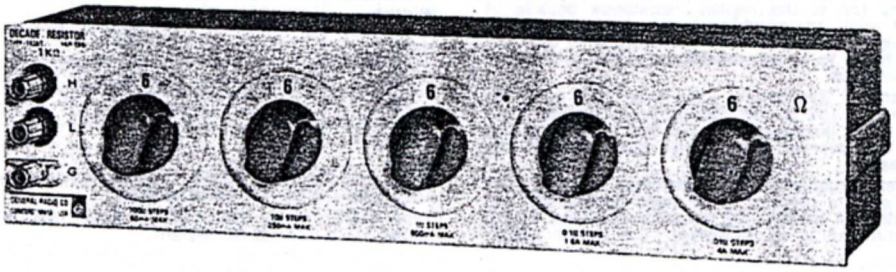
Type 1433 DECADE RESISTOR

- ±0.02% accuracy
- good frequency characteristics
- low temperature coefficient
- excellent stability
- low zero resistance



The 1433 Decade Resistors are primarily intended for precision measurement applications where their excellent accuracy, stability, and low zero resistance are important. They are convenient resistance standards for checking the accuracy of resistance-measuring devices and are used as components in dc and audio-frequency impedance bridges. Many of the models can be used up into the radio-frequency range. While they are also useful as substitution boxes for optimizing electronic circuitry, the less expensive Type 1434 Decade Resistors are recommended for such less exacting applications.

The individual decades (510 Decade-Resistance Units) are available for applications requiring only one decade or as components to be built into experimental equipment, production test equipment, or commercial instruments.

DESCRIPTION

The 1433 Decade Resistor is an assembly of 510 Decade-Resistance Units in a single cabinet. Mechanical as well as electrical shielding of the units and switch contacts is provided by the attractive aluminum cabinet and panel. The resistance elements have no electrical connection to the cabinet and panel, for which a separate shield terminal is provided.

Each Type 510 Decade-Resistance Unit is enclosed in an aluminum shield, and a knob and etched-metal dial plate are supplied. Each decade has ten resistors in series; the contacts in the lower-valued decades have a silver overlay to ensure stability of resistance, and all the decades have a silver contact on the zero setting to give low and constant zero resistance. Winding methods are chosen to reduce the effects of residual reactances.

— See **GR Experimenter** for November-December 1968.

specifications

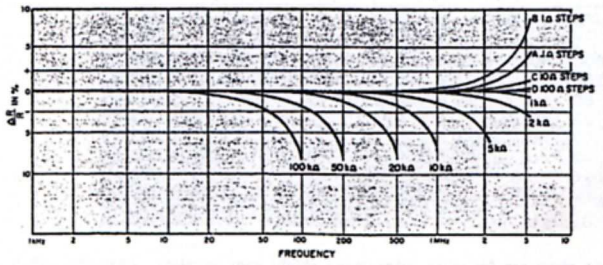
Long-Term Accuracy: Our two-year warranty applies to the tolerances given below unless the resistor is damaged by excessive current. These tolerances apply for low-current measurement at dc or low-frequency ac (see below).

Over-all Accuracy: The resistance difference between that at any setting and at the zero setting is equal to the indicated value ±(0.02% + 2 mΩ).

Incremental Accuracy: See table. This is the accuracy of the change in resistance between any two settings on the same dial.

Max Current: The max current for each decade is given in the table below and also appears on the panel of each decade box and on the dial plate of each decade resistance unit.

Frequency Characteristic: The accompanying plot shows the max percentage change in effective series resistance, as a function of frequency for the individual decade units. For low-resistance decades the error is due almost entirely to skin effect and is independent of switch setting, while for the high-resistance units the error is due almost entirely to the shunt capacitance and its losses and is approx proportional to the square of the resistance setting.



Max percentage change in series resistance as a function of frequency for Type 510 Decade-Resistance Units.

The high-resistance decades (510-E, -F, -G, and -H) are very commonly used as parallel resistance elements in resonant circuits, in which the shunt capacitance of the decades becomes part of the tuning capacitance. The parallel resistance changes by only a fraction (between a tenth and a hundredth) of the series-resistance change, depending on frequency and the insulating material in the switch.

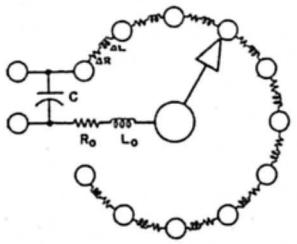
Characteristics of the 1433's are similar to those of the individual 510's modified by the increased series inductance, L_o, and shunt capacitance, C, due to the wiring and the presence of more than one decade in the assembly. At total resistance settings of approx 1000 ohms or less, the frequency characteristics of any of these decade resistors are substantially the same as those shown for the 510's. At higher settings, shunt capacitance becomes the controlling factor, and the effective value of this capacitance depends upon the settings of the individual decades.

Typical Values of R_o, L_o, and C for the Decade Resistors:

Zero Resistance (R_o): 0.001 Ω per dial at dc; 0.04 Ω per dial at 1 MHz; proportional to square root of frequency at all frequencies above 100 kHz.

Zero Inductance (L_o): 0.1 μH per dial + 0.2 μH.

Effective Shunt Capacitance (C): This value is determined largely by the highest decade in use. With the low terminal connected to the shield, a value of 15 to 10 pF per decade may be



Equivalent circuit of a resistance decade, showing location and nature of residual impedances.

assumed, counting decades down from the highest. Thus, if the third decade from the top is the highest resistance decade in circuit (i.e., not set at zero), the shunting terminal capacitance is 45 to 30 pF. If the highest decade in the assembly is in use, the effective capacitance is 15 to 10 pF, regardless of the settings of the lower-resistance decades.

