Accelerate Technology Adoption.
Lower costs.

Keysight Services

www.keysight.com/find/service

Keysight Services can help from acquisition to renewal across your instrument's lifecycle. Our comprehensive service offerings—one-stop calibration, repair, asset management, technology refresh, consulting, training and more—helps you improve product quality and lower costs.



Keysight Assurance Plans

www.keysight.com/find/AssurancePlans

Up to ten years of protection and no budgetary surprises to ensure your instruments are operating to specification, so you can rely on accurate measurements.

Keysight Channel Partners

www.keysight.com/find/channelpartners

Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

www.keysight.com/find/e4980a

www.keysight.com/find/e4980al

www.keysight.com/find/impedance

For more information on Keysight Technologies' products, applications or services, please contact your local Keysight office. The complete list is available at:

www.keysight.com/find/contactus

Americas

Canada	(877) 894 4414
Brazil	55 11 3351 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 11 2626
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 6375 8100

Europe & Middle East

Austria	0800 001122
Belgium	0800 58580
Finland	0800 523252
France	0805 980333
Germany	0800 6270999
Ireland	1800 832700
Israel	1 809 343051
Italy	800 599100
Luxembourg	+32 800 58580
Netherlands	0800 0233200
Russia	8800 5009286
Spain	800 000154
Sweden	0200 882255
Switzerland	0800 805353
	Opt. 1 (DE)
	Opt. 2 (FR)
	Opt. 3 (IT)
United Kingdom	0800 0260637

For other unlisted countries:

www.keysight.com/find/contactus
(BP-9-7-17)

DEKRA Certified
ISO 9001 Quality Management System

www.keysight.com/go/quality

Keysight Technologies, Inc.
DEKRA Certified ISO 9001:2015
Quality Management System