Application Note

Frequency Response of PRS-330 and PRS-370s

The IET Labs PRS-330 and PRS-370 is designed for DC application but as well can be used for AC applications. The frequency response of the PRS will be shown for each decade below from 1 Ω to 100 kΩs. The frequency response was measuring using a 7600 Plus from 1 kHz to 1 MHz.

AC Resistance Measurements

The IET Labs 7600 Plus is extremely easy to use and provides excellent accuracy for AC resistance measurements over its frequency range (10Hz to 2 MHz). Unfortunately, many precision resistance measurements call for DC instead of AC, even though AC measurements avoid thermal voltage errors, have lower noise, and can use precise transformer-ratio scaling techniques.

For most resistors, the AC-DC difference is negligible at 100Hz or even 1 kHz. For flat-card wire-wound resistors, the difference can be less than 1ppm up to 1MΩ if equivalent parallel resistance is used at high values to avoid errors due to lumped parallel capacitance and series resistance is used at low values to avoid errors due to series inductance. Lower measurement frequencies should also be used for very low values to avoid skin effect errors. There are significant differences for high-value, coil-wound resistors, because of capacitance not inductance, and for high-value, multi-resistor networks such as decade boxes and build-up standards. The AC-DC difference of resistance standards are generally very small and often can be easily determined by measuring it, and a small metal film resistor of similar value at both AC and DC. Here the assumption is made that the film unit has negligible AC-DC difference (which it probably does) and that it was stable for the time required (which it usually will be if one doesn't heat it up by applying too much power or touching it). Once such differences are determined, AC could be used for precision calibrations.

Hz	Rs	Diff. from Nom.	Rs	Diff. from Nom.
	1 Ωs		5 Ωs	
100	1.00033	0.033%	5.00138	0.028%
1000	1.00051	0.051%	5.00170	0.034%
10000	1.00138	0.138%	5.00295	0.059%
100000	1.00640	0.640%	5.00858	0.172%
1000000	1.01007	1.007%	4.93281	-1.344%
2000000	0.961837	-3.816%	4.73939	-5.212%

IET LABS, INC.
534 Main Street, Westbury, NY 11590
www.ietlabs.com
TEL: (516) 334-5959 • (800) 899-8438 • FAX: (516) 334-5988

Hz	Rs 10 Ω	Diff. from Nom.	Rs 50 Ω	Diff. from Nom.
100	10.0025	0.025%	50.0006	0.001%
1000	10.0027	0.027%	50.0006	0.001%
10000	10.0045	0.045%	50.0045	0.009%
100000	10.0097	0.097%	49.9852	-0.030%
1000000	9.8367	-1.633%	48.8592	-2.282%
2000000	9.4743	-5.257%	47.2277	-5.545%

Hz	Rs 100 Ω	Diff. from Nom.	Rs 500 Ω	Diff. from Nom.
100	100.022	0.022%	500.116	0.023%
1000	100.036	0.036%	500.026	0.005%
10000	100.034	0.034%	500.019	0.004%
100000	99.986	-0.014%	498.062	-0.388%
1000000	95.583	-4.417%	367.964	-26.407%
2000000	90.111	-9.889%	319.861	-36.028%

Hz	Rs 1 kΩ	Diff. from Nom.	Rs 5 kΩ	Diff. from Nom.
1000	999.83	-0.017%	5000.87	0.017%
50000	999.59	-0.041%	5000.92	0.018%
100000	999.73	-0.027%	5004.31	0.086%
250000	984.72	-1.528%	5291.02	5.820%
500000	429.12	-57.088%	10217.40	104.348%
1000000	329.03	-67.097%	2430.94	-51.381%

Hz	Rs 10 kΩ	Diff. from Nom.	Rs 50 kΩ	Diff. from Nom.
1000	10002.4	0.024%	50014.8	0.030%
50000	10004.0	0.040%	50039.9	0.080%
100000	10020.9	0.209%	50660.3	1.321%
250000	11857.9	18.579%	92810.7	85.621%
500000	24508.6	145.086%	36594.8	-26.810%
1000000	816.2	-91.838%	-2541.5	-105.083%

IET LABS, INC.
534 Main Street, Westbury, NY 11590
www.ietlabs.com
TEL: (516) 334-5959 • (800) 899-8438 • FAX: (516) 334-5988

Hz	Rs	Diff. from Nom.	Rs	Diff. from Nom.
	100 kΩ		500 kΩ	
1000	100079	0.079%	499912	-0.018%
50000	100037	0.037%	499698	-0.060%
100000	99651	-0.349%	478350	-4.330%
250000	81031	-18.969%	82008	-83.598%
500000	13172	-86.828%	-21812	-104.362%
1000000	-4693	-104.693%	-5236	-101.047%

Hz	Rs	Diff. from Nom.	Rs	Diff. from Nom.
	100 kΩ		500 kΩ	
1000	100079	0.079%	499912	-0.018%
50000	100037	0.037%	499698	-0.060%
100000	99651	-0.349%	478350	-4.330%
250000	81031	-18.969%	82008	-83.598%
500000	13172	-86.828%	-21812	-104.362%
1000000	-4693	-104.693%	-5236	-101.047%

Hz	Rs	Diff. from Nom.	Rs	Diff. from Nom.
	1 MΩ		5 MΩ	
1000	997551	-0.245%	5039920	0.798%
50000	996083	-0.392%	5595300	11.906%
100000	779384	-22.062%	576921	-88.462%
250000	27424	-97.258%	1707	-99.966%
500000	7584	-99.242%	-10594	-100.212%
1000000	-9233	-100.923%	-19299	-100.386%

Summary

The IET Labs Model 7600 Plus is ideal for characterizing resistors across a wide frequency range. The 1693 model can be used for even more measurements in lower-level labs and for almost all RLC measurements when AC resistance measurements are acceptable, and frequencies measured are below 200 kHz. The PRS-330 and PRS-370 can be used as a standard for AC resistance. For most resistance values up to 1 kHz there is minimal change in resistance from nominal. Low resistance values perform the best at high frequencies due to relatively small values of series inductance. At higher resistance values the inductance increase causing increased errors for values up to 100 kΩ. Above 100 kΩ parallel capacitance is the main cause of error.

IET LABS, INC.
534 Main Street, Westbury, NY 11590
www.ietlabs.com
TEL: (516) 334-5959 • (800) 899-8438 • FAX: (516) 334-5988

For complete product specifications on the PRS-330 and PRS-370 family or any of IET Labs's products, visit us at http://www.IET Labs.com/products. Call us at 1-800-253-1230 or email your questions to info@IET Labs.com.

References:

Hill, J.J.: "Calibration of DC Resistance Standards and Voltage Ratio Boxes by an AC Method", Proc. IEEE Vol. 112 No.1, January 1965

IET LABS, INC.
534 Main Street, Westbury, NY 11590
www.ietlabs.com
TEL: (516) 334-5959 • (800) 899-8438 • FAX: (516) 334-5988