Temperature Coefficient of Resistance: Less than ±10 ppm per degree C for values above 100 Ω and ±20 ppm per degree C for 100 Ω and below, at room temperatures. For the 1433's the box wiring will increase the over-all temperature coefficient of the 0.1- and 0.01-Ω decades.

Switches: Quadruple-leaf brushes bear on lubricated contact studs of ⅜-in. diameter in such a manner as to avoid cutting but yet give a good wiping action. A ball-on-cam detent is provided. There are eleven contact points (0 to 10 inclusive). The switch resistance is less than 0.0005 Ω. The effective capacitance is of the order of 5 pF, with a dissipation factor of 0.06 at 1 kHz for the standard cellulose-filled molded phenolic switch form and 0.01 on the mica-filled phenolic form used in the 510-G and 510-H units.

Max Voltage to Case: 2000 V pk.

Terminals: For 1433, low-thermal-emf jack-top binding posts on standard ¾-in. spacing; also provisions for rear-panel connections. Shield terminal is provided; 510's have soldering lugs.

Mounting: 1433's in lab-bench cabinet, rack models include mounting hardware; 510's complete with dial plate, knob, template, and mounting screws.

Dimensions and Weights: in. (mm), lb (kg):

	4-dial U, K, J, L, Q	5-dial T, N, M, P, Y	6-dial W, X, B, Z	7-dial F, G, H
Width*	12¼ (315)	14¾ (375)	17¼ (445)	
Height	3½ (89)			5¼ (135)
Depth	5 in. over-all, 4 in. behind panel			
Net Wt*	4¾ (2.2)	5¾ (2.7)	7 (3.2)	8¾ (4.0)
Ship. Wt*	5½ (2.5)	6½ (3.0)	8½ (3.9)	10¼ (4.7)

*Data given for bench models. All rack models same except 19 in. wide. Add approx 1 lb for rack-mount hardware.

Type 510's 3⅛ in. (78 mm) diameter, 3⅜ in. (85 mm) behind panel, 11 oz (0.4 kg) net weight.

Catalog Number				Ohms per Step	No. of Dials	Type 510 Decades Used
Bench	Rack	Type	Total Ohms			
1433-9700	1433-9701	1433-U	111.1	0.01	4	AA, A, B, C
1433-9702	1433-9703	1433-K	1111	0.1	4	A, B, C, D
1433-9704	1433-9705	1433-J	11,110	1	4	B, C, D, E
1433-9706	1433-9707	1433-L	111,100	10	4	C, D, E, F
1433-9708	1433-9709	1433-Q	1,111,000	100	4	D, E, F, G
1433-9710	1433-9711	1433-T	1111.1	0.01	5	AA, A, B, C, D
1433-9712	1433-9713	1433-N	11,111	0.1	5	A, B, C, D, E
1433-9714	1433-9715	1433-M	111,110	1	5	B, C, D, E, F
1433-9716	1433-9717	1433-P	1,111,100	10	5	C, D, E, F, G
1433-9718	1433-9719	1433-Y	11,111,000	100	5	D, E, F, G, H
1433-9720	1433-9721	1433-W	11,111.1	0.01	6	AA, A, B, C, D, E
1433-9722	1433-9723	1433-X	111,111	0.1	6	A, B, C, D, E, F
1433-9724	1433-9725	1433-B	1,111,110	1	6	B, C, D, E, F, G
1433-9726	1433-9728	1433-Z	11,111,100	10	6	C, D, E, F, G, H
1433-9729	1433-9730	1433-F	111,111.1	0.01	7	AA, A, B, C, D, E, F
1433-9731	1433-9732	1433-G	1,111,111	0.1	7	A, B, C, D, E, F, G
1433-9733	1433-9734	1433-H	11,111,110	1	7	B, C, D, E, F, G, H

Type 510 DECADE-RESISTANCE UNITS

Catalog Number	Type	Total Resistance Ohms	Resistance Per Step (ΔR) Ohms	Accuracy of Resistance Increments	Max Current 40° C Rise	Power Per Step Watts	ΔL μH	C** pF	L_o μH
0510-9806	510-AA	0.1	0.01	±2%	4 A	0.16	0.01	7.7–4.5	0.023
0510-9701	510-A	1	0.1	±0.4%	1.6 A	0.25	0.014	7.7–4.5	0.023
0510-9702	510-B	10	1	±0.1%	800 mA	0.6	0.056	7.7–4.5	0.023
0510-9703	510-C	100	10	±0.04%	250 mA	0.6	0.11	7.7–4.5	0.023
0510-9704	510-D	1000	100	±0.02%	80 mA	0.6	0.29	7.7–4.5	0.023
0510-9705	510-E	10,000	1000	±0.02%	23 mA	0.5	13	7.7–4.5	0.023
0510-9706	510-F	100,000	10,000	±0.02%	7 mA	0.5	70	7.7–4.5	0.023
0510-9707	510-G	1,000,000	100,000	±0.02%	2.3 mA	0.5	—	7.7–4.5	0.023
0510-9708	510-H	10,000,000	1,000,000	±0.02%	0.7* mA	0.5	—	7.5–4.5	0.023
0510-9604	510-P4	Switch only	(Black Phenolic Frame)						
0510-9511	510-P4L	Switch only	(Low-Loss Phenolic Frame)						

*Or a max of 4000 V, pk.

**The larger capacitance occurs at the highest setting of the decade. The values given are for units without the shield cans in place. With the shield cans in place, the shunt capacitance is from 0 to 20 pF greater than indicated here, depending on whether the shield is tied to the switch or to the zero end of the decade.